MONITORING REPORT
(VERSION – 03)

"Waste heat based 7MW Captive Power Project"
Reference no. UNFCCC 00000264-CDMP

Project Site:
Plot No. 428/2, Phase – I,
Industrial Area, Siltara, Raipur – 493111
Chattisgarh, India.

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Current Status of the Project

The 7 MW Waste Heat Recovery (WHR) Project at Godawari Power and Ispat Limited (GPIL) in Raipur, Chattisgarh, India was commissioned on 1st September 2002.

The project has been completed with major equipment supplied as follows:

Sl. No.	Equipment	Supplier
1	WHR Boiler # 1 (30 TPH)	M/s Thermal Systems (Hyderabad) Pvt. Ltd., Plot no. 01, Apoorupa Township, I.D.A., Jedimetla, Hyderabad – 500055.
2	WHR Boiler # 2 (54 TPH)	M/s Thermax Ltd., D1, Block, Plot No. 7/2, R D Aga Road, MIDC, Chinchwad Pune – 411019.
3	Turbo-generator (TG) Set # 1 (10 MW)	C.A. Parsons & Co. Limited, Newcastle, England (make).
4	TG Set # 2 (10 MW)	C.A. Parsons & Co. Limited, Newcastle, England (make).
5	TG Set # 3 (10 MW)	Hitachi, Ltd. Tokyo, Japan.
6	TG Set # 4 (30 MW)	Shandong Jinan Power Equipment Factory, The People Republic in China.
7	Balance of Plant	Cooling Water and Condensate Extraction pumps – Mather and Platt, Cooling Tower – Paharpur Cooling Towers, Boiler Feed Pumps – KSB, DCS - ABB.

The company provided the entire equity for the project and loans were raised from Canara Bank and State Bank of India.

Statement to what extent the project has been implemented as planned

The project has been completed as described in the Project Design Document (PDD).

The plant is in operation continuously (with outages – forced & planned) since 1st September 2002. The WHR boiler #1 is using waste heat of the flue gas from 350 tonnes per day (TPD) sponge iron kiln to produce steam. GPIL also installed another WHR boiler (viz. WHRB #2) which is utilizing waste heat of the flue gas from 500 tonnes per day (TPD) and two turbo-generators viz. TG #3 and TG #4. The four sets of turbo-generators are fed through a common steam header. The power thus generated is used to meet the in-house power demand as well as for wheeling to group companies.

After the first verification the following modifications have been undertaken at the project site by the project proponent and the monitoring has been done in line with the monitoring plan of the registered PDD.

(a) Installation of WHRB # 2

(b) Installation of TG # 3 and TG # 4.

(c) Replacement of electro mechanical energy meters with digital energy meters for TG # 1, TG # 2, TG # 3, Auxiliary Transformer Meter # 1, Auxiliary Transformer Meter # 2. During November 2006 all the three above-mentioned energy meters were changed to digital meters and as mentioned in the Monitoring Report accuracy of all the energy meters are now of 0.5s Class. Also, the meter reading multiplication factor for each of these energy meters was changed to 1000.

Monitoring Period

The monitoring period is from 1st January 2006 to 31st December 2006 (both days included).

Sustainability Issues

Environmental well-being: The project activity is a demonstration of clean technology implementation and does not by itself generate or release harmful gases. Hence, the project activity contributes to a better quality environment to the employees and the surrounding community. Being able to do away with equivalent grid power, GPIL has saved further depletion of natural resources like coal and gas in thermal power plants connected to the grid. The wastewater generated from the project activity is reused for sprinkling on roads and for green belt development. Ash from hoppers of Electrostatic Precipitator (ESP) and Air Pre Heater is collected in Ash Silo and sold to cement industries/ brick manufacturers.

GPIL regularly obtains the necessary environmental clearances from the Chattisgarh Environment Conservation Board (CECB).

Socio-economic well-being: The project activity has provided direct and indirect employment opportunities to the local people. The employees are given on-the-job training on power plant operation and maintenance for their skill development.

Obtained Parameters According To Monitoring Plan

Table 1: As mentioned in section D.2.1.3 of the PDD, following project related parameters are monitored:

ID No. (refer section D of PDD)	Data variable	Units	Recording Frequency	Measured (m), Calculated (c) or estimated (e)	Uncertainty Level
1. EG_{gen}	Total WHR (WHRB #1)electricity generated	kWh	Monthly	Calculated from measured data as shown in Table 2 below.	Low
2. EG_{aux}	Auxiliary consumption of Electricity from WHR sources	kWh	Monthly	Calculated from measured data as shown in Table 2 below.	Low
3. EG_y	Net WHR Electricity supplied	kWh	Monthly	Calculated (EG_{gen} - EG_{aux}.)	Low
4. EF_y	CO_2 Emission factor of the grid	tCO_2/ MWh	Once at the start of crediting period	Calculated ex-ante[1]	Low
5. $EF_{OM,y}$	CO2 operating margin emission factor of the grid	tCO2/ MWh	Once at the start of crediting period	Calculated	Low

[1] The combined margin emission factor is calculated ex – ante for the entire crediting period by considering three year average for Simple OM and Option -1 (ex–ante) for BM calculation as per guidelines in ACM0002.

6. $EF_{BM,y}$	CO2 Build Margin emission factor of the grid	tCO2/ MWh	Once at the start of crediting period	Calculated	Low
7. $F_{i,j,y}$	Amount of each fossil fuel consumed by each power source/ plant	t /year	Once at the start of crediting period	Calculated	Low
8. $COEF_{i,k}$	CO_2 emission coefficient of each fuel type and each power source/plant	tCO2/ t	Once at the start of crediting period	Calculated	Low
9. $GEN_{j,y}$	Electricity generation of each power source/plant	MWh/ year	Once at the start of crediting period	Calculated	Low

Table 2: As mentioned in Annex 4 of the PDD, following project related parameters are monitored:

ID No. (refer Table A4(1) to A4 (4) in Annex 4 of PDD)	Data variable	Units	Recording Frequency	Measured (m), Calculated (c) or estimated (e)	Accuracy level of measuring instrument	Uncertainty Level
1. Sgen	Total Steam generated from	tonnes per day	Daily	Differential Flow Meter with totalizer for individual boilers,	± 0.075% Full Scale	Low (DCS system generates error

	WHRB#1, WHRB#2 and FBC boiler			monitored through Distributed Control Systems (DCS).	Display (F.S.D)	messages, if any, for which corrective action is taken immediately)
2. Scons.	Steam Consumed by both TG # 1 , TG # 2, TG#3 and TG#4	tonnes per day	Daily	Differential Flow Meter with totalizer for individual steam turbines, monitored through DCS.	± 0.075% F.S.D.	Low (DCS system generates error messages, if any, for which corrective action is taken immediately)
3. Svent	Total Steam vented in the CPP	tonnes per day	Daily	Calculated (Sgen – Scons), if S_{WHR} < (Sgen – Scons) for a day, then Svent = S_{WHR}	-	Low
4. S_{WHR}	Flow of WHR Steam to Common header[2]	tonnes per day	Daily	Differential Flow Meter with totalizer, monitored through DCS. Same as Sgen above.	± 0.075% F.S.D.	Low (DCS system generates error messages, if any, for which corrective action is taken immediately)
5. S_1	Effective WHR Steam	tonnes per day	Daily	Calculated, (S_{WHR} – Svent)	-	Low
6. T_1	Avg. Temperature of WHR steam before Common	^{0}C	Daily	Resistance Temperature Detector (RTD) transmitter,	± 0.075% F.S.D.	Low (DCS system generates error

[2] ID.4. in Table 2 should read as - Flow of WHR steam 'to' and not 'from' common header as mentioned in PDD.

	header			monitored through DCS		messages, if any, for which corrective action is taken immediately)
7. P_1	Avg. Pressure of WHR steam before Common header	kg/cm^2	Daily	Pressure Transmitter, monitored through DCS.	± 0.075% F.S.D.	Low (DCS system generates error messages, if any, for which corrective action is taken immediately)
8. h_1	Enthalpy of WHR steam	kCal/kg	Daily	Estimated from Steam tables/ Mollier Diagram	-	Low
9. S_1	Flow of Effective WHR Steam to Common header	tonnes/day	Daily	Same as 5 above	-	Low
10. H_1	Enthalpy of Effective WHR Steam	kCal /day	Daily	Calculated (h_1 x S_1)	-	Low
11. T_2	Avg. Temperature of FBC steam before Common header	^0C	Daily	Resistance Temperature Detector (RTD) transmitter, monitored through DCS	± 0.075% F.S.D.	Low (DCS system generates error messages, if any, for which corrective action is taken immediately)

12. P_2	Avg. Pressure of FBC steam before Common header	kg/cm^2	Daily	Pressure Transmitter, monitored through DCS.	± 0.075% F.S.D.	Low (DCS system generates error messages, if any, for which corrective action is taken immediately)
13. h_2	Enthalpy of FBC steam	kCal/kg	Daily	Calculated from Steam tables/ Mollier Diagram.	-	Low
14. S_2	Flow of FBC Steam to Common header	tonnes per day	Daily	Differential Flow Meter with totalizer, monitored through DCS. Same as Sgen above	± 0.075% F.S.D.	Low
15. H_2	Enthalpy of FBC Steam	kCal /day	Daily	Calculated ($h_2 \times S_2$)	-	Low
16.$EG_{GEN\ CPP}$	Total electricity generated in the CPP	kWh	Monthly	Chattisgarh State Electricity Board (CSEB) monthly cess bills. The generation meters are calibrated and sealed by CSEB.[3]	As prescribed by CSEB standards	Low (since Main meter reading is regularly cross checked with Check meter reading for any deviation)
17. $EG_{AUX\ CPP}$	Total Auxiliary Consumption of the CPP	kWh	Daily	Auxiliary Energy Meter reading.	-	Low

[3] Although GPIL follows continuous monitoring of generation, the monthly CSEB cess bill records are considered for $EG_{GEN\ CPP}$.

18. EG_{GEN}	Waste Heat Recovery Based Power generated	kWh	Daily	Calculated.[4]	-	Low
19. EG_{AUX}	Auxiliary Electric Consumption (WHR)	kWh	Daily	Calculated. [5]	-	Low

The daily measured parameters given above are being recorded in the Daily Report by the Control Room Engineer at 6A.M. daily. In addition, data from DCS system can be obtained for the previous three days at any given point of time.

[4] Since the temperature and pressure ratings of both WHR and FBC boilers are same and readings found to be consistently identical during operation, steam flow is the only parameter affecting total enthalpy delivered from respective boilers. Hence, WHR power generation, EG_{GEN}, is calculated as a ratio $[H_1/ (H_1 + H_2)]$ of $EG_{GEN\ CPP}$. Now, H = h * (steam flow) Since the average enthalpy of the HP steam generated from WHRB#1 (h1), WHRB#2 (h2) and FBC boiler (h3) remain consistently same, the aproportioning of $EG_{GEN\ CPP}$ is being performed on the basis of steam flow. $EG_{GEN,\ WHRB\#1} = [S_1/ (S_1 + S_2)]\ EG_{GEN\ CPP}$

[5] Similar to EG_{GEN}, WHR auxiliary power consumption, EG_{AUX}, is calculated as a ratio $[S_1 / (S_1 + S_2)]$ of $EG_{AUX\ CPP}$

The equipment details along with the uncertainty analysis of the data for the monitoring parameters are given below:

Table- 1.1: Monitoring Parameters as per Registered Project Design Document	
Parameter 1: WHRB#1 Steam Flow	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	The data is continuously monitored at the DCS. The daily data of the same parameter obtained from the flow meter totalizer reading is recorded and maintained separately.
Data unit	tonnes/day
Recording frequency	Daily
Monitoring Equipment	Flow Meter
Specification of Monitoring Equipment	Tag No.: FT-002 Make: ABB Output: 4-20mADC Range: 2500 mmWc .
Calibration of Monitoring Equipment	The flow meter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate of the flow meter as well as of the master calibrator is available at the project site.
Accuracy of Monitoring Equipment	Accuracy: ± 0.075% of calculation span
Uncertainty of Data	Low
Justification	As the flow meters used is of standard make and regularly calibrated the parameter monitored is very accurate. Moreover, the continuous monitoring of the data is done through DCS system which produces error signal if any and corrective action is taken immediately.

Table- 1.2: Monitoring Parameters as per Registered Project Design Document	
Parameter 2: WHRB#1 Steam Temperature	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	The temperature is sensed through Resistance Temperature Detector (RTD) and monitored continuously through DCS. The daily data is

Table- 1.2: Monitoring Parameters as per Registered Project Design Document	
	also recorded and maintained separately.
Data unit	^{0}C
Recording frequency	Daily
Monitoring Equipment	Resistance Temperature Detector (RTD)
Specification of Monitoring Equipment	Tag No.: TI-006 Output: Resistance Range: 0-500 ^{0}C Accuracy: N.A.
Calibration of Monitoring Equipment	The RTD is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate of the RTD as well as of the master calibrator is available at the project site.
Accuracy of Monitoring Equipment	The RTD is calibrated regularly which reduces any chance of error in recording.
Uncertainty of Data	Low
Justification	As the RTD used is of standard make and regularly calibrated the accuracy of the data is high. Moreover, since the data is continuously monitored through DCS error signal is generated if any error occurs and corrective action is taken immediately.

Table- 1.3: Monitoring Parameters as per Registered Project Design Document	
Parameter 3: WHRB#1 Steam Pressure	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	The pressure is sensed through Pressure Transmitter and monitored continuously through DCS. The daily data is also recorded and maintained separately
Data unit	Kg/cm^2
Recording frequency	Daily
Monitoring Equipment	Pressure Transmitter
Specification of Monitoring Equipment	Tag No.: PT-003 Make: ABB Output: 4-20mADC Range: 0-40 kg/cm^2
Calibration of Monitoring Equipment	The pressure transmitter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate of the pressure transmitter as well as of the master calibrator is available at the project site.

Table- 1.3: Monitoring Parameters as per Registered Project Design Document	
Accuracy of Monitoring Equipment	Accuracy: 0.075% of calculation span.
Uncertainty of Data	Low
Justification	As the pressure transmitter used is of standard make and regularly calibrated the parameter monitored is very accurate.

Table- 1.4: Monitoring Parameters as per Registered Project Design Document	
Parameter 4: WHRB#2 Steam Flow	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	The data is continuously monitored at the DCS. The daily data of the same parameter obtained from the flow meter totalizer reading is recorded and maintained separately.
Data unit	tonnes/day
Recording frequency	Daily
Monitoring Equipment	Flow Meter
Specification of Monitoring Equipment	Tag No.: FT-727 Make: Tata Honeywell Output: 4-20mADC Range: 10000 mmWc
Calibration of Monitoring Equipment	The flow meter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate of the flow meter as well as of the master calibrator is available at the project site.
Accuracy of Monitoring Equipment	Accuracy: ± 0.075% of calculation span.
Uncertainty of Data	Low
Justification	As the flow meters used is of standard make and regularly calibrated the parameter monitored is very accurate. Moreover, the continuous monitoring of the data is done through DCS system which produces error signal if any and corrective action is taken immediately.

Table- 1.5: Monitoring Parameters as per Registered Project Design Document
Parameter 5: WHRB#2 Steam Temperature

Table- 1.5: Monitoring Parameters as per Registered Project Design Document	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	The temperature is sensed through Resistance Temperature Detector (RTD) and monitored continuously through DCS. The daily data is also recorded and maintained separately.
Data unit	^{0}C
Recording frequency	Daily
Monitoring Equipment	Resistance Temperature Detector (RTD)
Specification of Monitoring Equipment	Tag No.: TT-728 Make: Tata Honeywell Output: 4-20mADC Range: 0-500 ^{0}C
Calibration of Monitoring Equipment	The RTD is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate of the RTD as well as of the master calibrator is available at the project site.
Accuracy of Monitoring Equipment	Accuracy: ± 0.075% of calculation span.
Uncertainty of Data	Low
Justification	As the RTD used is of standard make and regularly calibrated the accuracy of the data is high. Moreover, since the data is continuously monitored through DCS error signal is generated if any error occurs and corrective action is taken immediately.

Table- 1.6: Monitoring Parameters as per Registered Project Design Document	
Parameter 6: WHRB#2 Steam Pressure	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	The pressure is sensed through Pressure Transmitter and monitored continuously through DCS. The daily data is also recorded and maintained separately
Data unit	Kg/cm^2
Recording frequency	Daily
Monitoring Equipment	Pressure Transmitter
Specification of Monitoring Equipment	Tag No.: PT-726 Make: Tata Honeywell Output: 4-20mADC

Table- 1.6: Monitoring Parameters as per Registered Project Design Document	
	Range: 0-60 kg/cm^2
Calibration of Monitoring Equipment	The pressure transmitter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate is available at the project site.
Accuracy of Monitoring Equipment	Accuracy: 0.075% of calculation span.
Uncertainty of the data	Low
Justification	As the pressure transmitter used is of standard make and regularly calibrated the parameter monitored is very accurate. Moreover, the data is monitored through DCS which generates error signal if any and corrective action is taken immediately.

Table- 1.7: Monitoring Parameters as per Registered Project Design Document	
Parameter 7: FBC Steam Flow	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	The data is continuously monitored at the DCS. The daily data of the same parameter obtained from the flow meter totalizer reading is recorded and maintained separately.
Data unit	tonnes/day
Recording frequency	Daily
Monitoring Equipment	Flow Meter
Specification of Monitoring Equipment	Tag No.: FT-302 Make: ABB Output: 4-20mADC Range: 5000 mmWc
Calibration of Monitoring Equipment	The flow meter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate of the flow meter as well as of the master calibrator is available at the project site
Accuracy of Monitoring Equipment	Accuracy: ± 0.075% of calculation span..
Uncertainty of Data	Low
Justification	As the flow meters used is of standard make and regularly calibrated the parameter monitored is very accurate. Moreover, the continuous monitoring of the data is done

Table- 1.7: Monitoring Parameters as per Registered Project Design Document	
	through DCS system which produces error signal if any and corrective action is taken immediately.

Table- 1.8: Monitoring Parameters as per Registered Project Design Document	
Parameter 8: FBC Steam Temperature	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	The temperature is sensed through Resistance Temperature Detector (RTD) and monitored continuously through DCS. The daily data is also recorded and maintained separately.
Data unit	^{0}C
Recording frequency	Daily
Monitoring Equipment	Resistance Temperature Detector (RTD)
Specification of Monitoring Equipment	Tag No.: TI-305 Output: Resistance Range: 0-500 ^{0}C
Calibration of Monitoring Equipment	The RTD is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate of the RTD as well as of the master calibrator is available at the project site.
Accuracy of Monitoring Equipment	The RTD is calibrated regularly to reduce errors.
Uncertainty of Data	Low
Justification	As the RTD used is of standard make and regularly calibrated the accuracy of the data is high. Moreover, since the data is continuously monitored through DCS error signal is generated if any error occurs and corrective action is taken immediately.

Table- 1.9: Monitoring Parameters as per Registered Project Design Document	
Parameter 9: FBC Steam Pressure	
Parameter	**Description**
Measured, Calculated, Estimated	Measured

Table- 1.9: Monitoring Parameters as per Registered Project Design Document	
Source of Data	The pressure is sensed through Pressure Transmitter and monitored continuously through DCS. The daily data is also recorded and maintained separately.
Data unit	Kg/cm^2
Recording frequency	Daily
Monitoring Equipment	Pressure Transmitter
Specification of Monitoring Equipment	Tag No.: PT-303 Make: ABB Output: 4-20mADC Range: 0-40 kg/cm^2
Calibration of Monitoring Equipment	The pressure transmitter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate is available at the project site.
Accuracy of Monitoring Equipment	Accuracy: 0.075% of calculation span.
Uncertainty of Data	As the flow meters used is of standard make and regularly calibrated the parameter monitored is very accurate. Moreover, the continuous monitoring of the data is done through DCS system which produces error signal if any and corrective action is taken immediately.

Table- 1.10: Monitoring Parameters as per Registered Project Design Document	
Parameter 10: TG#1 Inlet Steam Flow	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	The data is continuously monitored at the DCS. The daily data of the same parameter obtained from the flow meter totalizer reading is recorded and maintained separately.
Data unit	tonnes/day
Recording frequency	Daily
Monitoring Equipment	Flow Meter
Specification of Monitoring Equipment	Tag No.: FT-602 Make: ABB Output: 4-20mADC Range: 5000 mmWc
Calibration of Monitoring Equipment	The flow meter is calibrated regularly according to the calibration schedule (four times a year).

Table- 1.10: Monitoring Parameters as per Registered Project Design Document	
	The calibration certificate of the flow meter as well as of the master calibrator is available at the project site.
Accuracy of Monitoring Equipment	Accuracy: ± 0.075% of calculation span.
Uncertainty of Data	Low
Justification	As the flow meters used is of standard make and regularly calibrated the parameter monitored is very accurate. Moreover, the continuous monitoring of the data is done through DCS system which produces error signal if any and corrective action is taken immediately.

Table- 1.11: Monitoring Parameters as per Registered Project Design Document	
Parameter 11: TG#1 Electricity Generation	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	Log-book maintained at the plant
Data unit	kWh
Recording frequency	Daily
Monitoring Equipment	Energy Meter
Specification of Monitoring Equipment	Tag No.: MSE-64365 Make: SEMS Output: 11KV/110 volt Range: 800/1 Amp
Calibration of Monitoring Equipment	The energy meter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate of the flow meter as well as of the master calibrator is available at the project site
Accuracy of Monitoring Equipment	0.5s Class
Uncertainty of Data	Low
Justification	As the energy meter used is of standard make and regularly calibrated the parameter monitored is very accurate. A check meter has also been installed to maintain accuracy of the data.
Modification	Old energy meter (SIMCO make Sr. No. 195678) have been replaced with the New energy meter (SEMS make Sr. No. MSE-64365) tested by MRT-1 C.S.E.B. Seal No.

Table- 1.11: Monitoring Parameters as per Registered Project Design Document	
	MT23559 CSEB EE/0329269SEMS NIC. Replaced on 22nd November 2006.

Table- 1.12: Monitoring Parameters as per Registered Project Design Document	
Parameter 12: TG#2 Inlet Steam Flow	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	The data is continuously monitored at the DCS. The daily data of the same parameter obtained from the flow meter totalizer reading is recorded and maintained separately
Data unit	tonnes/day
Recording frequency	Daily
Monitoring Equipment	Flow Meter
Specification of Monitoring Equipment	Tag No.: FT-603 Make: ABB Output: 4-20mADC Range: 5000 mmWc
Calibration of Monitoring Equipment	The flow meter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate of the flow meter as well as of the master calibrator is available at the project site.
Accuracy of Monitoring Equipment	Accuracy: ± 0.075% of calculation span.
Uncertainty of Data	As the flow meters used is of standard make and regularly calibrated the parameter monitored is very accurate. Moreover, the continuous monitoring of the data is done through DCS system which produces error signal if any and corrective action is taken immediately.

Table- 1.13: Monitoring Parameters as per Registered Project Design Document	
Parameter 13: TG#2 Electricity Generation	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	Log-book maintained at the plant
Data unit	KWh

Table- 1.13: Monitoring Parameters as per Registered Project Design Document	
Recording frequency	Daily
Monitoring Equipment	Energy Meter
Specification of Monitoring Equipment	Tag No.: MSE-64364 Make: SEMS Output: 11KV/110 volt Range: 800/1 Amp
Calibration of Monitoring Equipment	The energy meter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate of the flow meter as well as of the master calibrator is available at the project site
Accuracy of Monitoring Equipment	0.5s Class
Uncertainty of Data	Low
Justification	As the energy meter used is of standard make and regularly calibrated the parameter monitored is very accurate. A check meter has also been installed to maintain accuracy of the data.
Modification	Old energy meter (SIMCO make Sr. No. 195667) have been replaced with the New energy meter (SEMS make Sr. No. MSE-64364) tested by MRT-1 C.S.E.B. Seal No. MT23558 CSEB EE/0329261SEMS NIC. Replaced on 05th November 2006.

Table- 1.14: Monitoring Parameters as per Registered Project Design Document	
Parameter 14: TG#3 Inlet Steam Flow	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	The data is continuously monitored at the DCS. The daily data of the same parameter obtained from the flow meter totalizer reading is recorded and maintained separately
Data unit	tonnes/day
Recording frequency	Daily
Monitoring Equipment	Flow Meter
Specification of Monitoring Equipment	Tag No.: FT-401 Make: Tata Honeywell Output: 4-20mADC

Table- 1.14: Monitoring Parameters as per Registered Project Design Document	
	Range: 10000 mmWc
Calibration of Monitoring Equipment	The flow meter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate of the flow meter as well as of the master calibrator is available at the project site.
Accuracy of Monitoring Equipment	Accuracy: ± 0.075% of calculation span.
Uncertainty of Data	Low
Justification	As the flow meters used is of standard make and regularly calibrated the parameter monitored is very accurate. Moreover, the continuous monitoring of the data is done through DCS system which produces error signal if any and corrective action is taken immediately.

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Table- 1.15: Monitoring Parameters as per Registered Project Design Document ... [1]

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Table- 1.15: Monitoring Parameters as per Registered Project Design Document	
Parameter 15: TG#3 Electricity Generation	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	Log-book maintained at the plant
Data unit	kWh
Recording frequency	Daily
Monitoring Equipment	Energy Meter
Specification of Monitoring Equipment	Tag No.: MSE-64366 Make: SEMS Output: 11KV/110 volt Range: 800/1 Amp
Calibration of Monitoring Equipment	The energy meter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate of the flow meter as well as of the master calibrator is available at the project site
Accuracy of Monitoring Equipment	0.5s Class
Uncertainty of Data	Low
Justification	As the energy meter used is of standard make and regularly calibrated the parameter monitored is very accurate. A check meter has also been installed to maintain accuracy of the data.

Table- 1.15: Monitoring Parameters as per Registered Project Design Document	
Modification	Old energy meter (SIMCO make Sr. No. 3511213642) have been replaced with the New energy meter (SEMS make Sr. No. MSE-64366) tested by MRT-1 C.S.E.B. Seal No. MT23557 CSEB EE/0329264SEMS NIC. Replaced on 08th October 2006.

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Table- 1.16: Monitoring Parameters as per Registered Project Design Document	
Parameter 16: TG#4 Inlet Steam Flow	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	The data is continuously monitored at the DCS. The daily data of the same parameter obtained from the flow meter totalizer reading is recorded and maintained separately. In TG#4 this flow meter is located before the line bifurcation takes place for auxiliary steam flow and therefore this data measures the sum of TG#4 net inlet steam flow and TG#4 auxiliary steam flow.
Data unit	tonnes/day
Recording frequency	Daily
Monitoring Equipment	Flow Meter
Specification of Monitoring Equipment	Tag No.: FT-001 Make: Tata Honeywell Output: 4-20mADC Range: 5000 mmWc
Calibration of Monitoring Equipment	The flow meter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate of the flow meter as well as of the master calibrator is available at the project site.
Accuracy of Monitoring Equipment	Accuracy: ± 0.075% of calculation span.
Uncertainty of Data	Low
Justification	As the flow meters used is of standard make and regularly calibrated the parameter monitored is very accurate. Moreover, the continuous monitoring of the data is done through DCS system which produces error signal if any and corrective action is taken immediately.

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Table- 1.17: Monitoring Parameters as per Registered Project Design Document	
Parameter 17: TG#4 Auxiliary Steam Flow	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	The data is continuously monitored at the DCS. The daily data of the same parameter obtained from the flow meter totalizer reading is recorded and maintained separately
Data unit	Tonnes/day
Recording frequency	Daily
Monitoring Equipment	Flow Meter
Specification of Monitoring Equipment	Tag No.: FT-406 Make: Tata Honeywell Output: 4-20mADC Range: 10000 mmWc
Calibration of Monitoring Equipment	The flow meter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate is available at the project site.
Accuracy of Monitoring Equipment	Accuracy: ± 0.075% of calculation span.
Uncertainty of Data	Low
Justification	As the flow meters used is of standard make and regularly calibrated the data monitored is accurate.

Table- 1.18: Monitoring Parameters as per Registered Project Design Document	
Parameter 18: TG#4 Electricity Generation	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	Log-book maintained at the plant
Data unit	KWh
Recording frequency	Monthly
Monitoring Equipment	Energy Meter
Specification of Monitoring Equipment	Tag No.: MSE-64369 Make: SEMS Output: 11KV/110 volt Range: 2500/1 Amp
Calibration of Monitoring Equipment	The energy meter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate of the flow meter as well as of the master calibrator is

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Table- 1.18: Monitoring Parameters as per Registered Project Design Document	
	available at the project site
Accuracy of Monitoring Equipment	0.5s Class
Uncertainty of Data	Low
Justification	As the energy meter used is of standard make and regularly calibrated the parameter monitored is very accurate. A check meter has also been installed to maintain accuracy of the data.

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Table- 1.19: Monitoring Parameters as per Registered Project Design Document	
Parameter 19: Power Plant Auxiliary Electricity Consumption	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	Log-book maintained at the plant
Data unit	kWh
Recording frequency	Daily
Monitoring Equipment	Energy Meter for Auxiliary Transformer 1.
Specification of Monitoring Equipment	Tag No.: MSE-64368 Make: SEMS Output: 11 KV/110 Volt Range: 200/1 Amp
Calibration of Monitoring Equipment	The energy meter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate of the flow meter as well as of the master calibrator is available at the project site
Accuracy of Monitoring Equipment	0.5s Class
Uncertainty of Data	Low
Justification	As the energy meter used is of standard make and regularly calibrated the parameter monitored is very accurate. A check meter has also been installed to maintain accuracy of the data.
Modification	Old energy meter (DUCATI make Sr. No. 27/020290) have been replaced with the New energy meter (SEMS make Sr. No. MSE-64368) tested by MRT-1 C.S.E.B. Seal No. MT23560 CSEB EE/0329272SEMS NIC. Replaced on 31st October 2006.

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Table- 1.20: Monitoring Parameters as per Registered Project Design Document	
Parameter 20: Power Plant Auxiliary Electricity Consumption	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	Log-book maintained at the plant
Data unit	kWh
Recording frequency	Daily
Monitoring Equipment	Energy Meter for Auxiliary Transformer 2.
Specification of Monitoring Equipment	Tag No.: MSE-64367 Make: SEMS Output: 11KV/110 Volt Range: 200/1 Amp
Calibration of Monitoring Equipment	The energy meter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate of the flow meter as well as of the master calibrator is available at the project site
Accuracy of Monitoring Equipment	0.5s Class
Uncertainty of Data	Low
Justification	As the energy meter used is of standard make and regularly calibrated the parameter monitored is very accurate. A check meter has also been installed to maintain accuracy of the data.
Modification	Old energy meter (ENERCON make Sr. No. E34/576-503) have been replaced with the New energy meter (SEMS make Sr. No. MSE-64367) tested by MRT-1 C.S.E.B. Seal No. MT23556 CSEB EE/0329279SEMS NIC. Replaced on 31st October 2006.

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Calculation of WHR Power Generation

Month wise data on waste heat power generated is placed two steps below.

Table 1A: Calculation of Effective WHR Steam Flow is shown in the Table below

CALCULATION OF EFFECTIVE WHR STEAM											
	a	b	c	d	e	f	g	h	i	j	k
Month	WHR # 1 Steam Generation	FBC Steam Generation	WHR # 2 Steam Generation	Total Steam Generation (a+b+c)	TG # 1 Steam Consumption	TG # 2 Steam Consumption	TG # 3 Steam Consumption	Net Steam Consumed in TG # 4*	Total Steam Consumption (e+f+g+h)	Vent Steam from WHR # 1	Effective WHR # 1 Steam
Jan, 06	11850	40467	18165	70482	20578	23229	24884	0	68691	1791	10059
Feb, 06	13795	27033	20367	61195	14492	22075	23883	0	60450	745	13050
Mar, 06	15303	24784	17443	57530	11117	19955	23590	0	54662	2868	12435
April, 06	14189	45151	19292	78632	30194	26413	19786	0	76393	2239	11950
May, 06	14708	45477	23899	84084	29958	27193	26151	0	83302	782	13926
Jun, 06	3257	44021	24237	71515	30068	16975	23676	0	70719	796	2461
July, 06	13933	44640	7756	66329	32583	20063	13465	0	66111	218	13715
Aug, 06	14645	39884	6621	61150	24443	18646	15381	0	58470	2680	11965
Sep, 06	13189	45783	13976	72948	31251	19398	20336	0	70985	1963	11226
Oct, 06	9198	49400	29234	87832	34987	24032	28703	0	87722	110	9088
Nov, 06	15490	45967	27606	89063	29926	24995	27803	5965	88689	374	15116
Dec, 06	14674	46961	22959	84594	6449	4963	9600	62807	83819	775	13899
Total	**154231**	**499568**	**231555**	**885354**	**296046**	**247937**	**257258**	**68772**	**870013**	**15341**	**138890**

Deleted: Steam Consumption

* Please refer to table (1.b) for Calculation of the Net Steam Consumed in the TG#4

Table 1.B: Calculation of the Net Steam consumed in TG#4

TG # 4 Steam Consumption	Auxiliary Steam Consumption in TG#4	Net Steam Consumed in TG#4
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
6032	67	5965
63002	195	62807
69034	**263**	**68772**

Table 2.B: Calculation of Waste Heat Based Power Generation for the monitoring period is provided below[6]:

	l	m	n	o	p	q	r
Month	Generation (kWh)				Gross Generation [TG#1+TG#2+ TG # 3+ TG # 4] (kWh) (l+m+n+o)	Auxiliary Consumption (kWh)	Net Generation (kWh) (p-q)
	TG#1	TG#2	TG#3	TG#4			
Jan, 06	4072480	4397600	5731456		14201536	1460115	12741421
Feb, 06	2968160	3976800	5158784		12103744	1086280	11017464
Mar, 06	2115040	3498560	5170064		10783664	1174585	9609079
April, 06	6170560	4561920	4048656		14781136	1504445	13276691
May, 06	6102720	5025600	5796080		16924400	1738020	15186380
Jun, 06	6134400	2827040	5038640		14000080	1646785	12353295
July, 06	6247680	3615040	2891840		12754560	1478800	11275760
Aug, 06	4936320	3465280	3344000		11745600	1482025	10263575
Sep, 06	5836160	2919680	4065120		12820960	1654095	11166865
Oct, 06	7083840	4174880	6383816		17642536	1771415	15871121
Nov, 06	6007520	4293000	5904800		16205320	1870350	14334970
Dec, 06	1331700	850500	2161700	14423200	18767100	1903367	16863733
Total	**59006580**	**43605900**	**55694956**	**14423200**	**172730636**	**18770282**	**153960354**

[6] Net WHR#1 power supplied is calculated through enthalpy apportioning method as mentioned in the registered PDD.

	A	B	C	D	E	F	G	H
Month	Enthalpy of WHR#1 steam (kcal/kg)	Enthalpy of FBC steam (kcal/kg)	Enthalpy ofWHR#2 steam (kcal/kg)	Total enthalpy of WHR#1 steam (Kcal) (A x a)	Total Enthalpy of FBC steam (kcal) (B x b)	Total enthalpy of WHR#2 steam (kcal) (C x c)	Total Enthalpy (kcal) (D + E +F)	Net WHR #1 Power Supplied (kWh) [D/G*Egnet]
Jan, 06	773.3	775.8	771.5	7778979330.2	31393144610.7	14014227412.0	53186351352.9	1863546.72
Feb, 06	773.8	774.8	772.4	10098258956.0	20944957948.4	15731547298.7	46774764203.0	2378573.284
Mar, 06	772.1	774.2	771.0	9601276647.5	19187651364.8	13448458200.8	42237386213.1	2184307.176
April, 06	770.6	773.1	770.9	9209103741.4	34906075968.2	14872644807.3	58987824516.9	2072740.023
May, 06	769.7	771.3	770.8	10718243774.2	35077726634.6	18420290935.6	64216261344.3	2534736.833
Jun, 06	772.5	771.7	771.2	1901003203.5	33969391613.7	18691226403.2	54561621220.4	430406.0774
July, 06	769.4	771.4	769.0	10552897946.8	34437455344.4	5964087692.9	50954440984.1	2335261.505
Aug, 06	772.4	773.1	771.5	9241810940.7	30834177181.3	5108234093.3	45184222215.3	2099273.044
Sep, 06	771.4	773.8	771.7	8660011300.3	35427478144.3	10784766752.1	54872256196.6	1762369.252
Oct, 06	771.1	773.9	772.4	7008100987.5	38228719370.4	22580451403.2	67817271761.1	1640089.845
Nov, 06	772.1	774.0	773.0	11670961662.8	35579740853.0	21338143322.2	68588845838.1	2439214.179
Dec, 06	768.9	772.7	769.7	10687171905.0	36287434161.0	17672200808.4	64646806874.4	2787850.201
Total	**771.5**	**773.3**	**771.2**	**107127820395.8**	**386273953194.7**	**178626279129.6**	**672028052720.1**	**24528368.14**

Table 3: Average Temperature and Pressure of the HP steam produced from WHRB#1, WHRB#2 and FBC

(Monthly average is calculated based on the daily data, Source: Daily Report)

Temperature and Pressure						
Month	WHRB#1		FBC		WHRB#2	
	Temperature (^oC)	Pressure (kg/cm^2)abs	Temperature (^oC)	Pressure (kg/cm^2)abs	Temperature (^oC)	Pressure (kg/cm^2)abs
Jan'06	406.1	35.3	410.9	35.9	402.6	35.0
Feb'06	407.3	35.8	409.2	36.0	404.8	35.8
Mar'06	404.0	35.4	408.2	36.1	401.7	35.0
Apr'06	401.5	35.6	406.1	35.9	402.0	35.6
May'06	399.8	35.7	403.0	36.0	401.9	35.9
Jun'06	404.6	35.4	403.4	35.7	402.3	35.4
Jul'06	399.5	35.8	403.3	36.1	398.8	36.0
Aug'06	404.7	35.7	406.3	36.2	403.0	35.5
Sep'06	402.9	35.6	407.6	36.2	403.3	35.6
Oct'06	402.6	35.9	407.6	36.1	404.7	35.7
Nov'06	404.3	35.9	407.9	36.1	405.7	35.7
Dec'06	398.4	35.6	405.5	36.0	399.7	35.4
Average	403.0	35.6	406.6	36.0	402.5	35.6

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Table 4: Average Enthalpy of WHRB#1, FBC and the WHRB#2 (Calculated from the Monthly Average Temperature and Pressure)

Month	Enthalpy (KCal/Kg)		
	WHRB#1	FBC	WHRB#2
Jan'06	773.3	775.8	771.5
Feb'06	773.8	774.8	772.4
Mar'06	772.1	774.2	771.0
Apr'06	770.6	773.1	770.9
May'06	769.7	771.3	770.8
Jun'06	772.5	771.7	771.2
Jul'06	769.4	771.4	769.0
Aug'06	772.4	773.1	771.5
Sep'06	771.4	773.8	771.7
Oct'06	771.1	773.9	772.4
Nov'06	772.1	774.0	773.0
Dec'06	769.0	772.7	770.0
Average	771.5	773.3	771.2

Emission Reductions

Baseline Emissions:

Carbon dioxide emission factor

as per the baseline adopted (kg CO_2/ kWh) = 0.75861

Net WHR Power Supplied (kWh) = **24528368.14**

Baseline emissions (tonnes of CO_2 equivalent) = 18607.5

Project Emissions:

Project Emissions (tonnes of CO_2 e) = NIL

Emission Reductions:

Baseline emissions – Project emissions = 18607.5 – NIL

= 18607 tonnes of CO_2 e

Measures to ensure the results/uncertainty analysis

As per requirement of Chattisgarh Government, cess is to be paid for captive power generation. The monthly cess bill, which is based on joint generation meter readings by both CSEB and GPIL personnel, is used to arrive at the power generation figures in the CPP. These generation meters are sealed and calibrated by CSEB. Further, GPIL annually undertakes calibration of auxiliary consumption meters, steam flow meters, pressure and temperature transmitters by government certified agencies so that the accuracy of measurement is ensured all the time.

Moreover, GPIL regularly undertakes Internal Audits to determine whether the GHG abatement project conforms to the planned arrangements of the monitoring methodology and plan (including other criteria related to GHG performance parameters). The audit report provides information on results of audits and recommends improvements to GPIL management. All these measures ensure that uncertainty levels for all parameters are low.

Roles & Responsibilities

In the complete implementation and monitoring plan referred above, GPIL is the sole agency responsible for implementation and monitoring.

Table- 1.15: Monitoring Parameters as per Registered Project Design Document

Parameter 15: TG#3 Auxiliary Steam Flow	
Parameter	**Description**
Measured, Calculated, Estimated	Measured
Source of Data	The data is continuously monitored at the DCS. The daily data of the same parameter obtained from the flow meter totalizer reading is recorded and maintained separately
Data unit	tonnes/day
Recording frequency	Daily
Monitoring Equipment	Flow Meter
Specification of Monitoring Equipment	Tag No.: FT-406 Make: Tata Honeywell Output: 4-20mADC Range: 10000 mmWc
Calibration of Monitoring Equipment	The flow meter is calibrated regularly according to the calibration schedule (four times a year). The calibration certificate is available at the project site.
Accuracy of Monitoring Equipment	Accuracy: ± 0.075% of calculation span.
Uncertainty of Data Justification	Low As the flow meters used is of standard make and regularly calibrated the data monitored is accurate.