Annex 4

During the issuance of the CER's for the period 01/01/2006 to 31/12/2006 the CDM-EB required the P.P. to file a revised monitoring plan before the subsequent verification (EB-32, Page No.16, Para 79 (d) (http://cdm.unfccc.int/EB/032/eb32rep.pdf). Hence this revised Monitoring Plan is submitted before the CDM-EB for approval. It includes the details for the existing and new facility. The revised monitoring plan details are as given below:

REVISED MONITORING PLAN

Introduction:

GPIL's Entire Captive Power Plant now consists of; a 30 TPH Waste Heat Recovery Boiler(WHR), now referred as WHRB1, that utilizes waste heat from 350 TPD sponge iron kiln as energy source, a 70 TPH Fluidized Bed Combustion (FBC) Boiler that uses coal rejects (coal char and coal fines) from sponge iron process as fuel, another new 50 TPH Waste Heat Recovery Boiler(WHRB2) that utilizes waste heat from another 500 tpd new sponge iron kiln as energy source, a common steam header, 3 Nos. x 10 MW each and one number 30 MW turbo generator (TG) sets as shown in Fig.4 below. WHR (WHRB1) was installed by GPIL as a CDM Project to improve the energy efficiency of the production process and FBC was installed to avoid the pollution problems associated with disposal of coal rejects as required by pollution control norms. The Project Proponent commissioned another Project Activity with it's new 500 TPD Sponge Iron Kiln along with WHRB2 Waste Heat Recovery Boiler (having 50 TPH Steam Generation capacity) with One 10 MW Turbine and 30 MW Turbine to generate 10 MW Power from the fresh facility i.e. the New Project Activity, which was registered by CDM-EB as "Waste Heat based 10 MW captive power project "GPIL- WHRB 2" CDM PROJECT ACTIVITY (Registration No. 0772).

The WHR (WHRB1) was commissioned in September 2002 along with the two numbers of 10 MW each TG sets and FBC boiler was commissioned later in September 2003. The WHRB2 was commissioned on 1/1/2006 along with one number of 10 MW & one number of 30 MW TG Set.

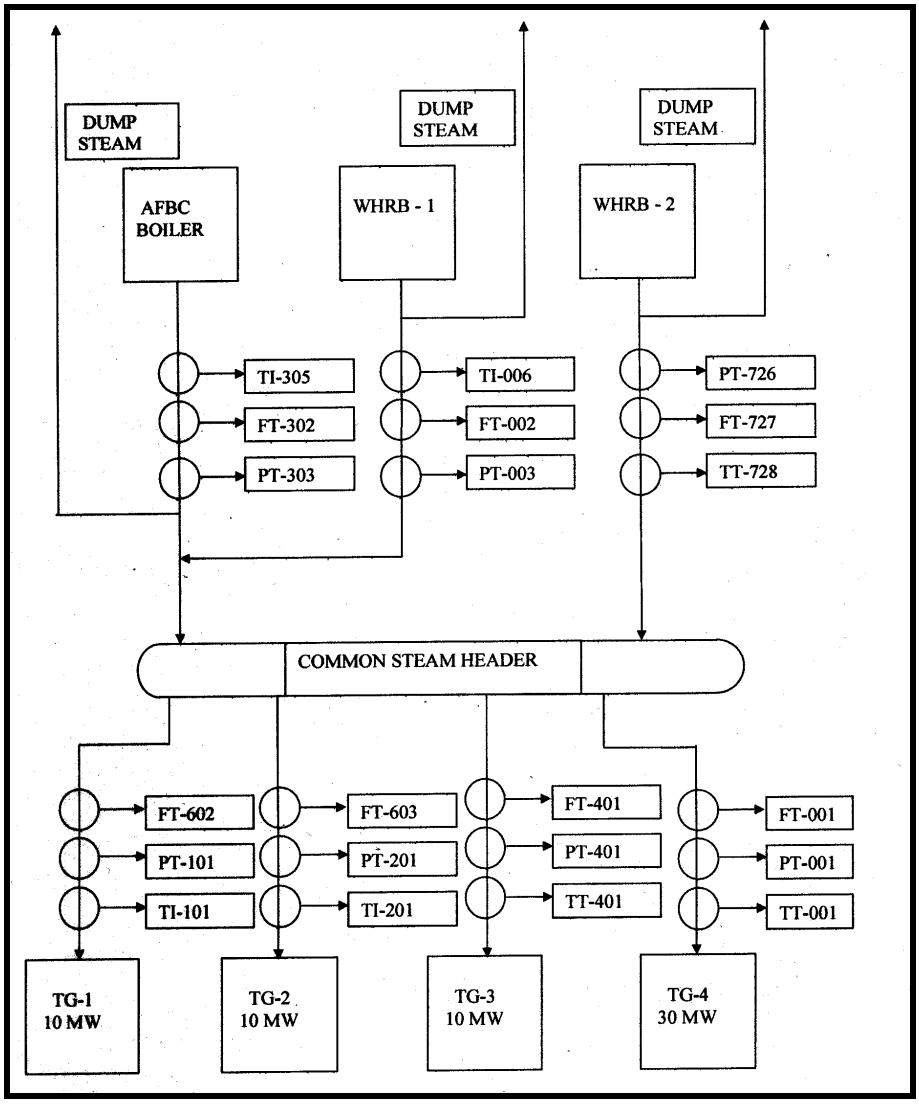

Fig 4 ; Schematic Diagram of GPIL's Entire CPP

The Steam parameters of pressure and temperature from both WHR (WHRB1), WHRB2 and FBC boilers are the same i.e. 35 kg/cm2 and 410 degree C. The working parameters of various equipments and location of Steam Flow meters, pressure and temperature gauges are as indicated in the figure. As working steam parameters of pressure and temperature are identical for both the boilers, the only dependent variable for calculation of waste heat power would be the steam flow from respective boilers. However, to maintain transparency in calculating WHR (WHRB1) power following monitoring methodology is used.

1. **Vent Steam**: To maintain the design pressure (35kg/cm2) in the common header, some quantity of steam generated is vented (or dumped) out intermittently. Vent position is after the location of flow meters in the AFBC steam mains pipes from boilers (see figure) to the common header. Since the quantity of vent steam is not measured at the site, thus to arrive at a conservative estimate for project activity purpose it is assumed to

be entirely coming from WHR (WHRB1) boiler alone (most conservative estimate). The total vent steam is calculated as the difference of total steam generated from both WHR (WHRB1) & WHRB2 and FBC) and the total steam consumed in the all the TG sets.

Svent = (Total steam generated in both WHR (WHRB1) & WHRB2 and FBC) – (Total Steam Consumed in TG#1 and TG#2 & TG#3 &TG#4)

The total vent steam quantity in tonnes per day is subtracted from WHR (WHRB1) steam (i.e. S_{WHR}) to get the value of **Effective WHR (WHRB1) steam (S_1).** i.e = WHR(WHRB1) steam - Svent

2. **Calculation of Waste Heat Power**: The waste heat power generated is calculated thermodynamically on the basis of Total Enthalpy (steam enthalpy per unit x units of steam flow) of Effective WHR (WHRB1) steam as a percentage of Total Enthalpy of Steam fed to the common header from both WHR (WHRB1) & WHRB2 and FBC boilers.

The calculation is shown as follows:

Total Enthalpy of Effective Steam from WHR (WHRB1) in kCal (H_1)
= (Enthalpy of steam at boiler outlet in kCal/kg=h1) x (Effective WHR (WHRB1) steam flow in kgs per day)

= $h_1 \times S_1$

The enthalpy of steam is calculated based on average temperature and pressure readings for the day and Effective WHR (WHRB1)steam flow per day is calculated as mentioned in section 1 of Annexe 4 above.

Similarly Total Enthalpy of Steam from FBC in kCal (H_2)
= Enthalpy of steam at boiler outlet in kCal/kg x steam flow in kgs per day
= $h_2 \times S_2$

The enthalpy of steam is calculated based on average temperature and pressure readings for the day and steam flow from the FBC outlet steam flow meter.

Similarly Total Enthalpy of Steam from WHRB2 in kCal (H_2)
= Enthalpy of steam at WHRB2 boiler outlet in kCal/kg x WHRB2 steam flow in Kgs per day

= $h_3 \times S_3$

If $EG_{GEN\ CPP}$ is the Total Power generated by the CPP per day (in MWh) then Power Generated by Waste heat Recovery Boiler (WHRB1) (EG_{GEN}) would be calculated as

$$EG_{GEN}\ (MWh) = \frac{EG_{GEN\ CPP} \times (H_1)}{(H1 + H2 + H3)} \quad \text{……..1}$$

Again, if Auxiliary Consumption for the CPP per day is $EG_{AUX\ CPP}$ (in MWh), then WHR (WHRB1) Auxiliary Consumption (EG_{AUX}) will also be calculated in the same ratio as

$$EG_{AUX}\ (MWh) = \frac{EG_{AUX\ CPP} \times (H_1)}{(H_1 + H_2 + H_3)} \qquad \text{…….2}$$

Therefore Net Generation from Waste heat Recovery (WHRB1) ie. project activity (1 – 2)

$$EGy\ (MWh) = (EG_{GEN} - EG_{AUX}) \qquad \text{…..3}$$

Table A4(1) – Calculation of Effective WHR (WHRB1) steam flow per day									
ID No.	**Data Type**	**Data variable**	**Data Unit**	**Measured (m), Calculated© or estimated (e)**	**Recording Frequency**	**Proportion of data to be monitored**	**How will the data be archived? (Electronic / paper)**	**For how long is archived data to be kept?**	**Comments**
1. Sgen	Quantitative	Total Steam generated from both WHR (WHRB1)& WHRB2 and FBC boiler .	tonnes per day	**Measured (m),** Online measurement	Daily	100%	Electronic/paper	Credit Period + 2 years	MONITORING LOCATION: The data will be monitored from flow meters at plant and DCS. Manager In-charge would be responsible for calibration of the meters.
2. Scons.	Quantitative	Total Steam Consumed by both TG#1, TG#2, TG#3 and TG#4 .	tonnes per day	**Measured (m),** Online measurement	Daily	100%	Electronic/paper	Credit Period + 2 years	MONITORING LOCATION: The data will be monitored from flow meters at plant and DCS. Manager In-charge would be responsible for regular calibration .
3. Svent	Quantitative	Total Steam Vented in the CPP .	tonnes	Calculated © (Sgen-Scons)	Daily	100%	Electronic/paper	Credit Period + 2 years	Calculated on a daily basis
4. S_{WHR}	Quantitative	Flow of WHR (WHRB1)Steam to common header	tonnes per day	**Measured (m),** Online Measurement	Daily	100%	Electronic/paper	Credit Period + 2 Years	MONITORING LOCATION: The data will be monitored from meters at plant and DCS. Manager In-charge would be responsible for regular calibration.

ID No.	Data Type	Data variable	Data Unit	Measured (m), Calculated© or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (Electronic / paper)	For how long is archived data to be kept?	Comments
5. S_1	Quantitative	Effective WHR (WHRB1)Steam .	tonnes per day	Calculated © (S_{WHR} - S vent)	Daily	100%	Electronic/paper	Credit Period + 2 years	Calculated on a daily basis

Table A4(2) – Total Enthalpy from Effective WHR (WHRB1)Steam									
ID No.	**Data Type**	**Data variable**	**Data Unit**	**Measured (m), Calculated© or estimated (e)**	**Recording Frequency**	**Proportion of data to be monitored**	**How will the data be archived? (Electronic / paper)**	**For how long is archived data to be kept?**	**Comments**
6. T_1	Quantitative	Avg. Temperature of WHR (WHRB1) steam before Common header	^0C	Online Measurement	Continuously	100%	Electronic/paper	Credit Period +2 years	MONITORING LOCATION: The data will be monitored from meters at plant and DCS. Manager In-charge would be responsible for calibration of the meters
7. P_1	Quantitative	Avg. Temperature of WHR steam before Common header	Kg/cm^2	Online Measurement	Continuously	100%	Electronic/paper	Credit Period +2 years	MONITORING LOCATION: The data will be monitored from meters at plant and DCS. Manager In-charge would be responsible for Regular calibration

ID No.	Data Type	Data variable	Data Unit	Measured (m), Calculated© or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (Electronic / paper)	For how long is archived data to be kept?	Comments
8. h_1	Quantitative	Enthalpy of WHR (WHRB1) steam	KCal/Kg	Calculated©	Daily	100%	Electronic/paper	Credit Period +2 years	Calculated from steam tables/ Mollier Diagram
9. H_1	Quantitative	Total Enthalpy of Effective WHR (WHRB1)steam	KCal	Calculated © (h_1 x S_1)	Daily	100%	Electronic/paper	Credit Period +2 years	Calculated on a daily basis

Table A4(3) – Total Enthalpy of Steam from FBC Boiler									
ID No.	**Data Type**	**Data variable**	**Data Unit**	**Measured (m), Calculated© or estimated (e)**	**Recording Frequency**	**Proportion of data to be monitored**	**How will the data be archived? (Electronic / paper)**	**For how long is archived data to be kept?**	**Comments**
10. T_2	Quantitative	Avg. Temperature of FBC boiler before Common header .	^{0}C	Online measurement	Continuously	100%	Electronic/paper	Credit Period + 2 years	MONITORING LOCATION: The data will be monitored from flow meters at plant and DCS. Manager In-charge would be responsible for calibration of the meters.

ID No.	Data Type	Data variable	Data Unit	Measured (m), Calculated© or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (Electronic / paper)	For how long is archived data to be kept?	Comments
11. P_2	Quantitative	Avg. Pressure of FBC steam before Common header .	kg/cm_2	Online measurement	Continuously	100%	Electronic/paper	Credit Period + 2 years	MONITORING LOCATION: The data will be monitored from flow meters at plant and DCS. Manager In-charge would be responsible for regular calibration.
12. h_2	Quantitative	Enthalpy of FBC steam	kCal/kg	Calculated	Daily	100%	Electronic/paper	Credit Period + 2 years	Calculated from steam tables / Mollier Diagram
13. S_2	Quantitative	Flow of Steam to Common header	tonnes per day	Online measurement	Continuously	100%	Electronic/paper	Credit Period + 2 years	MONITORING LOCATION: The data will be monitored from flow meters at plant and DCS. Manager In-charge would be responsible for regular calibration.
14. H_2	Quantitative	Total Enthalpy of FBC steam	kCal	Calculated – (h_2 x S_2	Daily	100%	Electronic/paper	Credit Period + 2 years	Calculated on a daily basis

Table A4(4) – Total Enthalpy from Effective WHRB2 Steam									
ID No.	**Data Type**	**Data variable**	**Data Unit**	**Measured (m), Calculated© or estimated (e)**	**Recording Frequency**	**Proportion of data to be monitored**	**How will the data be archived? (Electronic / paper)**	**For how long is archived data to be kept?**	**Comments**
15. T 3	Quantitative	Avg. Temperature of WHR steam before Common header	^{0}C	Online Measurement	Continuously	100%	Electronic/paper	Credit Period +2 years	MONITORING LOCATION: The data will be monitored from meters at plant and DCS. Manager In-charge would be responsible for calibration of the meters
16. P3	Quantitative	Avg. Temperature of WHR steam before Common header	Kg/cm^2	Online Measurement	Continuously	100%	Electronic/paper	Credit Period +2 years	MONITORING LOCATION: The data will be monitored from meters at plant and DCS. Manager In-charge would be responsible for Regular calibration
17. h_3	Quantitaative	Enthalpy of WHRB2 steam	kCal/kg	Calculated ©	Daily	100%	Electronic/paper	Credit Period + 2 years	Calculated from steam tables / Mollier Diagram
18. S_3	Quantitative	Flow of Effective WHRB2 steam to common header	Tones per day	Calculated	Daily	100%	Electronic/paper	Credit Period +2 years	As per Table A4 (1)
19. H_3	Quantitative	Total Enthalpy of WHRB2 steam	KCal	Calculated (h_3 x S_3)	Daily	100%	Electronic/paper	Credit Period +2 years	Calculated from steam tables/ Mollier Diagram Calculated on a daily basis

Table A4(5) – WHR (WHRB1)Power generated									
ID No.	**Data Type**	**Data variable**	**Data Unit**	**Measured (m), Calculated© or estimated (e)**	**Recording Frequency**	**Proportion of data to be monitored**	**How will the data be archived? (Electronic / paper)**	**For how long is archived data to be kept?**	**Comments**
20. EG GEN CPP	Quantitative	Total Electricity Generated by the CPP .	MWh/ day	Online measurement	Continuously	100%	Electronic/paper	Credit Period + 2 years	MONITORING LOCATION: The data will be monitored from energy meters at plant and DCS from all the four turbines. Manager In-charge would be responsible for calibration of the meters.
21. EG AUX CPP	Quantitative	Total Auxiliary consumption of the CPP	MWh/ day	Online measurement	Continuously	100%	Electronic/paper	Credit Period + 2 years	MONITORING LOCATION: The data will be monitored from energy meters supplying auxiliary power at plant and DCS. Manager In-charge would be responsible for calibration of the meters.
22. EG GEN	Quantitative	Waste Heat Recovery Based Power	MWh/ day	Calculated	Continuously	100%	Electronic/paper	Credit Period + 2 years	Calculated based on the ratio of Enthalpy values in Table A4 (2) and A4 (3) as H1/ (H1+H2+H3)
23. EG AUX	Quantitative	Auxiliary Electric consumption	MWh/day	Calculated	Continuously	100%	Electronic/paper	Credit Period + 2 years	Calculated based on the ratio of Enthalpy values in Table A4 (2) and A4 (3) as H1/ (H1+H2+H3).

Table A4(5) Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored			
Data (Indicate table and ID number e.g. 1. , -14.)	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
1-9	Low	Yes	It is a critical parameter that would be used to calculate the net / effective WHR (WHRB1) steam
10-14	Low	Yes	This data will be used for calculation of FBC steam parameters
15-19	Low	Yes	This data will be used for calculation of WHRB2 steam parameters
20-23	Low	Yes	This data is used for calculating power contributed from waste heat recovery steam generation system of the Project Activity.