**CLEAN DEVELOPMENT MECHANISM**
**PROJECT DESIGN DOCUMENT FORM (CDM-PDD)**
**Version 03 - in effect as of: 28 July 2006**

**CONTENTS**



**Annexes**

## SECTION A. General description of project activity

### A.1 Title of the project activity:

Aarti Steels Limited – Waste Heat Recovery based Captive Power Project.
Version: 01
Date: 24/01/2008

### A.2. Description of the project activity:

**Project activity:**

The project activity at Aarti Steels Limited (ASL) involves installation of a waste heat recovery boiler (WHRB) of 52 ton per hour (TPH) steam generation capacity to recover waste heat from the flue gas generated from the 500 tons per day (TPD) rotary kiln. The total waste flue gas generated is ducted to the WHRB to generate steam at 87 $Kg/Cm^2$ (the maximum pressure for which the WHRB is designed is 98 $kg/cm^2$) and $510^0C$. The generated steam is then introduced into the turbo-generator for power generation. The WHRB steam of about 52 TPH contributes to the power generation of about 12 MW.

The ASL Sponge Iron unit at present consists of one rotary kiln of 500 TPD and the flue gas generated from the kiln is about 120,000 $Nm^3/hr$ at $950\text{-}1000^0C$. Flue gas with high heat content is generated in the Rotary kiln in the Sponge iron plant during conversion of Iron Ore into Sponge Iron. The entire gas coming out from After Burning Chamber (ABC) of the Direct Reduced Iron (DRI) plant at about $950\text{-}1000^0C$ is passed through the Waste Heat Recovery Boiler (WHRB). The volume of the gas generated is proportionate to the production of the DRI. The boiler absorbs the sensible heat of gas and cooled gas at about $160^0C$ is passed through electrostatic precipitator (ESP) and subsequently vented to the atmosphere. The kiln when operating at full capacity can generate adequate waste gas to produce steam up to 52 TPH equivalent to 12 MW of power.

ASL has one turbogenerator of 40 MW capacity, wherein steam from both the 52 TPH WHRB as well steam from the coal and coal washery rejects based Atmospheric Fluidised Bed Combustion (AFBC) boiler (of 115 TPH steam generation capacity) are introduced through a common header. The WHRB steam contributes to 12 MW of power generation while the balance contribution of 28 MW power is from the steam generated by coal and coal washery rejects based AFBC boiler. In exigency cases, power from the grid is also imported.

The project activity was commissioned in September 2005. The contribution of WHRB to the power generation is estimated to be 52,342.5 MWh per annum.

The purpose of the project activity is to generate power through WHRB to partially meet the in-house requirements of ASL. In the absence of the WHRB, the equivalent power of about 12 MW would have been generated by a coal and coal washery rejects based captive power plant (CPP).

**Project promoter & Steel plant details:**
Aarti Steels Limited (ASL) has set up an Integrated Steel Plant at Ghantikhal-Nidhipur in Athagarh Sub division of Cuttack District, Orissa for producing sponge iron, Power, Steel Billets, Squares and

Ferro Alloys. The plant will finally produce about 0.5 Million tonnes of Value Added special steels annually in the form of billets, squares, rounds, flats, wires, etc.

Presently the complex consists of a coal washery, Sponge Iron unit, Fluidized Bed and Waste Heat Recovery Boilers, Steam turbine, Induction Furnace, Ladle Refining Furnace, Continuous Caster, Ferro Alloys Plant etc. Second unit of Power plant and sponge iron plant along with Arc Furnace, Vacuum Degassing unit, Mini Blast Furnace, Rolling Mill, Wire Drawing Mill will be added in immediate future.

- **Project's contribution to sustainable development**

The project activity has contributed to 'Sustainable Development of India' because the project activity is generating power using waste heat gases from the process. By generating clean power, ASL has replaced power generation from a coal and coal washery rejects based unit. Therefore, the project activity enables reduction in $CO_2$ emissions and saves the conventional fuel.

The project imparts a direct positive impact by improvement of quality of life of local people by providing direct employment, indirect job generation, technological & managerial capacity building etc. The company is also doing peripheral development in the areas of infrastructure, education and health. The following paragraphs illustrate briefly how the project activity contributes to the four pillars (indicators) of sustainable development of India:

**Social aspects**

The location of the project in rural setting contributes towards poverty alleviation by generating both direct and indirect employment.

**Economic aspects**

The project's initial investment is to the tune of INR 2762.4 Million in addition to which there will be continuous inflow of funds considering CDM revenues. The project will also earn additional revenue to the local and central government.

**Environmental aspects**

Majority of the power generation in the country is from the fossil fuels like coal, oil and gas. However, the project activity generates the electricity from the waste flue gas and thereby reduces the GHG emissions. The project activity utilizes the enthalpy of the hot flue gas, which will protect the environment from thermal pollution.

**Technological aspects**

The Captive Power Plant (CPP) is based on the WHR technology, a clean technology for power generation from waste hot flue gas (which would otherwise have been quenched, cleaned and released into the atmosphere and the heat content would have been wasted). The project comprises of 52 tons per hour (TPH) capacity boiler with the outlet steam parameters of 87 kg/cm$^2$ (maximum pressure of 98 kg/cm$^2$), and 510º C.

**A.3. 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) |
|---|---|---|
| India | Aarti Steels Limited | No |

**A.4. Technical description of the project activity:**

**A.4.1. Location of the project activity:**

**A.4.1.1. Host Party(ies):**

India

**A.4.1.2. Region/State/Province etc.:**

Orissa

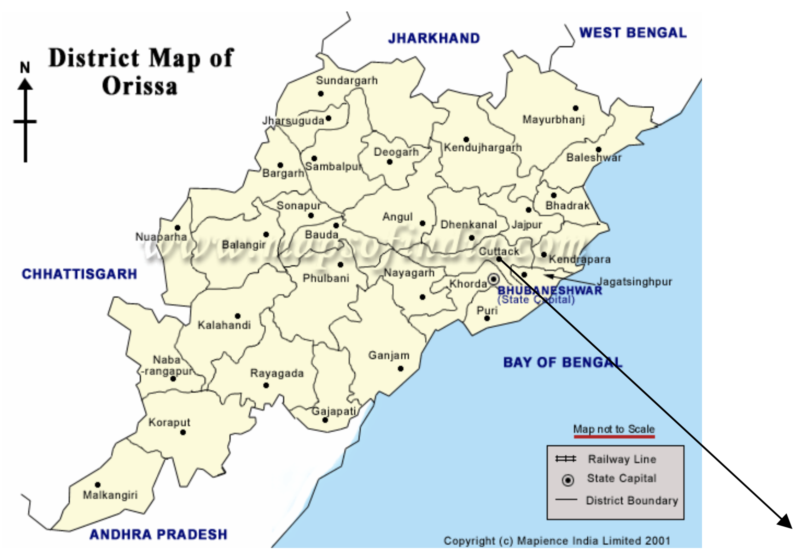
**A.4.1.3. City/Town/Community etc:**

Ghantikhal, P.O. Mahakalabasta, Via. Athagarh, District Cuttack,

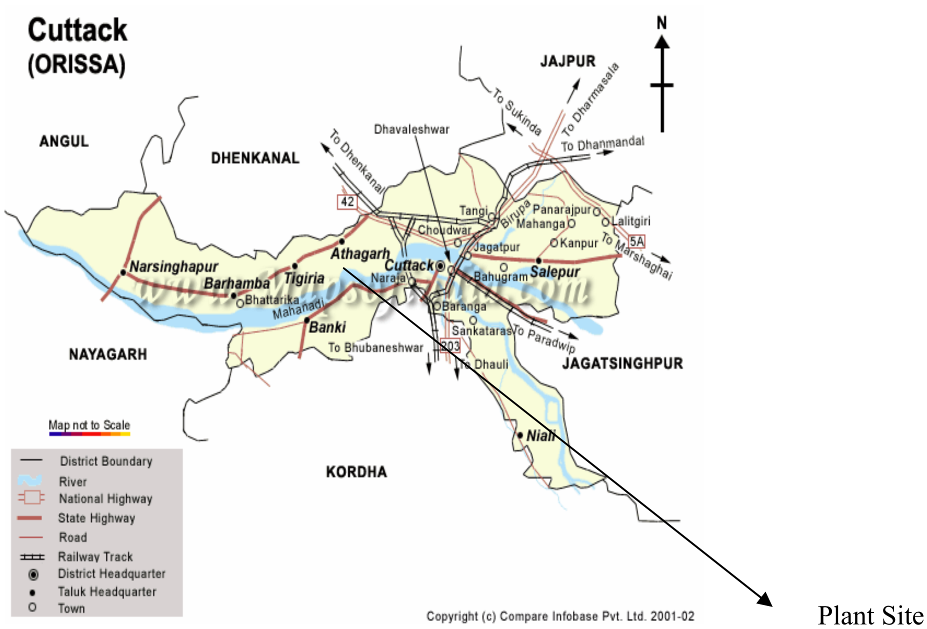
**A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):**

The Project has been implemented at Ghantikhal, P.O. Mahakalabasta, Via. Athagarh, District Cuttack It is located at latitude of $20^0$ 30' 30" to $20^0$ 31' 15" N and longitude of $85^0$ 44' 15" to $85^0$ 44' 15" E. The project site is situated at 40 kms from Cuttack town in Orissa State. Infrastructural requirements including water, motorable road, electricity *etc*. are available at the site. Railway siding is under construction and will be commissioned by February 2008.


Orissa State




Cuttack District




## A.4.2. Category(ies) of project activity:

The project activity is generating electricity from the waste hot gas generated from the sponge iron plant. It comes under Sectoral Scope 1: Energy Industries (renewable/non renewable sources) and Sectoral Scope 4: Manufacturing Industries as per "List of Sectoral Scopes", Version 11. The methodology used for this project activity is 'Approved Consolidated Baseline and Monitoring Methodology - ACM0012:
Version: 02
Date: 02 November 2007

## A.4.3. Technology to be employed by the project activity:

ASL's integrated complex consists of facilities amongst others are one AFBC and one WHRB boiler. The WHRB is a single drum water tube boiler of 52 TPH capacity operating at 87 ata (maximum pressure of 98 kg/cm$^2$) and at a temperature of 510$^0$C. The Power generated from the generator at 11 kV is supplied to other units net of the auxiliary power consumption of WHR power plant. The technology used for this project activity is based on Rankine cycle technology.

The ASL Sponge Iron unit consists of one rotary kiln of 500 TPD. The generation of flue gas from the kiln at full capacity is 120,000 Nm$^3$/hr at 950-1000$^0$C. The rotary kiln is directly connected to the WHRB Boiler, with a steam generation capacity of 52 TPH. The total waste flue gas generated is ducted to the WHRB to generate steam at 87 kg/cm$^2$ and 510$^0$C.

The generated steam is then introduced in to the Single flow with downward exhaust condensing Turbo Generator for power generation. After transferring the heat, the waste flue gas is passed through the Electro Static Precipitator (ESP) and vented to atmosphere. The equipment technical details are provided in Table A-1.

**Table A-1: Equipment Technical Details**

| Sr. No | Parameter | Details |
|---|---|---|
| A. | **Turbine** | |
| 1. | Make | ALSTOM Power Turbine presently known as Siemens Ltd. |
| 2. | Type | Single flow with downward exhaust condensing |
| 3. | Rating | 40 MW |
| 4. | Inlet steam pressure | 85 $kg/cm^2$ |
| 5. | Inlet steam temperature | 500 $^0C$ |
| 6. | Turbine Speed | 7059 rpm |
| B. | **Boiler Make-Cethar Vessels Limited.** | |
| 7. | Type | Single drum water tube boiler |
| 8. | Net Steaming Capacity at MCR | 52 TPH |
| 9. | Super heater outlet pressure | 87 $kg/cm^2$ |
| 10. | Super heater outlet temperature | 510 $^0C$ |
| 11. | Gas temperature | 950-1000 $^0C$ |

### A.4.4 Estimated amount of emission reductions over the chosen crediting period:

The project would result in a $CO_2$ emission reduction of 801,140 tons during the 10 -year crediting period from 2008 - 2018 which relates to the electrical energy generation from the project of about 523,425 MWh through waste heat recovery during the same period. The project activity enables reduction of greenhouse gas (GHG) emissions as provided in Table A-2 below.

**Table A-2: Emission reductions**

| **Years** | **Annual estimation of emission reductions in tonnes of $CO_2$ e** |
|---|---|
| Year 1 | 80,114 |
| Year 2 | 80,114 |
| Year 3 | 80,114 |
| Year 4 | 80,114 |
| Year 5 | 80,114 |
| Year 6 | 80,114 |
| Year 7 | 80,114 |
| Year 8 | 80,114 |
| Year 9 | 80,114 |
| Year 10 | 80,114 |
| Total CER's | 801,140 |
| Crediting Period | 10 years |
| **Annual average over the crediting period of estimated reductions (**(tones of $CO_2$ e) | 80,114 |

### A.4.5. Public funding of the project activity:

The project has not received any public funding.

## SECTION B. Application of a baseline and monitoring methodology

### B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

**Title: "Consolidated baseline methodology for GHG emission reductions for waste gas or heat or pressure based energy system".**

**Reference: Approved consolidated baseline and monitoring methodology ACM0012.**

Version : 02,

Sectoral Scope : 01 and 04

Date : 02 November 2007

### B.2 Justification of the choice of the methodology and why it is applicable to the project activity:

The applicability criteria of the methodology ACM0012 (version 02, dated 2 November 2007) and how it applies to the project activity is detailed in Table B-1 below:

**Table B-1: Justification of how the project meets the applicability criteria of ACM0012**

| **Applicability condition in ACM0012** | **Description of how the project activity meets the applicability condition** |
|---|---|
| The consolidated methodology is for project activities that utilize waste gas and/or waste heat (hence forth referred to as waste gas/heat) as an energy source for:<br>• Cogeneration; or<br>• Generation of electricity; or<br>• Direct use as process heat source; or<br>• For generation of heat in element process (e.g. steam, hot water, hot oil, hot air);<br>The consolidated methodology is also applicable to project activities that use waste pressure to generate electricity | The project activity utilises waste gas/ heat as an energy source for generation of electricity and therefore meets this applicability criteria |
| If project activity is use of waste pressure to generate electricity, electricity generated using waste gas pressure should be measurable | Not relevant to the project activity as the project does not involve use of waste pressure |
| Energy generated in the project activity may be used within the industrial facility or exported outside the industrial facility; | The energy generated in the project activity is used in the industrial facility and if in surplus the same is exported to the grid (i.e. outside the industrial facility). Thus this applicability condition is satisfied by the project activity |
| The electricity generated in the project activity may be exported to the grid; | The energy generated in the project activity is used in the industrial facility and if in surplus the same may be exported to the grid. Thus this applicability condition is satisfied by the project activity |
| Energy in the project activity can be generated by the owner of the industrial facility producing the | Energy in the project activity is generated by the owner of the industrial facility (ASL) producing |

| Applicability condition in ACM0012 | Description of how the project activity meets the applicability condition |
|---|---|
| waste gas/heat or by a third party (e.g. ESCO) within the industrial facility. | the waste gas/heat. Thus this applicability condition is satisfied by the project activity |
| Regulations do not constrain the industrial facility generating waste gas from using the fossil fuels being used prior to the implementation of the project activity. | No regulations constrain ASL from using fossil fuels for the purpose of generating electricity |
| The methodology covers both new and existing facilities. For existing facilities, the methodology applies to existing capacity. If capacity expansion is planned, the added capacity must be treated as a new facility | ASL's project activity i.e. WHRB was implemented in a new facility which satisfies the applicability criteria |
| The waste gas/pressure utilized in the project activity was flared or released into the atmosphere in the absence of the project activity at existing facility. This shall be proven by either one of the 5 methods as listed under ACM0012 | ASL's project was implemented in a new facility and therefore this criteria is not relevant to the project activity. |
| The credits are claimed by the generator of energy using waste gas/heat/pressure. | ASL is the generator of energy using waste gas/ heat and therefore would be claiming the credits. |
| For those facilities and recipients, included in the project boundary, which prior to implementation of the project activity (current situation) generated energy on-site (sources of energy in the baseline), the credits can be claimed for minimum of the following time periods:<br>o The remaining lifetime of equipments currently being used; and<br>o Credit period. | This is not relevant to the project activity as it is implemented in a new facility |
| Waste gas/pressure that is released under abnormal operation (emergencies, shut down) of the plant shall not be accounted for. | ASL will not account for these releases of waste gas under abnormal conditions |
| Cogeneration of energy is from combined heat and power and not combined cycle mode of electricity generation. | This is not relevant to the ASL's project activity. |

The project activity utilizes the waste gas emanating from the DRI kilns to produce electricity. The generated electricity will be displacing the electricity generation by another coal and coal washery rejects based AFBC boiler which could have generated additional power equivalent to that of the WHRB system in the absence of the project activity. As apparent from the above table, the project activity satisfies all the applicability conditions as specified in the methodology ACM0012 (version 02, dated 2 November 2007), and hence the methodology is applicable to the project activity.

**B.3. Description of how the sources and gases included in the project boundary**

As per the methodology ACM0012 – version 02, 'the geographical extent of the project boundary shall include the following:

1. *The industrial facility where the waste gas/ heat/ pressure is generated (generation of waste energy)*
2. *The facility where process heat in element process/ steam/ electricity are generated (generator of process heat/ steam/ electricity). Equipment providing auxiliary heat to the waste heat recovery process shall be included within the project boundary*
3. *The facility/s where the process heat in element process/ steam/ electricity is used (the recipient plant (s) and/ or grid where the electricity is exported, if applicable*

In the project activity the project boundary comprises the following which is in line with ACM0012:

1. *The industrial facility where the waste gas/ heat/ pressure is generated (generation of waste energy):* The industrial facility where the waste gas/ heat is generated is ASL's sponge iron plant/ DRI kiln. The source of waste heat is the After Burning Chamber (ABC) where the waste gas from the DRI kiln of ASL facility is combusted. The DRI Kiln and the ABC are included in the project boundary
2. *The facility where process heat in element process/ steam/ electricity are generated (generator of process heat/ steam/ electricity). Equipment providing auxiliary heat to the waste heat recovery process shall be included within the project boundary:* The project activity generates steam through WHRB and power through the turbo-generator as defined in Section A.2 of the PDD. Hence the project boundary includes the Waste heat recovery boiler, related accessories for steam distribution, Steam Turbine Generator (STG), captive power plant and the power evacuation system. There is no equipment that provides auxiliary heat to the waste heat recovery process.
3. *The facility/s where the process heat in element process/ steam/ electricity is used (the recipient plant (s) and/ or grid where the electricity is exported, if applicable:* The electricity generated by the project activity is used in the same facility that generates electricity i.e. ASL is the generator and recipient of electricity that is generated by the project activity. However the captive power plant would export power to the Orissa state grid which is within the Eastern regional electricity grid if the power is in surplus of the captive requirements. Therefore the project boundary includes the ASL's facility as well as the Eastern regional grid to which the power is exported

Fig B.1 represents the project boundary of the project activity under consideration.

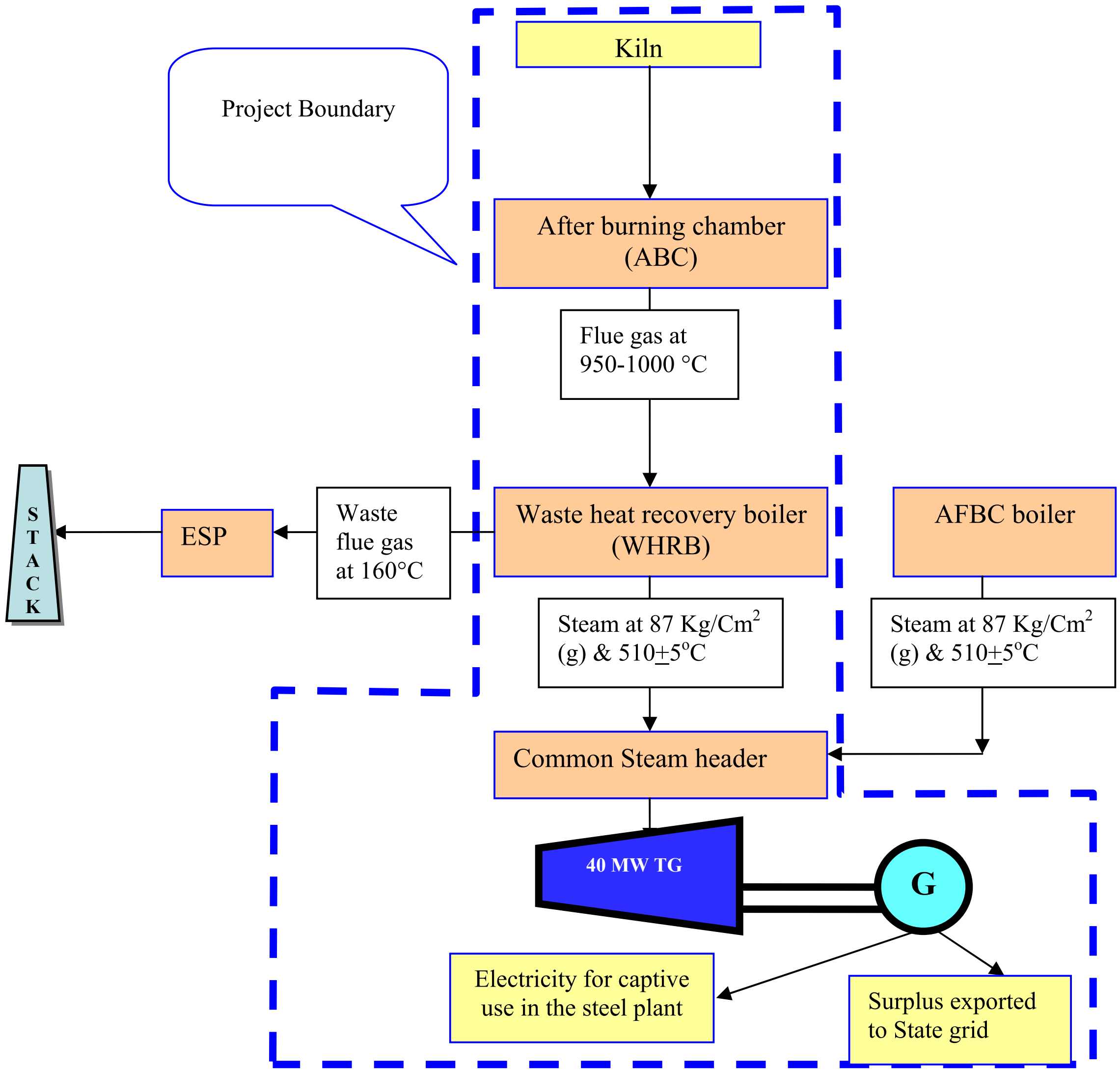



**Fig B.1 Project boundary**

The sources and gases included in the project boundary for the project activity are as provided in Table B-2

**Table B-2: Sources and Gases included in the project boundary:**

| | Source | Gas | Included | Justification/Explanation |
|---|---|---|---|---|
| Baseline | Electricity Generation, grid or captive source | $CO_2$ | Included | The baseline would be the coal and coal washery rejects based captive power plant which would form the main emission source.<br><br>Electricity generation from grid would not be the baseline and therefore this emission source would be excluded |
| | | $CH_4$ | Excluded | Excluded for simplification. This is conservative |
| | | $N_2O$ | Excluded | Excluded for simplification. This is conservative |
| | Fossil fuel consumption in boiler for thermal energy | $CO_2$ | Excluded | Excluded as this is not relevant to the project activity |
| | | $CH_4$ | Excluded | Not applicable |
| | | $N_2O$ | Excluded | Not applicable |
| | Fossil fuel consumption in cogeneration plant | $CO_2$ | Excluded | Excluded as this is not relevant to the project activity. |
| | | $CH_4$ | Excluded | Not applicable |
| | | $N_2O$ | Excluded | Not applicable |
| | Baseline emissions from generation of steam used in the flaring process, if any | $CO_2$ | Excluded | Excluded as this is not relevant to the project activity. |
| | | $CH_4$ | Excluded | Not applicable |
| | | $N_2O$ | Excluded | Not applicable |
| Project Activity | Supplemental fossil fuel consumption at the project plant | $CO_2$ | Excluded | Excluded as there is no fossil fuel consumption for auxiliary firing in the project activity |
| | | $CH_4$ | Excluded | Not applicable |
| | | $N_2O$ | Excluded | Not applicable |
| | Supplemental electricity consumption | $CO_2$ | Included | Power from coal & coal washery rejects based AFBC would be used for start-up/ maintenance of WHRB in case of exigencies and therefore included as main emission source |
| | | $CH_4$ | Excluded | Excluded for simplification |
| | | $N_2O$ | Excluded | Excluded for simplification. |

| | Source | Gas | Included | Justification/Explanation |
|---|---|---|---|---|
| Project Activity | Project emissions from cleaning of gas | $CO_2$ | Excluded | Waste gas cleaning is not required and therefore these emissions related to energy requirement for cleaning process is not included. |
| | | $CH_4$ | Excluded | Not applicable |
| | | $N_2O$ | Excluded | Not applicable |

**B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:**

As per the approved methodology, ACM0012, the baseline scenario is identified as the most plausible baseline scenario among all realistic and credible alternative(s). The realistic and credible alternatives are determined for:

- Waste gas/ heat/ pressure use in the absence of the project activity; and
- Power generation in the absence of the project activity; and
- Steam/ heat generation in the absence of the project activity

The above involves identification of baseline scenario / alternative that is most likely to occur in the absence of the project activity. As the project activity at ASL involves use of waste heat in the flue gas for generating power, the alternatives considered would be only for **waste gas/ heat use** in the absence of the project activity and **power generation** in the absence of the project activity. Baseline steam / heat generation options are not relevant to the project activity and hence not discussed further.

The project participant shall exclude baseline options that:

- do not comply with legal and regulatory requirements; or
- depend on fuels (used for generation of heat and/ or power), that are not available at the project site

***Step 1: Define the most plausible baseline scenario for the generation of heat and electricity using the following baseline options and combinations:***

The baseline candidates would be considered for the following facilities:

- For the industrial facility where the waste gas/heat/pressure is generated; and
- For the facility where the energy is produced; and
- For the facility where the energy is consumed

It should be noted that in case of ASL's project activity, the facilities where waste gas is generated, energy is produced and energy is consumed are the same i.e. ASL's sponge iron kiln produces waste gas, their own captive power plant based on WHR produces energy and their own industrial facility consumes the energy produced. Further only if the energy generated is in surplus, the same would be exported to the grid. The baseline candidates are selected based on the above consideration.

A) For Use of Waste Gas, the following alternatives are provided in ACM0012:

| Scenario | Description |
|---|---|

| | |
|---|---|
| W1 | Waste gas is directly vented to atmosphere without incineration |
| W2 | Waste gas is released to the atmosphere after incineration or ***waste heat is released to the atmosphere*** (waste pressure energy is not utilized); |
| W3 | Waste gas/heat is sold as an energy source; |
| W4 | Waste gas/heat/pressure is used for meeting energy demand. |

It needs to be noted that the project activity was implemented in a new facility (sponge iron kiln/ DRI kiln) and therefore there was no prior release of waste heat/ gas in the baseline scenario.

However in the absence of the project involving waste gas/ heat recovery, the waste gas could not have been directly vented into the atmosphere and neither does this waste gas require incineration. Since there is practically no other use of waste gases (emanating from the kiln) in the steel plant, in absence of the proposed project the waste gas thus generated would have been quenched, cleaned and released into the atmosphere and the heat content would have been wasted. Therefore the option W2 i.e. 'Waste heat is released to the atmosphere' would be more relevant baseline scenario for the project activity.

In the absence of the project activity, the waste gas/heat would neither have been used for meeting energy demand at ASL's facility i.e. in the current process of sponge iron making; nor would the waste gas/heat have been sold as an energy source. Therefore the most likely alternative of use of waste gas/ heat in the baseline scenario would be 'waste heat is released into the atmosphere' as defined in W2.

B) For Power generation, the following alternatives are provided in ACM0012:

| Scenario | Description |
|---|---|
| P1 | Proposed project activity not undertaken as a CDM project activity |
| P2 | On-site or off-site existing/new fossil fuel fired cogeneration plant; |
| P3 | On-site or off-site existing/new renewable energy based cogeneration plant |
| P4 | On-site or off-site existing/new fossil fuel based existing captive or identified plant |
| P5 | On-site or off-site existing/new renewable energy based existing captive or identified plant; |
| P6 | Sourced Grid-connected power plants |
| P7 | Captive Electricity generation from waste gas (if project activity is captive generation with waste gas, this scenario represents captive generation with lower efficiency than the project activity) |
| P8 | Cogeneration from waste gas (if project activity is cogeneration with waste gas, this scenario represents cogeneration with lower efficiency than the project activity). |

**Alternative P1: Proposed project activity not undertaken as a CDM project activity**

ASL have set up a 12 MW waste heat recovery based electricity generation at its facility for partially meeting in-house requirements. This alternative is in compliance with all applicable legal and regulatory requirements. In order to implement this project activity ASL had to face number of barriers, financial and technological barriers, which makes this alternative, less attractive for the project activity without CDM benefits. The same is explained in the Section B.5 of the PDD. Hence this option can be eliminated for consideration as a baseline scenario.

**Alternative P2: On-site or off-site existing/new fossil fuel fired cogeneration plant**

ASL does not have any existing/new fossil fuel based cogeneration plant and also does not require steam in the processes involved in the sponge iron kiln. Further as the project activity is not a cogeneration plant, this baseline alternative is not a realistic alternative to the project, though it is in compliance with the legal and regulatory requirements.

**Alternative P3: On-site or off-site existing/new renewable energy based cogeneration plant**
ASL does not have any existing/ new renewable energy based cogeneration plant and also does not require steam in the processes involved in the sponge iron kiln. Further as the project activity is not a cogeneration plant, this baseline alternative is not a realistic alternative to the project, though it is in compliance with the legal and regulatory requirements

**Alternative P4: On-site or off-site existing/new fossil fuel based existing captive or identified plant**

ASL could implement a new fossil fuel based captive power plant in the absence of the project activity. Considering the fuel options for captive power generation, under this alternative P4, there could be 3 possible options:

Option 4a: Coal and coal washery rejects based captive power generation
Option 4b: Diesel based captive power generation
Option 4c: Gas based captive power generation

The above alternative is in compliance with legal and regulatory requirements and could be a possible baseline alternative. This alternative is considered for further evaluation.

**Alternative P5: On-site or off-site existing/new renewable energy based existing captive or identified plant;**

There is no existing renewable energy based captive power plant at the sponge iron facility of ASL. Renewable energy is generated from sources such as biomass, hydro, wind etc. This alternative is in compliance with the legal and regulatory requirements, and could be a possible baseline alternative. This alternative is considered for further evaluation.

**Alternative P6: Sourced Grid-connected power plants**

In the absence of the CDM project activity, ASL would have imported electricity from the Eastern regional grid, which will further lead to GHG emissions from fossil fuel based thermal power plants. This alternative is in compliance with all applicable legal and regulatory requirements and may be a part of the baseline. This alternative is considered for further evaluation.

**Alternative P7: Captive Electricity generation from waste gas (if project activity is captive generation with waste gas, this scenario represents captive generation with lower efficiency than the project activity)**

The project activity involves electricity generation from waste gas. This alternative scenario on the captive electricity generation from Waste Heat Recovery (WHR) project with lower efficiency than the proposed project activity could be a possible baseline alternative. This baseline alternative is considered for further evaluation.

**Alternative P8: Cogeneration from waste gas (if project activity is cogeneration with waste gas, this scenario represents cogeneration with lower efficiency than the project activity):**

ASL does not require a cogeneration plant and steam is not required for the processes involved in the sponge iron kiln. This alternative is not a realistic baseline alternative, though in compliance with the legal and regulatory requirements, and therefore not considered as a baseline scenario.

***STEP 2: Identify the fuel for the baseline choice of energy source taking into account the national and/or sectoral policies as applicable.***

The following baseline alternatives have been identified based on Step 1 which may be considered for evaluation under Step 2:

For waste gas use scenario:

- W2: Waste gas is released to the atmosphere after incineration or ***waste heat is released to the atmosphere*** (waste pressure energy is not utilized);

For power generation scenario:

- P4: On-site or off-site existing/new fossil fuel based existing captive or identified plant
- P5: On-site or off-site existing/new renewable energy based existing captive or identified plant**;**
- P6: Sourced Grid-connected power plants
- P7: Captive Electricity generation from waste gas (if project activity is captive generation with waste gas, this scenario represents captive generation with lower efficiency than the project activity)

Under this step 2, the fuel that may have been used in the baseline as a choice of energy source is evaluated taking into account the national and sectoral policies as applicable. As per this step 2, it is required to demonstrate the following:

- Demonstrate that the identified baseline fuel is available in abundance in the host country and there is no supply constraint.
- Detailed justification shall be provided for the selected baseline fuel. As a conservative approach, the available fuel with the lowest carbon emission factor (e.g., natural gas) shall be used.
- In case of partial supply constraints (seasonal supply), the project participants shall consider the available alternative fuel that result in lowest baseline emissions during the period of partial supply.

**Evaluation of P4 alternative:**
In the power generation scenario, for alternative P4 there are 3 options considering the available fossil fuels in the country (India) as discussed in Step 1. These are further discussed based on fuel for baseline choice as per the requirement under Step 2:

*Option 4a: Coal and coal washery rejects based captive power generation*

Coal is available in abundance in the host country (India) and is one of the main fossil fuels used for power generation[1]. As per World Coal Institute, the following are some key facts on coal availability and use in the host country (India):

- Coal is the dominant commercial fuel, meeting half of commercial primary energy demand and a third of total energy needs.
- The power sector will be the main driver of India's coal consumption - currently around 69% of India's electricity is generated from coal
- Coal reserves in India are plentiful and India has 10% of the world's coal, at over 92 billion tonnes, third only to the USA and China in total reserves. At current rates of production, India has enough coal for the next 217 years

Use of coal for power generation is in compliance with the legal and regulatory requirements. As apparent from Section A.2, ASL has implemented coal and coal washery rejects based AFBC at their facility to also cater to the captive power requirements along with WHRB (the project activity). For ASL, the coal washery rejects are sourced from the coal washeries. This justifies the abundant availability of this fossil fuel i.e. coal as well as coal washery rejects for power generation at ASL's facility itself.

It needs to be noted that as described in Section A.2, ASL has implemented both the WHRB and AFBC (based on coal and coal washery rejects) systems in their facility and in the absence of the proposed CDM Project activity, ASL could have generated the 12 MW of equivalent electricity (generated otherwise by WHRB i.e. the project activity) by expanding the existing coal and coal washery rejects based CPP in order to meet their demand.

As the company is already operating one AFBC boiler of 115 TPH capacity using coal, coal washery rejects from their existing washeries, this additional power generation of 12 MW (equivalent to the capacity of the project activity i.e. the WHRB) could have been achieved by increasing the capacity of the existing AFBC boiler with a marginal increase in the project cost. The AFBC boiler with this increased/ expanded capacity using coal and coal washery rejects would also have had technological advantages of higher plant load factor (PLF) and also abundant availability of fuel from their existing and nearby coal washeries resulting in lesser capital cost and cost of generation per unit.

This alternative is in compliance with all applicable legal and regulatory requirements and may be a part of the baseline.

**Option 4b: Diesel based captive power generation**

In the absence of the proposed CDM Project activity, ASL could generate power by implementing a diesel-based power plant to meet their power demand. This will lead to emission of GHG gases, by the diesel based captive power generation. This option 4b is in compliance with all applicable legal and regulatory requirements and may be a part of the baseline.

**Option 4c: Gas based captive power generation**

[1] http://www.worldcoal.org/pages/content/index.asp?PageID=402

ASL could generate its own power using natural gas based captive power plant. Although this alternative is in compliance with all regulatory and legal requirements, it is not a realistic alternative due to non availability of natural gas distribution network in Orissa. Therefore, option 4c may be excluded from baseline scenario.

**Evaluation of P5 alternative:**
Renewable energy would be primarily from biomass, hydro or wind. Considering the non – availability of renewable energy sources at the vicinity of project site and also considering that the extent of power required by ASL's facility is quite large to be met by these renewable energy sources, this alternative is not considered for further evaluation.

***STEP 3: Step 2 and/or step 3 of the latest approved version of the "Tool for the demonstration and assessment of additionality" shall be used*** to identify the most plausible baseline scenarios by eliminating non-feasible options (e.g. alternatives where barriers are prohibitive or which are clearly economically unattractive).

**The step 2 and/ or step 3 as per** latest approved version of additionality tool is further detailed in Section B.5 as required.

It may be noted that Alternative P7 involving captive electricity generation from waste gas but with lower efficiency than the project activity could have been a valid baseline scenario but for the following reasons. At the time of implementation of the project activity, there were very few sponge iron plants in the state of Orissa that had WHR for captive power generation and the penetration of such systems in the state is very low[2]. Most of the sponge iron plants import power from the grid or use fossil fuels for power generation. Given this prevailing practice scenario, the option P7 cannot be a valid/ plausible baseline scenario for the project activity. Hence based on prevailing practice in the region this alternative P7 is not considered for further evaluation as it could not have been the baseline alternative to the project activity.

Based on the above, the plausible alternatives that are considered for further evaluation under this Step 3 are as follows:

- P4, i.e. Option 4 (a) *Coal and coal washery rejects based captive power generation* and Option 4 (b) *Diesel based captive power generation*
- P6: Sourced Grid-connected power plants

*Evaluation of alternatives for baseline selection:*

Among all the alternatives, the one that does not face any prohibitive barrier and is the most economically attractive should be considered as the baseline scenario. Thus from the above identified alternatives, it can be found that alternatives P4 – 4a & 4b and P6 are the most likely alternatives for the baseline scenario.

The P4 – 4a & 4b and P6 alternatives are compared on capital investment required and cost of power generation as provided in the Table B-3 below:

**Table B-3 Comparison of economic attractiveness**

| Parameter | Grid Based Power (Option P6) | Coal Based Power plant | Diesel based power plant |
|---|---|---|---|

[2] Reference: Letter from Orissa Sponge Iron Manufacturer's Association (OSIMA)

| | | (Option 4a) | (Option 4b) |
|---|---|---|---|
| Capital Cost | Nil | INR 45 Million/MW | INR 40 Million/MW |
| Cost of Power | INR 4.00/kWh | INR 1.56/kWh[3]<br><br>INR 1.22 /kWh for the coal and coal washery rejects based power plant as per ASL | INR 5.96/kWh[4] |

The Central Electricity Authority (CEA) report namely 'Report of the Expert Committee on Fuels for Power generation, Executive Summary' provides the cost of generation by various fuels at 80% plant load factor (PLF) based on different distances of procurement of fuels. For coal based captive power plant, if domestic coal is procured within 200km from the project site, the cost of generation at 80% PLF would be 1.56 INR/kWh. As per the same report, the cost of generation using diesel, procured from within 200km from project site would be 5.96 INR/ kWh. The cost of importing power from the grid (Orissa state electricity grid) would be 4.0 INR/kWh.

As apparent from the Table B-3, it may be noted that there is no initial capital cost for importing power from the grid as compared to the cost of setting up a coal and diesel based power plant. The cost of power generation from diesel is the highest among the options considered. However, in comparison with the grid power cost (4 INR/kWh), the cost of power generation per unit is relatively cheaper for a coal based CPP (about 1.56 INR/ kWH) and even cheaper for a coal and coal washery rejects based power plant as the availability of coal washery rejects from the existing coal washeries further reduces the cost of generation to 1.22 INR/kWh[5]. As apparent from the above discussions, Option P-4b (diesel based power) and Option P6 (grid power) being economically un-attractive when compared to Option 4a (coal and coal washery rejects based power), are not considered as baseline alternatives.

Considering the various factors available, the most likely baseline scenario would be Alternative-4a, i.e. a coal and coal washery rejects based CPP to cater to the equivalent power as that of the WHRB system considering the economic attractiveness of a coal and coal washery rejects based CPP as detailed above.

---

[3] Reference: Report of the Expert Committee on fuels for Power Generation, Executive Summary – By Government of India, Central Electricity Authority, Planning Wing, dated February 2004

[4] Reference: Report of the Expert Committee on fuels for Power Generation, Executive Summary – By Government of India, Central Electricity Authority, Planning Wing, dated February 2004

[5] Reference: Cost of power generation from coal and coal washery rejects as estimated by ASL

***STEP 4: If more than one credible and plausible alternative scenario remain, the alternative with the lowest baseline emissions shall be considered as the most likely baseline scenario.***

As apparent from the above discussions under Step 3, there is only one most likely / plausible baseline scenario Alternative-4a, i.e. a coal and coal washery rejects based CPP to cater to the equivalent power as that of the WHRB system after considering the economic attractiveness of a coal and coal washery rejects based CPP as compared to the diesel based captive power plant and grid based power (as required under Step 3 above). Therefore since there is only one credible / plausible alternative that remains at this stage of assessment, the Alternative P4 (a) is identified as the baseline scenario for the project activity.

**B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality)**: >>

As per the decision 17/cp.7, paragraph 43, a CDM project activity is additional if anthropogenic emissions of green house gases by sources are reduced below those that would have occurred in absence of registered CDM project activity. The methodology requires the project proponent to determine the additionality based on 'Tool for the demonstration and assessment of additionality ver 04' as per EB-36 meeting.

The project proponent, ASL had initiated the project in December 2003 as apparent from the work order for the waste heat recovery boiler[6]. The project (WHRB) was originally scheduled for commissioning in September 2004. However due to unexpected delays the project could start regular commercial production only in September 2005. Further the project had faced operational problems for a few more months due to failure of some critical equipment. Therefore, though the project proponent had initiated the project in 2003, considering the delays and problems in the commissioning and operation of the project, the onset of CDM process also got delayed[7].

Additionality of project activity as described is discussed hereunder.

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

*Sub- step 1a. Define alternatives to the project activity:*

All the plausible and credible alternatives to the project as per the requirement of ACM 0012 have been discussed in section B4. The alternatives to the project activity have been evaluated based on Steps 1 to 4 as required by the ACM0012 methodology. Based on (a) fuel choice and availability, (b) taking into account national and/or sectoral policies, as well as (c) alternatives where barriers are prohibitive or which are clearly economically unattractive, it was determined that coal and coal washery rejects based AFBC boiler would have been the alternative source of power in absence of the project activity.

---

[6] Reference: Work order for Waste Heat Recovery Boiler

[7] Reference: The documentary evidence supporting the delays would be provided to the DOE.

*Sub-step 1b*

*Consistency with mandatory applicable laws and regulations*

The alternatives discussed in section B4 are all in compliance with applicable legal and regulatory requirements. Moreover, there are no foreseeable regulatory changes that would make the above alternatives non- compliant.

The project proponent has opted for Step-3 i.e. barrier analysis

**Step-3. Barrier Analysis**

In this step it needs to be determined whether the project activity faces barriers that:

- Prevented the implementation of this type of proposed project activity
- Do not prevent the implementation of at least one of the alternatives

***Sub-step 3a: Identify barriers that would prevent the implementation of the proposed CDM project activity:***

In this sub-step it is required to establish that there are realistic and credible barriers that would prevent the implementation of the proposed project activity from being carried out if the project activity was not registered as a CDM activity.

These realistic and credible barriers include the following:

**Investment Barrier**

The project activity i.e. the WHRB faced barriers to investment which is detailed in this section.

ASL has put up a 40 MW captive power plant with steam contribution from both AFBC boiler (115 TPH) and WHRB (52 TPH) boilers. The cost of the AFBC (115 TPH) boiler and WHRB (52 TPH) boiler along with Electro Static Precipitators (ESPs) for AFBC and WHRB including erection and commissioning was about 503.0 Million INR[8].

In the absence of the WHRB, the existing AFBC boiler could have been expanded from 115 TPH to 165 TPH steam generation capacity (the additional 50 TPH would cater to the steam generation that would have been generated by the WHRB in the project activity). The cost of this 165 TPH AFBC boiler along with the ESPs and including erection and commissioning would be about 400.0 Million INR[9].

It is apparent from the above that the WHRB system is more costly when compared to expanding the AFBC boiler to cater to the same/ equivalent steam and power generation as that of the WHRB. Therefore in the absence of the WHRB, ASL could have increased the capacity of the existing boiler equivalent to the capacity of the WHRB (of 52 TPH) as it requires only a marginal increase in the project cost. However, ASL in order to reduce the GHG emissions and also to avail the carbon benefits due to power

---

[8] Reference: Offer from Thermax Limited

[9] Reference: Offer from Thermax Limited

generation from WHRB, proposed to set up a WHRB with 52 TPH capacity. ASL, having decided to go ahead with the WHRB further faced the following barriers:

The plan originally envisaged to be commissioned in September 2004, was delayed by a year[10] due to the following reasons:

- Delay in delivery of equipment by vendors
- Delay in work to be done by contractors
- Unavailability of skilled work force in the area

The above delays increased the project cost by 32% and the additional fund requirement had to be met through internal accruals which put a severe strain on the company's financial resources.

**Technological barriers**

The following technological barriers were evidenced in the project activity:

**(A) Training related**

As per additionality tool definition it is required to prove that '*Skilled and/or properly trained labour to operate and maintain the technology is not available, which leads to an unacceptably high risk of equipment disrepair and malfunctioning or other underperformance*';

At the time when ASL ordered the WHRB boiler, not a single boiler of this configuration was in operation in the region. ASL had taken the decision of implementing the project, being fully aware that they would have to provide necessary training and provide for skill development to the employees/ people in order to face the technological challenges in operating this type of boiler.

For ensuring continuous power generation, consistent supply of gas at requisite heat value to the WHRB is required. This would require trained manpower to operate such kind of system. As ASL had no prior experience in this sector, they had to face many technological barriers during and after commissioning of the plant. ASL was aware that they would have to get people trained to operate and maintain the system for ensuring consistent and reliable power generation through the waste heat recovery from the DRI kilns without adversely affecting the kiln operation and product quality. Therefore ASL ensured that their personnel obtain relevant training for which ASL hired the service of consultant M/s Avante Garde Engineers and Consultants (P) Ltd, Chennai for operating the plant initially for a few months and simultaneously training the people/ employees in order to successfully run the plant[11].

**(B) Risk of technological failure:**

As per additionality tool '*the process/technology failure risk in the local circumstances is significantly greater than for other technologies that provide services or outputs comparable to those of the proposed CDM project activity, as demonstrated by relevant scientific literature or technology manufacturer information'*.

---

[10] Reference: Documentary evidence would be provided to DOE

[11] Reference: Training records pertaining to training of ASL personnel by M/s Avante Garde Engineers and Consultants (P) Ltd.

The project activity i.e. the power generation from waste heat recovery systems has the following technical hurdles/ challenges when compared to other technologies such as AFBC which can provide the same output/ service:

**(i) Waste gas quality from DRI kiln:**

The operation of the Kiln and the WHRB are interrelated without any isolation mechanism i.e. the kiln cannot run without the WHRB in operation and the entire gases generated from the kiln are routed through WHRB. Any instability in the quality of raw material of the DRI kiln, affects the flue gases generated. Usually the hot waste gases coming out of the kiln contain high level of SOx and NOx and hence the temperature needs to be maintained at a certain level (above acid dew point) so as to prevent formation of corrosive acids due to condensation of these gases. Corrosive acids may lead to acute damage in the boiler due to boiler tube failure and subsequently in the down stream equipments like ESP, ID Fan, dampers and the exhaust stack and hence boilers are to be taken to shut down for maintenance and kiln also has to be stopped. The cooling and heating cycle of the kiln takes minimum of about 5-6 days involving a substantial expenditure. Also, off grade sponge iron generation takes place in the kiln while cooling and restarting it. Moreover such irregularities in boiler operation also hamper smooth functioning of electric furnaces. Thus all these technical difficulties lead to colossal operational barriers which need to be properly addressed to ensure smooth functioning of the unit. The operational barriers can probably be handled/ managed by providing appropriate training to personnel who would operate the WHR boilers (discussed above).

Whereas all these technical barriers do not appear for the baseline alternatives i.e. the AFBC boiler as it can operate smoothly through coal injection which is controlled by the operators.

**(ii) Temperature control related**

Steam temperature control in WHRB is one of the critical functions in the operation of waste heat recovery boiler used with sponge iron kiln.

Unlike AFBC, steam temperature of WHRB depends on the steam flow and the temperature of flue gas generated from sponge iron kiln which passes through WHRB boiler. Some times the flow of flue gas from sponge iron kiln could rise abruptly and rush through WHRB which could result in sudden rise of steam temperature in WHRB. To control steam temperature, the temperature of flue gas from sponge iron kiln must be controlled. This could be controlled by spraying water on flue gas in the After Burning Chamber (ABC) which in turn could pose many problems in WHRB's operation.

The water sprayed on flue gas could vaporize and form cakes along with dust particles of the flue gas. These cakes can get carried over and get deposited on evaporators and economizer coils of WHRB. Over a period of time these cakes could get accumulated and form heavy masses. These heavy masses could fall on the other tubes of the boiler causing severe damage to it. Some times it could fall on the wet scrapper and damage its chain link. Hence the WHRB requires extra care and precautions to minimize the above operational problems related to temperature control. Further, higher moisture and un-burnt carbon carried along with waste gas could cause deposition on ESP electrodes leading to poor development on voltage across of electrodes and further resulting in poor collection of dust and hence causing higher emissions from stack. Also higher moisture in gas could cause cracking of support insulators and could drastically reduce the collection efficiency. All this could lead to stoppage of kiln operation as ESP would have to be rectified for compliance of environmental norms before restarting the kiln. The above could result in loss of sponge iron production and also correspondingly reduce the power generation from the project activity.

On the contrary, controlling of steam temperature in AFBC boiler is simpler as it is controlled by fuel injected to the boiler which is entirely dependent on the operator. Therefore, this barrier is more relevant to the project activity and does not affect the baseline i.e. the AFBC boiler

**(iii) Boiler operational problems**

Considering its high pressure and temperature configuration, ASL's project activity did face some operational problems post commissioning and to sort out the problems associated with operating WHRB at high pressure (87ata) and 510$^0$C temperature, ASL had to shut down the kiln many a times leading to huge financial loss to the tune of INR 135 Million. The other production units of the plant could also not be run due to non-availability of power. ASL has also shut down kilns due to maintenance related problems of the WHRB several times after commissioning.

The details of various technological barriers faced by ASL and the subsequent financial loss due to it would be provided to the DOE during the validation.

**(iv) Other equipments:**

The gas coming out from the kiln contains moisture and un-burnt coal which could stick to the wall of the electrodes and adversely affect the performance of the ESP connected to the WHRB. Any disruption in the operation of the pollution control equipment like ESP or any other down stream auxiliaries will lead to boiler failure and hence the operation of the DRI kiln also will be disrupted due to interconnectivity of the kiln with the boiler without any isolation scheme. ASL during the plant operation faced this technological barrier many a times and had to stop the kiln on a number of occasions to clean the ESP in order to meet the environmental regulations. These stoppages in turn affects the power generation from WHRB. Thus the WHRB demands exact functioning of all the down stream equipments so as to ensure hassle free operation in all the production facilities.

A fully condensing turbine has been installed so as to maximise the electrical output. Besides this an economiser also has been set to operation with an aim to maintain lowest possible exhaust gas temperature which will enable maximum heat recovery from the waste gases. Thus designing of the economiser demands additional technical sophistication so as to ensure gas temperature is maintained above acid dew point before the gas leaves through the exhaust stack.

**(v) Low capacity utilisation of WHRB:**

It is a known fact that the capacity utilisation of WHRB is lower than the capacity utilisation of the AFBC boilers considering the operational problems of WHRB as compared to the AFBC boiler as well as due to the dependence of the WHRB on the kiln operation and other downstream equipments (as apparent from the above discussions).

It is also to be noted that despite the WHRB having a capacity of 52 TPH, the capacity utilisation[12] as evidenced during the period April 2007 to August 2007 at ASL was only about 60% as compared to the AFBC boiler whose capacity utilisation was about 92%. However, considering the improved operation of the boiler and removal of constraints on power evacuation system, ASL expects to achieve 70% and 95% capacity utilisation of WHRB and AFBC respectively in the future. This reduced capacity utilisation of

[12] Reference: Capacity utilisation of WHRB and AFBC boiler at ASL during the period

WHRBs can be attributed to various problems associated with the availability of flue gases from the kilns and other related operational difficulties as detailed above.

It was also observed that due to unavailability of right quality and quantity of Iron ore, the sponge iron production could not be more than 60% which in turn affected the power generation from the WHRB. The same problems cannot be encountered with the AFBC and therefore there would be assured supply of steam from AFBC as against the WHRB system. Had an equivalent capacity AFBC boiler been installed in place of the WHRB boiler, correspondingly the power generation from the captive power plant would have been much higher. Further, as surplus power from the captive power plant is sold to the state grid, the revenues from the sale of power would also have been higher.

This further justifies the fact that ASL could have opted to implement AFBC in place of WHRB considering better capacity utilisation of AFBC as compared to WHRB.

**(C) The particular technology used in the proposed project activity is not available in the relevant region**.

The project activity (waste heat recovery boiler) was second in the State of Orissa for generating steam with the high pressure and temperature configuration of 87 $kg/cm^2$ and 510 deg C respectively for recovering waste heat from 500 TPD sponge iron kiln flue gases[13].

**Barriers due to prevailing practice**

ASL was the 2$^{nd}$ company[14] in the state to initiate the work on its plant and signed a Memorandum of Understanding (MOU) with the Orissa Government. Though, ASL had initiated the work of setting up the integrated complex earlier, it could not do so in time, as it faced many barriers during the implementation of the project.

The project activity (waste heat recovery boiler) was second in the State of Orissa for generating steam with the high pressure and temperature configuration of 87 $kg/cm^2$ and 510 deg C respectively for recovering waste heat from 500 TPD sponge iron kiln flue gases[15].

**Institutional Barrier**

ASL has signed a power purchase agreement (PPA) with Grid Corporation of Orissa (GRIDCO) for exporting power to the grid. GRIDCO has signed the PPA for a tariff of INR 2.02 for the whole tenure of the PPA. Also, as per the PPA, GRIDCO has to pay ASL for the power exported within seven days of the receipt of the invoice. However, there have been consistent delays in payment from GRIDCO. This has led to further financial constraints to ASL. Carbon funds i.e. CDM revenues, will ease out these financial constraints.

In the Memorandum of Understanding (MoU) signed with the Government of Orissa, the Govt had promised to provide the right quality and quantity of iron ore for the kiln at ASL. However only 21% of

[13] Reference: Letter from Directorate of Factories and Boilers, Orissa, Bhubhaneshwar that ASL was the second in the State of Orissa to put up a high pressure and temperature configuration WHRB with maximum pressure of 98 $kg/cm^2$

[14] Pioneer special MOU-Orissa (mines and Minerals)

[15] Reference: Letter from Directorate of Factories and Boilers, Orissa, Bhubhaneshwar that ASL was the second in the State of Orissa to put up a high pressure and temperature configuration WHRB with maximum pressure of 98 $kg/cm^2$

the requirement could be met and balance had to be procured from the market at higher price which was also of poor quality. This low quality and quantity of iron ore affected the kiln operation (as the kiln had to operate at lower throughput) which adversely affected the capacity utilisation /PLF of the WHRB boiler as the performance of the WHRB depends on the waste gases/heat from the kiln. This institutional barrier has affected the performance of the WHRB in the project activity.

***Sub-step 3 b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity):***

The above identified barriers do not prevent the implementation of the baseline option i.e. the coal/ coal washery rejects based captive power plant which is the most likely and economically attractive alternative to the project. This is considering the below:

(1) The capital cost of the coal based CPP is lower when compared to the project activity (WHRB based power with high pressure and temperature configuration) as detailed above in the investment barrier section. An equivalent capacity AFBC boiler would have been much cheaper than the WHRB. Further due to delays in project commissioning there was a significant rise in the project cost which ASL had to source through internal accruals which put a strain on the company's financial resources.

(2) The AFBC technology is common and is prevailing practice and, therefore does not face technology related barriers as compared to a WHRB system of high temperature pressure configuration (as described in the Technological barriers section in Sub-step 3a).

- Operation of AFBC boiler being common practice in the region and in the country, it does not require specialized training as compared to WHRB boilers with the high pressure and temperature configuration as that of the project activity
- The process/technology failure risk in the local circumstances is significantly greater for WHRB than for AFBC which provides similar outputs considering the following:

a. WHRB's depend on the operation of the DRI kiln and cannot operate in isolation where as AFBC boiler operation is smoothly controlled by operators

b. Controlling steam temperature in the WHRB is operationally more difficult when compared to that of the AFBC boiler

c. Boiler operational problems occurred in the WHRB (as apparent in the project activity) where as AFBC boiler does not face such operational problems. The operation and maintenance cost of a WHRB is much higher than that of AFBC boiler.

d. The capacity utilization of WHRB is significantly less when compared to that of AFBC boiler due to operational problems which reduces the power generation and therefore revenues from sale of power. AFBC of equivalent capacity would have generated more power and generated more revenues from sale of power.

**e.** Technological risks / uncertainties of the WHRB in the project activity, is primarily on account of high technical configuration (high pressure and temperature) and its dependence on kiln operational parameters, where as such risks are not associated with the AFBC boilers

**Step 4. Common practice analysis**

Based on the information about activities similar to the proposed project activity, ASL need to demonstrate a common practice analysis to complement and reinforce the barrier analysis. ASL is required to identify and discuss the existing common practice through the following sub-steps:

*Step 4a: Analyze other activities similar to the proposed project activity*

A recent study conducted by Joint Plant Committee under the guidance of Ministry of Steel, Government of India pinpoints that out of 147 coal based sponge iron units surveyed the number of units with captive power generation facility is only 16 with maximum concentration in Chhattisgarh. Thus it clearly indicates that captive power generation is not a common phenomenon (only 10.88% in the country) in the similar industrial units. Captive power generation includes waste heat recovery based power generation as well.

During the time of project implementation, 64 sponge iron units were operating in Orissa out of which 58 plants[16] import electricity from the state grid and only 6 units were identified to have the waste heat recovery based captive power plant in their facility. Amongst these six units, three plants (Tata Sponge Iron Limited (TSIL) – 7.5 MW, OCL – 8 MW, Orissa Sponge Iron Limited (OSIL) – 10 MW) have implemented the waste heat recovery projects taking into account potential benefits available under CDM and therefore not included in the common practice analysis. Thus it can be interpreted that during the time of implementation the project activity was observed in only 3 other units i.e. 4.6 % of total plants in Orissa. Moreover the temperature and pressure configuration of the WHRB system in the project activity is the second highest amongst the existing waste heat recovery based captive power plants in similar industrial units in the State of Orissa.

The letter from the Directorate of Factories and Boilers, confirms the fact that the identified project activity is the second of its kind in the State of Orissa, with regard to the high pressure and temperature configuration. Although, it is to be noted that when ASL decided to go for the project, none of the plants with similar configuration were in operation in the State. Further, the Orissa Sponge Iron Manufacturer's Association (OSIMA) has mentioned that the waste heat recovery boiler installed by ASL with steam capacity of 52 TPH and with 515 ± 5 deg C temperature and 87 ata pressure is technically one of the early systems to be installed operating at higher temperature and pressure.

Thus in light of the above discussion it can be concluded that the waste heat recovery based captive power plant is not a common practice in the region and moreover adaptation of such a high pressure and temperature configuration in the identified captive power plant has made the project even more exceptional in the region.

Thus in light of the above discussion it can be concluded that there were significant barriers and technological challenges associated with the project activity which has restricted other similar industrial units from establishing such a project (of similar technological features) where as ASL has gone ahead with the proposed project activity considering CDM revenues into account.

*Step 4b: Discuss any similar options that are occurring*

It is apparent from the above discussion that out of 64 sponge iron plants in the Orissa state (at the time of project activity implementation) only six of them had captive power plant based on waste heat recovery of which 3 of the projects have already been registered at UNFCCC as CDM projects and are availing the

[16] http://cdm.unfccc.int/UserManagement/FileStorage/1XPWFZQB692QDF7NEK8WYUPYRG3MMN

carbon benefits. It is evident that similar options occurring in the region are considering inflow of CDM revenues due to the risks/ challenges faced by them. Further ASL's project is relatively unique as it is relatively a higher technical configuration when compared to other WHR projects in sponge iron plants in the region, which obviously faces greater risks and uncertainties and therefore CDM revenues are essential to mitigate these technical hurdles.

## B.6. Emission reductions:

### B.6.1. Explanation of methodological choices:

**A) Baseline Emissions**

As per ACM0012, baseline emissions for the year y shall be determined as follows:

$BE_{y} = BE_{EN,y} + BE_{flst,y}$

Where

$BE_{y}$ are the total baseline emissions during the year y in tons of CO2

$BE_{EN,y}$ are baseline emissions from energy generated by the project activity during the year y in tons of CO2

$BE_{flst,y}$ are baseline emissions from generation of steam if any, using fossil fuel, that would have been used for flaring the waste gas in absence of the project activity (tCO2e per year), calculated as per equation 1c of ACM0012. This is relevant for those project activities where in the baseline steam is used to flare the waste gas. As ASL's project activity was implemented in a new facility, there is no plant specific historic data available to estimate the steam required per unit of waste gas flared and therefore as per ACM0012, the baseline emissions from this source is ignored. Hence $BE_{flst,y}$ is not considered relevant to the project activity.

The calculation of baseline emissions ($BE_{EN,y}$) depends on the identified baseline scenario. For the project activity the baseline emissions are determined as per *Scenario 1 of ACM0012* has been used.

*Baseline emissions for Scenario 1:*

Scenario 1 represents the situation where the electricity is obtained from a specific existing power plant or from the grid and heat from a fossil fuel based element process (e.g. steam boiler, hot water generator, hot air generator, hot oil generator).

$BE_{EN,y} = BE_{Elec,y} + BE_{Ther,y}$

$BE_{Elec,y}$ are baseline emissions from electricity during the year *y* in tons of CO2

$BE_{Ther,y}$ are baseline emissions from thermal energy (due to heat generation by element process) during the year *y* in tons of CO2

As the project activity involves only generation of electricity, the factor $BE_{Elec,y}$ is only considered for estimating baseline emissions. Therefore the following subsection (a) in ACM0012 has been used for the purpose:

***Baseline emissions from electricity ($BE_{electricity,y}$) that is displaced by the project activity***:

$$BE_{Elec,y} = f_{cap}\ x\ f_{wg}\ x \sum_{j}\sum_{i}((EG_{i,j,y}\ x\ EF_{Elec,i,j,y})$$

Where:

$BE_{elec,y}$ are baseline emissions due to displacement of electricity during the year *y* in tons of CO2.

$EG_{i,j,y}$ is the quantity of electricity supplied to the recipient *j* by generator, which in the absence of the project activity would have been sourced from *i*th source (*i* can be either grid or identified source) during the year *y* in MWh, and

$EF_{elec,i,j,y}$ is the CO2 emission factor for the electricity source i (i=gr (grid) or i=is (identified source)), displaced due to the project activity, during the year *y* in tons CO2/MWh

$f_{wg}$ Fraction of total electricity generated by the project activity using waste gas. As the steam used for generation of the electricity in ASL is produced in dedicated boilers but supplied through common header, this factor is estimated using equation (1d/1e) of ACM0012.

$f_{cap}$ Energy that would have been produced in project year y using waste gas/heat generated in base year expressed as a fraction of total energy produced using waste gas in year y. The ratio is 1 if the waste gas/heat/pressure generated in project year y is same or less then that generated in base year.

***Estimation of CO2 emission factor ($EF_{Elec,i,j,y}$) for the captive power plant at ASL***

As the baseline for ASL's project activity has been identified as the power generation from coal and coal washery rejects based captive power plant, the CO2 emission for the same would be estimated/ determined as follows as per ACM0012:

$$EF_{Elec,is,j,y} = \frac{EF_{CO2,is,j}}{\eta_{Plant,j}}\ x\, 3.6 * 10^{-3}$$

Where:

$EF_{CO2,is,j}$ is the CO2 emission factor per unit of energy of the fossil fuel *used* in the baseline generation source *i* in (tCO2 / TJ), o*btained from reliable local or national data if available, otherwise, taken from the country specific IPCC default emission factors*

$\eta_{Plant,j}$ is the overall efficiency of the existing plant that would be used by jth recipient in the absence of the project activity.

As per ACM0012, Efficiency of the power plant ($\eta_{Plant,j}$) shall be one of the following:

- (i) Assume a constant efficiency of the captive plant and determine the efficiency, as a conservative approach, for optimal operation conditions i.e. design fuel, optimal load, optimal oxygen content in flue gases, adequate fuel conditioning (temperature, viscosity, moisture, size/mesh etc), representative or favorable ambient conditions (ambient temperature and humidity); or
- (ii) Highest of the efficiency values provided by two or more manufacturers for power plants with specifications similar to that that would have been required to supply the recipient with electricity that it receives from the project activity; or
- (iii) Assume a captive power generation efficiency of 60% based on the net calorific values as a conservative approach; or
- (iv) Estimated from load v/s efficiency curve(s) established for equipment(s) through measurement and described in Annex I of ACM0012. Follow international standards for estimation of efficiency of power plants.

For determining the efficiency of the captive power plant at ASL, option (ii) mentioned above has been used. As per this option (ii), the efficiency of the captive power plant at ASL has been estimated to be 22.49% considering the following values:

- Net calorific value of blend of coal and coal washery rejects is 2200 kCal/kg
- Boiler efficiency as per manufacturer's details is 79%
- Turbine heat rate is 3021.0 Kcal/kWh

Considering the above efficiency of 22.49% and emission factor of coal as per IPCC being 26.1 tC/TJ, the CO2 emission factor of the captive power plant is derived as 1.53 tCO2/MWh.

***Estimation of fraction of total electricity generated by using waste gas in the project activity ($f_{wg}$):***

At ASL, the steam used for generation of electricity is produced in dedicated boilers i.e. Waste Heat Recovery Boiler (WHRB) and coal based AFBC boiler but supplied through a common header. As explained in Section A.2, in the project activity there is 1 WHRB boiler (52 TPH steam generation capacity) and 1 coal/ coal washery reject based AFBC boiler (115 TPH steam generation capacity) supplying steam to a 40 MW TG set through a common header

It is hence not possible to determine the electricity generated by using waste gas by means of direct measurement. The ACM0012 methodology provides two situations/ options to calculate the fraction of energy produced. Of the two options, Situation 2 is adopted for the project activity. Situation 2 says that '*An alternative method that could be used when it is not possible to measure the net calorific value of the waste gas/heat, and steam generated with different fuels in dedicated boilers are fed to turbine/s through common steam header takes into account that the relative share of the total generation from waste gas is calculated by considering the total steam produced and the amount of steam generated from each boiler'*

Since the measurement of the net calorific value of the waste gas on continuous basis is not possible at ASL's facility, it has been decided to choose this *Situation 2*, based on steam generation from boilers.

Therefore this factor ($f_{wg}$) on fraction of electricity generated using waste gas in the project activity is determined as per equation 1e of ACM0012:

$$f_{WG} = \frac{ST_{whr,y}}{ST_{whr,y} + ST_{other,y}}$$

Where,

| | |
|---|---|
| $ST_{whr,y}$ , | Energy content of the steam generated in waste heat recovery boiler fed to turbine via common steam header |
| $ST_{other\,y}$ | Energy content of steam generated in other boilers fed to turbine via common steam header. In ASL's project activity, this refers to the AFBC boiler based on coal and coal washery rejects |

As per ACM0012, the Situation/ Method 2 as detailed above requires that:

- All the boilers have to provide superheated steam.
- The calculation should be based on the energy supplied to the steam turbine. The enthalpy and the steam flow rate must be monitored for each boiler to determine the steam energy content.
- The calculation implicitly assumes that the properties of steam (temperature and pressure) generated from different sources are the same. The enthalpy of steam and feed water will be

determined at measured temperature and pressure and the enthalpy difference will be multiplied with quantity measured by steam meter.
- Any vented steam should be deducted from the steam produced with waste gas/heat.

***Estimation of baseline cap ($f_{cap}$) for the project activity:***
As an element of conservativeness, the ACM0012 methodology requires that baseline emissions should be capped irrespective of planned/ unplanned or actual increase in output of plant, change in operational parameters and practices, change in fuels type and quantity resulting into increase in waste gas generation. In case of project activity like ASL's which is implemented in a new facility, the method 2 shall be used for determining $f_{cap}$.Under this method 2, following equations should be used to estimate $f_{cap}$.

$$f_{cap} = \frac{Q_{WG,BL}}{Q_{WG,y}}$$

$$Q_{WG,BL} = Q_{BL,product}\ x\ q_{wg,product}$$

Where;

| | |
|---|---|
| $Q_{WG,BL}$ | Quantity of waste gas generated prior to the start of the project activity |
| $Q_{WG,y}$ | Quantity of waste gas used for energy generation during year y (Nm3) |
| $Q_{BL\ product}$ | Production by process that most logically relates to waste gas generation in baseline. |
| $q_{wg,\ product}$ | Amount of waste gas/heat/pressure the industrial facility generates per unit of product generated by the process that generates waste gas/heat/pressure. |

As ASL's project is implemented in a new facility, there is no historic waste gas generation prior to the start of the project activity and therefore the manufacturer's data for the industrial facility shall be used to estimate the amount of waste gas/heat the industrial facility (ASL) generates per unit of product (sponge iron) generated by the sponge iron kiln. The value arrived at would be used to estimate baseline cap.

**B) Project Emissions**

As per the methodology-ACM0012, the project emissions include emissions due to combustion of auxiliary fuels used to supplement the waste gas and electricity emissions due to consumption of electricity for cleaning the gas before being used for generation of heat/ energy/ electricity.

$PE_y = PE_{AF,y} + PE_{EL,y}$

| | |
|---|---|
| $PE_y$ | Project emissions due to the project activity |
| $PE_{AF,y}$ | Project activity emissions from onsite consumption of fóssil fuels by the cogeneration plants in case they are used as supplementary fuels, due to non availability of waste gas to the project activity or due to any other reason. |
| $PE_{EL,y}$ | Project activity emissions from onsite consumption of electricity for gas cleaning equipment |

In the project activity, no auxiliary fuel is used to supplement waste gas and hence there would be no emissions from combustion of auxiliary fuels for supplementing the waste gas. Further the gas is not cleaned before its use in generating electricity and therefore there are no related emissions due to electricity consumption for cleaning of gas. However it needs to be noted that in case of start-up/ maintenance of WHRB, during emergencies etc, power/ electricity generated from the coal and coal washery rejects based AFBC boiler would be used. Based on the electricity consumed during this start up/ maintenance of WHRB and during emergencies, as per ACM0012, the project emissions from consumption of additional electricity by the project activity is determined as follows:

$PE_{EL,y} = EC_{PJ,y} \times EF_{CO2,EL,y}$

Where,

| | |
|---|---|
| $PE_{EL,y}$ | Project emissions from consumption of electricity in tCO2/ yr (considering use of fossil fuel based power for start up/ maintenance purposes i.e. power generated from coal and coal washery rejects based AFBC) |
| $EC_{PJ,y}$ | Additional electricity consumed in the year y as a result of the implementation of the Project activity in MWh |
| $EF_{CO2,EL,y}$ | CO2 emission factor for electricity consumed by the project activity in year y (tCO2/ MWh) |

Since electricity used by the project activity is generated on-site using coal and coal washery rejects based AFBC, the CO2 emission factor for electricity ($EF_{CO2,EL,y}$) may be determined by one of the options as per ACM0012:

- Use of default emission factor of 1.3 tCO2/ MWh
- Calculate the emission factor of the captive power plant at the project site, calculated based on the fuel consumption and electricity generation in year y, as follows.

For the project activity at ASL, a default emission factor of 1.3 tCO2/MWh is used for the purpose of calculating the project emissions.

**C) Leakage**

No leakage is applicable under this methodology ACM0012.

**Emission Reduction**

The emission reduction $ER_y$ by the project activity during a given year *y* is the difference between the baseline emissions ($BE_y$) and project emissions ($PE_y$), as follows:

$$ER_y = BE_y - PE_y$$

Where:

| | |
|---|---|
| $ER_y$ | are the total emissions reductions of the project activity during the year *y* in tons of $CO_2$, |
| $BE_{,y}$ | are the baseline emissions for the project activity during the year *y* in tons of $CO_2$, |
| $PE_y$ | are the emissions from the project activity during the year *y* in tons of $CO_2$, |

**B.6.2. Data and parameters that are available at validation:**

*(Copy this table for each data and parameter)*

| **Data / Parameter:** | $\eta_{BL}$ ( $\eta_{Plant,j}$) |
|---|---|
| Data unit: | % |
| Description: | Baseline efficiency of the captive power plant |

| | |
|---|---|
| Source of data used: | Manufacturers data |
| Value applied: | 22.49 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Efficiency of the captive power plant is as per (ii) Highest of the efficiency values provided by two or more manufacturers for captive power plants used in the project activity; |
| Any comment: | The following values have been considered to estimate the efficiency as per the method indicated above:<br>• Net calorific value of coal and coal washery rejects is 2200 kCal/kg<br>• Boiler efficiency as per manufacturer's details is 79%<br>• Turbine heat rate is 3021.0 Kcal/kWh |

| | |
|---|---|
| Data / Parameter: | $EF_{CO2,is,y}$ |
| Data unit: | tCO2/TJ |
| Description: | CO2 emission factor per unit of energy of the fossil fuel (coal) used in the baseline generation source |
| Source of data to be used: | The source of data is IPCC default values |
| Value applied: | 95.7 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | - |
| Any comment: | This value is sourced from IPCC |

| | |
|---|---|
| Data / Parameter: | $EF_{Elec,i,j,y}$ |
| Data unit: | tCO2/MWh |
| Description: | CO2 emission factor for the electricity source (coal and coal washery rejects based AFBC), displaced due to the project activity, during the year *y* |
| Source of data to be used: | ASL's calculation sheets |
| Value applied: | 1.53 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The emission factor is calculated based on the equation 1a-11 of ACM0012 which requires values of:<br>(a) CO2 emission factor per unit of fossil fuel used in the baseline i.e. $EF_{CO2,is,y}$. This value has been obtained from IPCC which is 26.1 tC/TJ or 95.7 tCO2/TJ for coal.<br>(b) Overall efficiency of the existing plant ($\eta_{BL}$ ( $\eta_{Plant,j}$) that would be used in the absence of the project activity. This has been estimated as 22.49% |
| Any comment: | This value is calculated based on equation 1a-11 of ACM0012 |

| | |
|---|---|
| **Data / Parameter:** | $Q_{WG,BL}$ |
| Data unit: | Nm3 |
| Description: | Quantity of waste gas generated prior to the start of the project activity. |

| | |
|---|---|
| Source of data used: | Source of data is manufacturer's specification |
| Value applied: | 864,000,000 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Estimated based on information provided by the technology supplier on the waste gas/heat per unit of product (sponge iron) and volume or quantity of production of sponge iron. |
| Any comment: | As the project activity is implemented in a new facility the method 2 is adopted |

| **Data / Parameter:** | $Q_{BL, Product}$ |
|---|---|
| Data unit: | Tons/ yr |
| Description: | Plant or departmental. Production process which most logically relates to waste gas generation in baseline. |
| Source of data used: | ASL, the project proponent |
| Value applied: | 150,000. |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The maximum potential sponge iron production output of the kilns as per the rated capacity of the kiln, obtained from the technology specification/ manufacturers specification |
| Any comment: | - |

| **Data / Parameter:** | $q_{wg, Product}$ |
|---|---|
| Data unit: | $m^3$/ Ton |
| Description: | Specific waste gas production per unit of sponge iron which most logically relates to waste gas generation generated as per manufacturer's data. |
| Source of data used: | Manufacturer |
| Value applied: | 5760 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | From manufacturer's specification |
| Any comment: | - |

### B.6.3 Ex-ante calculation of emission reductions:

**A) Baseline Emissions**

The following equations as explained in B.6.1 are used for estimation of baseline emissions.
$BE_{EN,y} = BE_{Elec,y} + BE_{Ther,y}$

As $BE_{Ther,,y}$ is not relevant only $BE_{Elec,y}$ is considered for computing baseline emissions.

**Computation of $BE_{Elec,y}$ :**

$$BE_{Elec,y} = f_{cap}\ x\ f_{wg}\ x \sum_{j}\sum_{i}((EG_{i,j,y}\ x\ EF_{Elec,i,j,y})$$

Since the baseline scenario has been determined as coal and coal washery rejects based captive power generation, the emission factor for displaced electricity as per ACM0012 is calculated as follows.

**Computation of $EF_{Elec,i,j,y}$ :**

$$EF_{Elec,is,j,y} = \frac{EF_{CO2,is,j}}{\eta_{Plant,j}}\ x 3.6 * 10^{-3}$$

For determining the efficiency of the captive power plant at ASL, option (ii*) "Highest of the efficiency values provided by two or more manufacturers for power plants with specifications similar to that would have been required to supply the recipient with electricity that it receives from the project activity*" has been used. The details of efficiency calculations are provided in Table B-4 below:

| Table B-4: Determination of $CO_2$ Baseline Emission Factor for Electricity Displaced $EF_{Elec,i,j,y}$ | | |
|---|---|---|
| **Description** | **Value** | **Unit** |
| Net calorific value of coal and coal washery rejects | 2200 | kCal/kg |
| | 0.00921096 | TJ/tonne |
| Energy input to the boiler | 2.56 | MWh/tonne |
| Boiler efficiency as per manufacturers' detail (%) | 79.0% | |
| Energy available at the boiler outlet | 2.0 | MWh/tonne |
| | 1,738,000 | kCal/tonne |
| Turbine heat rate | 3,021 | kCal/kWh |
| Energy available at the turbine outlet | 575.3 | kWh/tonne |
| Efficiency of the captive power plant ($\eta_{plant}$) | 0.2249 | |
| **Emission Factor of the baseline plant ($EF_{Elec,i,j,y}$)** | 1.53 | tCO2/MWh |

As per this option (ii), the efficiency of the captive power plant at ASL has been estimated to be 22.49%. Considering the above efficiency of 22.49% and emission factor of coal as per IPCC being 26.1 tC/TJ, the CO2 emission factor of the captive power plant is derived as 1.53 tCO2/MWh.

**Computation of $f_{wg}$ :**

$f_{wg}$ i.e. the fraction of electricity generated using waste gas in the project activity is determined as below:

$$f_{WG} = \frac{ST_{whr,y}}{ST_{whr,y} + ST_{other,y}}$$

***Steps to estimate the fraction of electricity generated using waste gas:***

*Step 1*: The quantity of steam generated from the WHRB ($QS_{WHRB}$) and the AFBC ($QS_{AFBC}$) are measured.

*Step 2*: The quantity of steam lost due to steam venting and blow down ($QS_{loss}$) is calculated as 5% of the total steam generation from both the WHRB and AFBC boilers.

*Step 3*: The net quantity of steam generated from the WHRB ($QS_{WHRB-Net}$) is estimated as $QS_{WHRB-Net} = QS_{WHRB} - QS_{loss}$.

*Step4*: The enthalpy of the steam from the WHRB ($H_{WHRB}$) and AFBC ($H_{AFBC}$) are derived from the steam tables based on the steam pressure and steam temperature at the WHRB and AFBC respectively.

*Step 6*: The enthalpy of feedwater at the inlet to the WHRB ($H_{feed\_WHRB}$) and AFBC ($H_{feed\_AFBC}$) is determined

*Step 7*: The energy content of the steam from WHRB ($ST_{whr,y}$)is estimated as $ST_{whr,y} = QS_{WHRB-Net}$ X ($H_{WHRB} - H_{feed\_WHRB}$) and energy content of the steam from AFBC ($ST_{other,y}$) is estimated as $ST_{other,y} = QS_{AFBC}$ X ($H_{AFBC} - H_{feed\_AFBC}$). This is as per requirement of ACM0012 that the *'enthalpy of steam and feed water* *will be determined at measured temperature and pressure and the enthalpy difference will be multiplied with quantity measured by steam meter'*

Based on the above Steps 1-7, for the project activity at ASL, $f_{wg}$ is determined. The details of estimating $f_{wg}$ is provided below in Table B-5:

| Table B-5 Estimation of fraction of electricity generated using waste gas (fwg) | | |
|---|---|---|
| **Description** | **Value** | **Units** |
| Total steam generation from WHRB & AFBC | 1,153,548,000 | kg/annum |
| Total steam loss due to venting and other blow down losses (Assumed as 5% of the generation) | 57,677,400 | kg/annum |
| Total Steam Generation from WHRB | 288,288,000 | kg/annum |
| Net steam generated from WHRB (Total steam generation from WHRB - Total steam loss) | 230,610,600 | kg/annum |
| Steam generated from AFBC boiler | 865,260,000 | kg/annum |
| Enthalpy of steam generated from WHRB (based on steam pressure of 87 kg/cm$^2$ and steam temperature of 510 deg C) | 815 | kcal/kg |
| Enthalpy of steam generated from AFBC (based on steam pressure of 87 kg/cm$^2$ and steam temperature of 510 deg C) | 815 | kcal/kg |
| Enthalpy of feedwater (at temperature of 150 deg C) at inlet to WHRB | 150 | kcal/kg |
| Enthalpy of feedwater (at temperature of 180 deg C) at inlet to AFBC boiler | 166.6 | kcal/kg |
| Steam energy content from WHRB ($ST_{whr,y}$) | 153,356,049,000 | kcal/annum |
| Steam energy content from AFBC ($ST_{other,y}$) | 561,034,584,000 | kcal/annum |
| Fraction of electricity generated using waste gas from WHRB ($f_{wg}$) = $ST_{whr,y}$/ ($ST_{whr,y}$ + $St_{other,y}$) | 0.215 | |

As apparent from the above Table, ($f_{wg}$) is 21.5% indicating the proportion or fraction of electricity generated using waste heat in the project activity.

**Total quantity of electricity supplied by the captive power plant ($EG_{i,j,y}$ )**

The total quantity of electricity supplied by the 40 MW CPP is provided below in Table B-6:

| Table B-6: Total electricity supplied by the 40 MW CPP | | |
|---|---|---|
| Total electricity generated by the 40 MW CPP | 273,967,650 | kWh/annum |
| Auxiliary consumption (11% of total electricity generated) | 30,136,442 | kWh/annum |
| Net electricity supplied by 40 MW CPP ( ($EG_{i,j,y}$) | 243,831,209 | kWh/annum |

Using equation $BE_{Elec,y} = f_{cap}\ x\ f_{wg}\ x \sum_j \sum_i ((EG_{i,j,y}\ x\ EF_{Elec,i,j,y})$ the baseline emissions in the absence of the project activity (WHRB) is estimated as below in Table B-7:

| Table B-7: Total baseline emissions from electricity displaced due to WHRB in the project activity | | |
|---|---|---|
| Baseline emissions from electricity that is displaced by the project activity ($BE_{Elec,y\text{-}40\,MW}$) = $f_{cap}$ X $f_{wg}$ * $EG_{i,j,y}$X $EF_{Elec,i,j,y}$ | 80,200 | tCO2/annum |

$BE_{Elec,y}$ = BE $_{Elec,y\,=}$ 80,200 tCO2/ annum

$BE_{EN,y}$ = $BE_{Elec,y}$ + $BE_{Ther,y}$
= $BE_{Elec,y}$ + 0
= 80,200 tCO2/annum

**B) Project Emissions**

Project Emissions are applicable to the project activity as power from AFBC boiler is used for generation start-up/ maintenance of the WHRB, in emergencies etc. For the project activity (consisting of 1 WHRB) about 66.168 MWh of power would be required annually for start–up / maintenance purpose. For the project activity at ASL, a default emission factor of 1.3 tCO2/MWh is used for the purpose of calculating the project emissions. The project emission determination is provided in Table B-8 below:

| Table B-8: Determination of Project Emissions (startup power, maintenance of WHRB, exigencies) | | |
|---|---|---|
| Power required for startup due to the project activity | 66.168 | MWh/ annum |
| Emission factor for the CPP (assumed as per ACM0012) | 1.30 | tons CO2/MWh |
| **Project emissions (PEy)** | **86.02** | **tons CO2/annum** |

(c) Emission reductions:

The emission reduction ERy by the project activity during a given year y is the difference between the baseline emissions (BEy) and project emissions (PEy), as follows:

ERy = BEy - PEy

Therefore

ERy = BEy - PEy

ERy = 80,200 – 86 = 80,114 $tCO_2$ /yr

### B.6.4 Summary of the ex-ante estimation of emission reductions:

| Year | Estimation of project activity emissions (tons) | Estimation of baseline emissions (tons) | Estimation of leakage (tons) | Estimation of overall emission reductions (tons) |
|---|---|---|---|---|
| Year 1 | 86 | 80,200 | 0 | 80,114 |
| Year 2 | 86 | 80,200 | 0 | 80,114 |
| Year 3 | 86 | 80,200 | 0 | 80,114 |
| Year 4 | 86 | 80,200 | 0 | 80,114 |
| Year 5 | 86 | 80,200 | 0 | 80,114 |
| Year 6 | 86 | 80,200 | 0 | 80,114 |
| Year 7 | 86 | 80,200 | 0 | 80,114 |
| Year 8 | 86 | 80,200 | 0 | 80,114 |
| Year 9 | 86 | 80,200 | 0 | 80,114 |
| Year 10 | 86 | 80,200 | 0 | 80,114 |
| **Total** | 860 | 802,000 | 0 | 801,140 |

## B.7 Application of the monitoring methodology and description of the monitoring plan:

### B.7.1 Data and parameters monitored:

*(Copy this table for each data and parameter)*

| **Data / Parameter:** | $Q_{WG,y}$ |
|---|---|
| Data unit: | $Nm^3$ |
| Description: | Quantity of waste gas used for energy generation during year y |
| Source of data to be used: | Generators of gas i.e. ASL |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 864,000,000 |
| Description of measurement methods and procedures to be applied: | Direct Measurements by project participants through an appropriate metering Device. An online flow meter would be installed at the WHRB duct (after ESP). |
| QA/QC procedures to be applied: | Measuring equipment would be calibrated once in a year. During the calibration period of the measuring equipment, the quantum of gas flow will be calculated based on the corresponding steam generated from the WHRB during that period. The steam flow is continuously measured by means of flow transmitter. |
| Any comment: | This data will be measured. |

| **Data / Parameter:** | **$EG_{40\ Gen}$** |
|---|---|
| Data unit: | MWh/year |
| Description: | Total Electricity generated from the 40 MW CPP of ASL (from both AFBC and WHRB) |
| Source of data to be used: | Onsite Instrumentation. The instrument used would be the KWh Meter. |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 273,967.65 |
| Description of measurement methods and procedures to be applied: | Tri vector energy meters have been installed to measure the gross energy generated. |
| QA/QC procedures to be applied: | The electrical engineers are responsible for the collection of data from energy meter. The data will be recorded in the log sheets on daily basis. The Shift in charge will cross check the data as recorded in the log book and will archive the log sheet in the management information systems (MIS) which will be reviewed and approved by the Deputy General Manager - DGM (Electrical and Instrumentation, E&I) and communicated to the Vice President (VP) – Sponge Iron and Power (SI & P). The data will be archived either electronically or in paper and will be available up to two years after crediting period<br><br>The energy meters are calibrated annually by the Standard Testing Laboratory (STL). |
| Any comment: | This data will be measured and a standby energy meter is available in the event of failure of the energy meter. |

| **Data / Parameter:** | **$EG_{40\ Aux}$** |
|---|---|
| Data unit: | MWh/yr |
| Description: | Auxiliary Consumption by the 40 MW CPP |
| Source of data to be used: | Onsite Instrumentation. The instrument used would be the Energy Meter. |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 30,136.4 |
| Description of measurement methods and procedures to be applied: | Energy meters have been installed to measure the auxiliary consumption. |
| QA/QC procedures to be applied: | The electrical engineers are responsible for the collection of data from energy meter. The data will be recorded in the log sheets on daily basis. The Shift in charge will cross check the data as recorded in the log book and will archive the log sheet in the management information systems (MIS) which will be reviewed and approved by the DGM (E&I) and communicated to the Vice President (VP) – (SI & P). The data will be archived either electronically or in paper and will be |

| | |
|---|---|
| | available up to two years after crediting period<br><br>The energy meters are calibrated annually by the Standard Testing Laboratory (STL). |
| Any comment: | This data will be measured and a standby energy meter is available in the event of failure of the energy meter. |

| **Data / Parameter:** | **$EG_{i,j,j}$** |
|---|---|
| Data unit: | MWh/yr |
| Description: | Net electricity generated by the 40 MW CPP |
| Source of data to be used: | Records at ASL |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 243,831.21 |
| Description of measurement methods and procedures to be applied: | The net electricity generated would be calculated by deducting auxiliary consumption from total electricity generation |
| QA/QC procedures to be applied: | The electrical engineers are responsible for the calculation and recording of data on the log sheets on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will archive the log sheet in the management information systems (MIS) which will be reviewed and approved by the DGM (E&I) and communicated to the Vice President (VP) – (SI & P). The data will be archived either electronically or in paper and will be available up to two years after crediting period |
| Any comment: | This data will be calculated |

| **Data / Parameter:** | **$QS_{WHRB}$** |
|---|---|
| Data unit: | T/day |
| Description: | Total steam generation from WHRB |
| Source of data to be used: | Onsite instrumentation (Flow meter) |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 873.6 |
| Description of measurement methods and procedures to be applied: | Flow meter has been installed to measure the flow. |
| QA/QC procedures to be applied: | The control desk engineers will record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and prepare the report which will be reviewed and approved by the Sr.DGM (PP) and further communicated to the Vice President (VP) – (SI & P). The data will be |

| | |
|---|---|
| | archived either electronically or in paper and will be available up to two years after crediting period<br><br>A detailed calibration system is already in place at ASL. The flow meter is calibrated annually by ASL through standard calibration procedures. |
| Any comment: | This parameter will be measured and a standby flow meter is available in the event of failure of the flow meter. |

| **Data / Parameter:** | **$QS_{AFBC}$** |
|---|---|
| Data unit: | T/day |
| Description: | Total steam generation from AFBC |
| Source of data to be used: | Onsite instrumentation (Flow meter) |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 2622 |
| Description of measurement methods and procedures to be applied: | Flow meter has been installed to measure the flow. |
| QA/QC procedures to be applied: | The control desk engineers will record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr.DGM (PP) which will be further communicated to the Vice President (VP) – (SI & P). The data will be archived either electronically or in paper and will be available up to two years after crediting period<br><br>A detailed calibration system is already in place at ASL. The flow meter is calibrated annually by ASL through standard calibration procedures. |
| Any comment: | This data will be measured and a standby flow meter is available in the event of failure of the flow meter. |

| **Data / Parameter:** | **$QS_{TG}$** |
|---|---|
| Data unit: | T/day |
| Description: | Total steam inlet to the turbine |
| Source of data to be used: | Onsite instrumentation (Flow meter) |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 3320.8 |
| Description of measurement methods and procedures to be applied: | Flow meter has been installed to measure the flow. |
| QA/QC procedures to | The control desk engineers will record the data in the log sheet on daily basis. |

| | |
|---|---|
| be applied: | The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr.DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period<br><br>A detailed calibration system is already in place at ASL. The flow meter is calibrated annually by ASL through standard calibration procedures. |
| Any comment: | This data will be measured |

| | |
|---|---|
| **Data / Parameter:** | **$QS_{loss}$** |
| Data unit: | T/day |
| Description: | Total steam lost due to venting, blow down etc at 40 MW CPP |
| Source of data to be used: | The data is calculated at ASL |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 174.78 |
| Description of measurement methods and procedures to be applied: | The data will be calculated. |
| QA/QC procedures to be applied: | The control desk engineers will record the calculated data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr.DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period |
| Any comment: | This parameter will be calculated as 5% of the total steam generation from both the WHRB and AFBC boiler. |

| | |
|---|---|
| **Data / Parameter:** | **$T_{WHRB}$** |
| Data unit: | $^{0}C$ |
| Description: | Average steam temperature from WHRB |
| Source of data to be used: | Onsite instrumentation (therrmocouple) |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 510 |
| Description of measurement methods and procedures to be applied: | Thermocouple has been installed to measure the temperature |

| | |
|---|---|
| QA/QC procedures to be applied: | The control desk engineers will record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr.DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period<br><br>A detailed calibration system is already in place at ASL. The thermocouple is calibrated annually by ASL through standard calibration procedures.<br>. |
| Any comment: | This data will be measured and a standby thermocouple is available in the event of failure of the thermocouple. |

| **Data / Parameter:** | **$T_{AFBC}$** |
|---|---|
| Data unit: | $^{0}C$ |
| Description: | Average steam temperature from AFBC boiler |
| Source of data to be used: | Onsite instrumentation (thermocouple) |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 510 |
| Description of measurement methods and procedures to be applied: | Thermocouple has been installed to measure the temperature |
| QA/QC procedures to be applied: | The control desk engineers will record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr.DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period<br><br>A detailed calibration system is already in place at ASL. The thermocouple is calibrated annually by ASL through standard calibration procedures |
| Any comment: | This data will be measured and a standby thermocouple is available. |

| **Data / Parameter:** | **$T_{feed\ WHRB}$** |
|---|---|
| Data unit: | $^{0}C$ |
| Description: | Temperature of feed water at inlet to WHRB |
| Source of data to be used: | Onsite instrumentation (thermocouple) |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 150 |
| Description of | Thermocouple has been installed to measure the temperature |

| | |
|---|---|
| measurement methods and procedures to be applied: | |
| QA/QC procedures to be applied: | The control desk engineers will record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr.DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period<br><br>A detailed calibration system is already in place at ASL. The thermocouple is calibrated annually by ASL through standard calibration procedures |
| Any comment: | This data will be measured and a standby local temperature gauge is available. |

| **Data / Parameter:** | $T_{feed\ AFBC}$ |
|---|---|
| Data unit: | $^{0}C$ |
| Description: | Temperature of feed water at inlet to AFBC |
| Source of data to be used: | Online instrumentation (thermocouple) |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 180 |
| Description of measurement methods and procedures to be applied: | Thermocouple has been installed to measure the temperature |
| QA/QC procedures to be applied: | The control desk engineers will record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr.DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period<br><br>A detailed calibration system is already in place at ASL. The thermocouple is calibrated annually by ASL through standard calibration procedures |
| Any comment: | This data will be measured and a standby local temperature gauge is available. |

| **Data / Parameter:** | $T_{TG}$ |
|---|---|
| Data unit: | $^{0}C$ |
| Description: | Average steam temperature at the inlet of Turbine |
| Source of data to be used: | Onsite instrumentation (thermocouple) |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 500 |

| | |
|---|---|
| Description of measurement methods and procedures to be applied: | Thermocouple has been installed to measure the temperature |
| QA/QC procedures to be applied: | The control desk engineers will record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr.DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period<br><br>A detailed calibration system is already in place at ASL. The thermocouple is calibrated annually by ASL through standard calibration procedures |
| Any comment: | This data will be measured and a standby thermocouple is available in the event of failure of the thermocouple |

| **Data / Parameter:** | $\mathbf{P_{WHRB}}$ |
|---|---|
| Data unit: | $Kg/cm^2$ |
| Description: | Average steam pressure from WHRB |
| Source of data to be used: | Onsite instrumentation (Pressure gauge) |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 87 |
| Description of measurement methods and procedures to be applied: | Pressure gauge has been installed to measure the pressure |
| QA/QC procedures to be applied: | The control desk engineers will record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr. DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period<br><br>A detailed calibration system is already in place at ASL. The pressure gauge is calibrated annually by ASL through standard calibration procedures |
| Any comment: | This data will be measured |

| **Data / Parameter:** | $\mathbf{P_{AFBC}}$ |
|---|---|
| Data unit: | $Kg/cm^2$ |
| Description: | Average steam pressure from AFBC |
| Source of data to be used: | Onsite instrumentation (Pressure gauge) |
| Value of data applied for the purpose of | 87 |

| | |
|---|---|
| calculating expected emission reductions in section B.5 | |
| Description of measurement methods and procedures to be applied: | Pressure gauge has been installed to measure the pressure |
| QA/QC procedures to be applied: | The control desk engineers will record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr. DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period<br><br>A detailed calibration system is already in place at ASL. The pressure gauge is calibrated annually by ASL through standard calibration procedures |
| Any comment: | This data will be measured |

| **Data / Parameter:** | **$P_{TG}$** |
|---|---|
| Data unit: | $Kg/cm^2$ |
| Description: | Average steam pressure inlet of Turbine |
| Source of data to be used: | Onsite instrumentation |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 85 |
| Description of measurement methods and procedures to be applied: | Pressure gauge has been installed to measure the pressure |
| QA/QC procedures to be applied: | The control desk engineers will record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr.DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period<br><br>A detailed calibration system is already in place at ASL. The pressure gauge is calibrated annually by ASL through standard calibration procedures |
| Any comment: | This data will be measured and a standby pressure gauge is available in the event of failure of the pressure gauge. |

| **Data / Parameter:** | **$H_{WHRB}$** |
|---|---|
| Data unit: | kCal/kg |
| Description: | Enthaply |
| Source of data to be used: | Steam tables |

| | |
|---|---|
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 815 |
| Description of measurement methods and procedures to be applied: | This data will be calculated from steam tables based on the steam pressure and steam temperature at the WHRB. . |
| QA/QC procedures to be applied: | The control desk engineers will calculate and record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr.DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period |
| Any comment: | This data will be calculated from the steam tables |

| **Data / Parameter:** | **$H_{AFBC}$** |
|---|---|
| Data unit: | kCal/kg |
| Description: | Enthaply |
| Source of data to be used: | Steam tables |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 815 |
| Description of measurement methods and procedures to be applied: | This data will be calculated from steam tables based on the steam pressure and steam temperature at the AFBC. |
| QA/QC procedures to be applied: | The control desk engineers will calculate and record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr.DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period |
| Any comment: | This data will be calculated from the steam tables |

| **Data / Parameter:** | **$H_{feed\_WHRB}$** |
|---|---|
| Data unit: | kCal/kg |
| Description: | Enthaply of feed water at inlet of WHRB |
| Source of data to be used: | Steam tables |
| Value of data applied for the purpose of calculating expected | 150 |

| | |
|---|---|
| emission reductions in section B.5 | |
| Description of measurement methods and procedures to be applied: | The data will be calculated from steam tables based on feed water temperature |
| QA/QC procedures to be applied: | The control desk engineers will calculate and record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr.DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period |
| Any comment: | - |

| **Data / Parameter:** | **$H_{feed\_AFBC}$** |
|---|---|
| Data unit: | kCal/kg |
| Description: | Enthaply of feedwater at inlet of AFBC |
| Source of data to be used: | Steam tables |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 166.6 |
| Description of measurement methods and procedures to be applied: | The data will be calculated from steam tables based on feed water temperature |
| QA/QC procedures to be applied: | The control desk engineers will calculate and record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr.DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period |
| Any comment: | - |

| **Data / Parameter:** | **$H_{TG}$** |
|---|---|
| Data unit: | kCal/kg |
| Description: | Enthaply |
| Source of data to be used: | Steam tables |
| Value of data applied for the purpose of calculating expected emission reductions in | 810 |

| | |
|---|---|
| section B.5 | |
| Description of measurement methods and procedures to be applied: | This data will be calculated from steam tables based on the steam pressure and steam temperature at the turbine inlet. |
| QA/QC procedures to be applied: | The control desk engineers will calculate and record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr.DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period |
| Any comment: | This data will be calculated from the steam tables |

| **Data / Parameter:** | $\mathbf{ST_{whr,\,y}}$ |
|---|---|
| Data unit: | kCal/ annum |
| Description: | Energy content of the steam generated in WHRB fed to the turbine via common header |
| Source of data to be used: | ASL |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 153,356,049,000 |
| Description of measurement methods and procedures to be applied: | This data will be calculated from equation $ST_{whr,y} = QS_{WHRB\ -\ Net}$ X $(H_{WHRB} - H_{feed\_WHRB})$ |
| QA/QC procedures to be applied: | The control desk engineers will calculate and record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr.DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period |
| Any comment: | This data will be calculated |

| Data / Parameter: | $\mathbf{ST_{Other,\,y}}$ |
|---|---|
| Data unit: | kCal/ annum |
| Description: | Energy content of the steam generated in AFBC fed to the turbine via common header |
| Source of data to be used: | ASL |
| Value of data applied for the purpose of calculating expected emission reductions in | 561,034,584,000 |

| | |
|---|---|
| section B.5 | |
| Description of measurement methods and procedures to be applied: | This data will be calculated from equation $ST_{other,y} = QS_{AFBC} X (H_{AFBC} - H_{feed\_AFBC})$. |
| QA/QC procedures to be applied: | The control desk engineers will calculate and record the data in the log sheet on daily basis. The shift-in-charge will cross check the data as recorded in the log book and will prepare the report which will be reviewed and approved by the Sr.DGM (PP) and further communicated to the Vice President (VP) – (SI&P). The data will be archived either electronically or in paper and will be available up to two years after crediting period |
| Any comment: | This data will be calculated |

### B.7.2 Description of the monitoring plan:

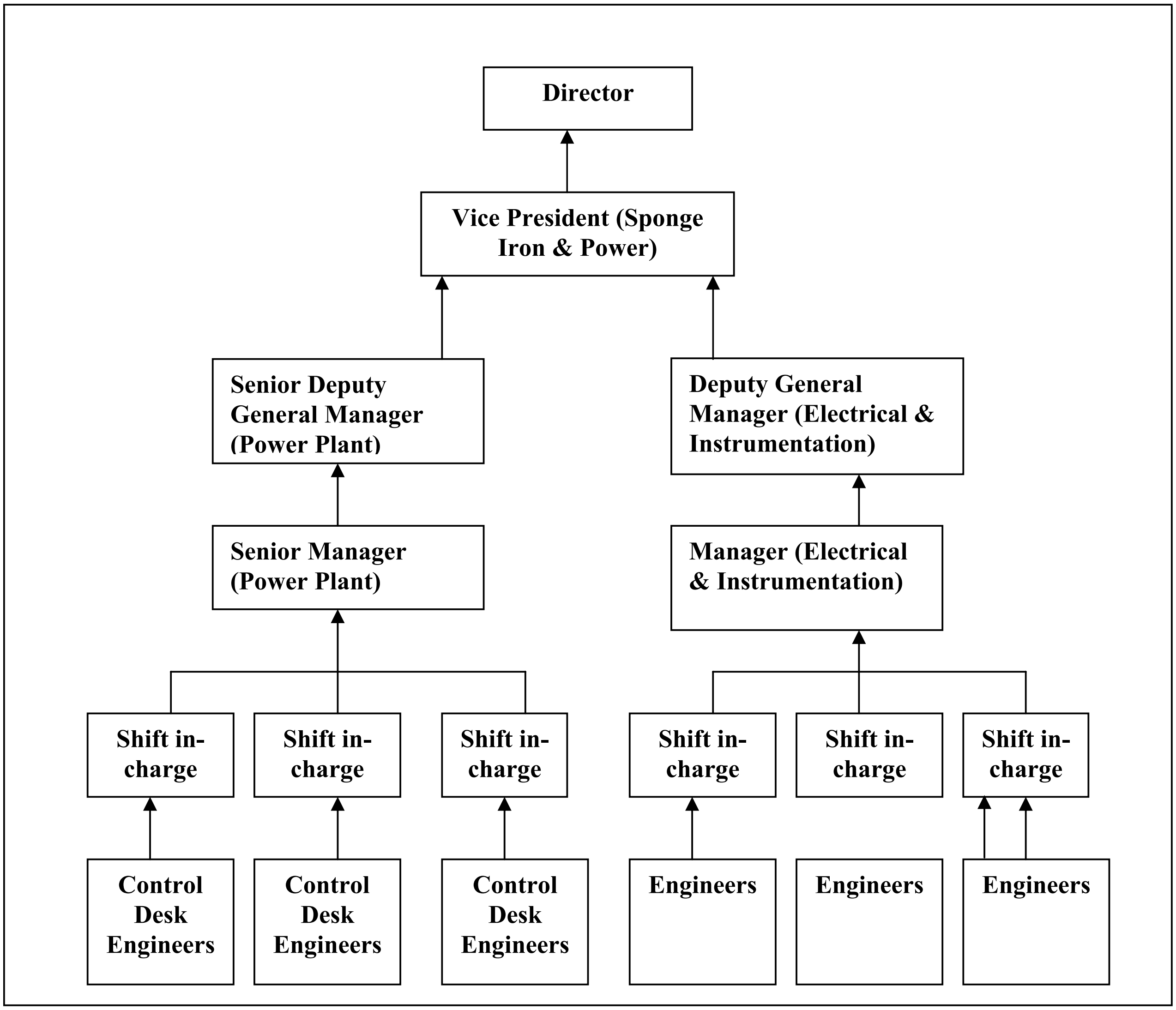
The management structure at ASL for the monitoring of parameters in the project activity is detailed in Fig B.2 as below:

The Vice President –Sponge Iron & Power (VP) is responsible for the operation and maintenance of the power plant. The VP is assisted by Senior Deputy General Manager (Sr.DGM) - Power Plant (PP), Deputy General Manager (DGM) – Electrical & Instrumentation (E&I) and Sr. Manager- Power Plant (PP). Regular shift engineers (electrical) / control desk engineers monitor the operation of the plant for all the three shifts. The VP reports to the Director and the Director would be overall responsible for the operation and maintenance of the power plant.

The Deputy General Manager (E&I) is responsible for the data of power generation at generation end. The Daily and monthly reports (data collection and gathering) stating the gross / total generation, auxiliary power requirement and net power consumed is prepared by the Electrical Engineers, checked and reported by the shift in-charge and reviewed and approved by the DGM – E&I.

The Senior Deputy General Manager (PP) is responsible for the data recording of the steam parameters such as steam quantity (flow), steam pressure and steam temperature at the WHRB, AFBC and turbine inlet. The data collection on the steam parameters is performed by the control desk engineers, checked and reported by the shift-in-charge and reviewed and approved by the Sr.DGM (PP).

**Fig B.2: Management structure at ASL for monitoring of parameters in the project activity**



*Procedures for emergency Preparedness*

ASL has standby measuring instruments for all the required power and steam parameters. In case of failure/ malfunctioning of one instrument, the data from standby instrument is taken for monitoring purposes. The defective equipment/ instrument is immediately repaired/ replaced after calibration with master calibrator.

*Calibration of monitoring equipments /instruments*

All the monitoring equipments are calibrated as per the schedule mentioned in section B.7.1 of this document to ensure the accuracy of all the monitoring parameters. The energy meters measuring the total power generation and auxiliary consumption are calibrated by the Standard Testing Laboratory (STL) annually whereas ASL performs calibration of the flow meters, thermocouple and pressure gauges once a year and necessary records are maintained at the site.

The equipment to be calibrated is taken out of the circuit preferably during the shut down with prior information from process department. The equipment is then calibrated as per well defined calibration procedures defined by ASL[17]. Once the calibration is completed, and if the deviation is within 1%, the equipment is again put to service and if the deviation is more than 1% it is adjusted within the limit.

*Modalities and Procedures towards periodic training for the monitoring personnel*

1. The control desk engineers are responsible for collecting and recording the on-line data displayed in the Distributed Control Systems (DCS) monitor and they are experienced enough to take the responsibility. However induction training is given to them at the time of joining by their superiors. Only when they become conversant with the system they are given independent responsibility.

2. The engineers were also internally trained on operation, maintenance and calibration of the equipments involved in the project activity by the equipment supplier/ technology provider.[18]

*CDM internal audit team*

The internal audit team consisting of the following members will audit the functioning of the CDM project activity:

- Vice President (SI & P)
- Deputy General Manager (SI & W)
- Assistant Manager (Environment)

The frequency of the audit will be once a year. The outcome/ findings of the audit team will be discussed in the review meeting called by the Director/ VP (SI&P). The non-conformities, if any, will be complied within a defined time span.

**B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)**

[17] Reference: Calibration procedure at ASL would be provided to DOE

[18] Reference: Training document would be provided to DOE

24/01/2008.

The contact detail of the person responsible is given in Annexure-1.

## SECTION C. Duration of the project activity / crediting period

### C.1 Duration of the project activity:

#### C.1.1. Starting date of the project activity:

10/12/2003. The starting date refers to the purchase order date for the WHRB involved in the project activity.

#### C.1.2. Expected operational lifetime of the project activity:

25 years

### C.2 Choice of the crediting period and related information:

Fixed crediting period is chosen

#### C.2.1. Renewable crediting period

##### C.2.1.1. Starting date of the first crediting period:

>>

##### C.2.1.2. Length of the first crediting period:

>>

#### C.2.2. Fixed crediting period:

##### C.2.2.1. Starting date:

01/05/2008 or subsequent to the date of registration of the project which ever is later.

##### C.2.2.2. Length:

10 years, 0 months

## SECTION D. Environmental impacts

>>

### D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

Assessment of Environmental Impact due to the project activity was carried out as a part of the Environmental Impact Assessment (EIA) for the integrated steel plant which includes the project activity as well, and submitted to the local pollution control board and the Ministry of Environment and Forests (MoEF), Government of India (GoI). On reviewing and assessing the report, the Orissa State Pollution Control Board (OSPCB) and MoEF have accorded clearances to set up the plant.

**Impacts during construction**:

*Impacts on Ambient Air quality:*

During the construction phase, a lot of civil works were carried out and this would have led to fugitive dust emissions. However fugitive dust is not expected to spread too far. The impacts on ambient air quality due to construction activities are not permanent and do not exist beyond the construction phase.

*Impact on Noise levels:*

Noise levels would have increased due to movement of trucks and other diesel powered material handling equipments during the construction phase. The impact on ambient noise levels do not exist once the construction works are completed.

*Impact on Water:*

During the construction phase a lot of debris, mud etc would have been generated and during monsoon period, storm water runoff from the project site would have contained lot of suspended solids. However, these impacts would have lasted for a short duration i.e. only during the construction period and do not exist beyond the construction phase.

*Impact on ecology:*

The proposed units (integrated steel plant and power plant) would cover an area of about 283.4 hectares of land which is not covered with thick vegetation and therefore it would have least impact on the ecology. Even the pipeline connecting the intake well of the Mahanadi river to the project site is around 4 kms in length and would pass through barren land without affecting the existing land forms.

*Impact on Socio-economic environment:*

The construction activity involved generation of employment, both direct and indirect which has improved the economic condition in the study area.

**Impacts during operation**:

*Impact on Ambient Air Quality:*

The impact on air quality during the operational phase is primarily from the emissions from stacks of the proposed units and emissions of fugitive dusts. However all the procedures have been applied to ensure that the stack emission and ambient air quality are maintained within the norms. ASL has installed an electrostatic precipitator to reduce the particulate emissions less than 100 $mg/Nm^3$. Further the habitation centres such as Cuttack are more than 10 kms from the plant and the level of air pollutants expected is much less and hence no significant impact is envisaged due to the project activity. ASL monitors the Air quality regularly and the reports are submitted to the local pollution control board.

*Impact on Water resources & water quality:*

The water for the plant would be sourced from the Mahanadi River and permission has been obtained from the Department of Water Resources, Govt. of Orissa for withdrawal of water for the purpose of the plant operations. Groundwater would not be withdrawn and hence the ground water availability would not be affected.

The water system is designed based on re-circulation system thus the effective discharge from the plant to outside will be negligible. As most of the water is recycled there would be negligible amount of water discharged outside and therefore this will not affect the water quality in the region.

All effluent and blow down water of power plant are treated in a neutralisation pit made for this purpose. The treated water is used for ash slurry making and disposed to Ash Pond. The return water from Ash Pond is recycled for Ash disposal. Further ASL monitors the Water quality regularly and the reports are submitted to the local pollution control board.

*Impact on noise levels:*

During the normal operation of the project, the ambient noise levels will increase significantly only close to the turbines but this will be confined only within the plant boundary. Personnel operating close to the noise generating equipments are provided with personnel protective equipments (PPE) in order to reduce the impacts of high noise levels. ASL monitors the Noise levels regularly and the reports are submitted to the local pollution control board.

*Impact on ecology:*

No adverse impact on ecology is envisaged due to the project activity as there would be minimum changes to ambient air quality; and minimum discharge of waste water outside the plant. Further minimum no of trees would be cut and those trees lost would be compensated for by ASL as a part of their afforestation scheme.

*Impact on socio-economics:*

The project activity has led to improvement and up-liftment of skilled and unskilled manpower in the region. The project will be providing employment opportunities not only during the construction phase, but also during its operational lifetime. The project activity improves employment rate and livelihood of local populace in the vicinity of the project

***Conclusion***

The net impact on the environment would be positive as all necessary abatement measures are being adopted and periodically monitored. ASL monitors the Air quality, Noise levels and Water quality regularly and the reports are submitted to the local pollution control boards. The project activity does not have any major adverse impacts on environment during its construction or operational phase. The socio economic parameters would show positive impacts due to increased job opportunities.

**D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:**

Host party regulations requires ASL to obtain Pollution Control Board clearance in the form of "No objection Certificate" from OSPCB. The local pollution control boards after reviewing the project have accorded "consent to establish" and "consent to operate". ASL has also obtained the Environmental Clearance from the Ministry of Environment & Forest (MoEF), Government of India.

## SECTION E. Stakeholders' comments

>>

### E.1. Brief description how comments by local stakeholders have been invited and compiled:

ASL published a notice in the news paper 'Dhwani Pratidhwani' on 15th October 2003 inviting views, comments, objections and suggestions from the stakeholders about the proposed project activity. Subsequent to this the public hearing meeting was conducted on 17th November, 2003 at 11.00 a.m. in the Revenue IB Athagarh. The stakeholders identified for the project are state government, state pollution control board, representatives of the local panchayat etc. After a detailed discussion a unanimous decision was given in favour of the proposed project.

The village Panchayat /local elected body of representatives administering the local area have provided their consent / permission to set up the project. The no objection certificate from the local panchayat for setting up this project was obtained and the same would be provided to the DOE during validation.

### E.2. Summary of the comments received:

As per the public hearing document 'Proceedings of the public hearing in respect of proposed project "An integrated steel plant & captive power plant" of M/s Aarti Steels Ltd conducted on 17.11.2003 at 11.00 AM in The Revenue 1.B, Athagarh', all the stakeholders have given their consent for the project. They have in their suggestions expressed that the project should enable in upbringing the socio-economic condition of the habitats mainly the employment opportunities from the project and that the project proponent should take care of the pollutants to be generated.

Most of the members who attended the meeting have appreciated the work of ASL in setting up the project activity and having heard the public comments, the committee unanimously recommended the establishment of the project activity by adopting all pollution prevention and control measures for the protection of the environment. As apparent from the above, there were no adverse comments on the project. The details of the public hearing would be made available to the DOE.

**E.3. Report on how due account was taken of any comments received:**

It may be noted that in response to the stakeholder comments received for the project during public hearing, employment opportunities have been provided to the local people by ASL[19] and further towards environmental protection ASL conducts periodic sampling and analysis of the environmental parameters in order to check whether they meet/ conform to the statutory requirements[20]. The Project Design Document (PDD) would be hosted on UNFCCC website for global stakeholders' comments.

[19] Reference: Documentary evidence would be provided to the DOE

[20] Reference: Air and Water quality report of ASL

## Annex 1

### CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

| | |
|---|---|
| Organization: | Aarti Steels Limited |
| Street/P.O.Box: | Plot No. 11/1B/41, |
| Building: | Sector-11, C.D.A., Bidanasi |
| City: | Cuttack |
| State/Region: | Orissa |
| Postfix/ZIP: | 753014 |
| Country: | India |
| Telephone: | + 91 671 2603285/ 94370 83134 |
| FAX: | + 91 671 2603407 |
| E-Mail: | aartisteel@mail.lnsel.net |
| URL: | |
| Represented by: | |
| Title: | Vice President (Sponge Iron & Power) |
| Salutation: | Mr. |
| Last Name: | Narayan |
| Middle Name: | |
| First Name: | L.T.P |
| Department: | Sponge Iron & Power. |
| Mobile: | + 91 9437039337 |
| Direct FAX: | + 91 671 2603407 |
| Direct tel: | + 91 94370 83134 |
| Personal E-Mail: | narayan.ltp@gmail.com |

## Annex 2

### INFORMATION REGARDING PUBLIC FUNDING

No public funding for this project

# Annex 3

## BASELINE INFORMATION

The project activity generates electricity by using waste gases emanating out of the DRI kiln in the production facility. Thus it displaces equivalent quantum of power which otherwise would have been generated in a captive coal and coal washery rejects fired plant. The emission reduction due to the project activity will depend upon the net quantity of electricity supplied by the WHRB and the $CO_2$ baseline emission factor of the coal and coal washery rejects based captive power plant.

| **(A) Determination of $CO_2$ Baseline Emission Factor for Electricity Displaced $EF_{Elec,i,j,y}$** | | |
|---|---|---|
| **Description** | **Value** | **Unit** |
| Net calorific value of coal and coal washery rejects | 2200 | kCal/kg |
| | 0.00921096 | TJ/tonne |
| Energy input to the boiler | 2.56 | MWh/tonne |
| Boiler efficiency as per manufacturers' detail (%) | 79.0% | |
| Energy available at the boiler outlet | 2.0 | MWh/tonne |
| | 1738000 | kCal/tonne |
| Turbine heat rate | 3021 | kCal/kWh |
| Energy available at the turbine outlet | 575.3 | kWh/tonne |
| Efficiency of the captive power plant ($\eta_{plant}$) | 0.2249 | |
| **Emission Factor of the baseline plant ($EF_{Elec,i,j,y}$)** | 1.53 | tCO2/MWh |

| **(B) Total electricity supplied by the 40 MW CPP** | | |
|---|---|---|
| Total electricity generated by the 40 MW CPP | 273,967,650 | kWh/annum |
| Auxiliary consumption (11% of total electricity generated) | 30,136,442 | kWh/annum |
| Net electricity supplied by 40 MW CPP ( ($EG_{i,j,y}$) | 243,831,209 | kWh/annum |

| **(C) Estimation of fraction of electricity generated using waste gas (fwg)** | | |
|---|---|---|
| **Description** | **Value** | **Units** |
| Total steam generation from WHRB & AFBC | 1,153,548,000 | kg/annum |
| Total steam loss due to venting and other blow down losses (Assumed as 5% of the generation) | 57,677,400 | kg/annum |
| Total Steam Generation from WHRB | 288,288,000 | kg/annum |
| Net steam generated from WHRB (Total steam generation from WHRB - Total steam loss) | 230,610,600 | kg/annum |
| Steam generated from AFBC | 865,260,000 | kg/annum |
| Enthalpy of steam generated from WHRB (based on steam pressure of 87 kg/cm2 and steam temperature of 510 deg C) | 815 | kcal/kg |
| Enthalpy of steam generated from AFBC (based on steam pressure of 87 kg/cm2 and steam temperature of 510 deg C) | 815 | kcal/kg |

| | | |
|---|---|---|
| Enthalpy of feedwater (at temperature of 150 deg C) at inlet to WHRB | 150 | kcal/kg |
| Enthalpy of feedwater (at temperature of 180 deg C) at inlet to AFBC | 166.6 | kcal/kg |
| Steam energy content from WHRB ($ST_{whr,y}$) | 153,356,049,000 | kcal/annum |
| Steam energy content from AFBC ($ST_{other,y}$) | 561,034,584,000 | kcal/annum |
| Fraction of electricity generated using waste gas from WHRB ($f_{wg}$) = $ST_{whr,y}$/ ($ST_{whr,y}$ + $St_{other,y}$) | 0.215 | |
| | | |
| **(D) Total baseline emissions from electricity displaced due to WHRB in the project activity** | | |
| Baseline emissions from electricity that is displaced by the project activity ($BE_{Elec,y\text{-}40\ MW}$) = $f_{cap}$ X $f_{wg}$ * $EG_{i,j,y}$X $EF_{Elec,i,j,y}$ | 80,200 | tCO2/annum |

| | | |
|---|---|---|
| **(II) Determination of Project Emissions (startup power, maintenance of WHRB, exigencies)** | | |
| Power required for startup due to the project activity | 66.168 | MWh/ annum |
| Emission factor for the CPP (assumed as per ACM0012) | 1.30 | tons CO2/MWh |
| **Project emissions (PEy)** | **86.02** | **tons CO2 /annum** |

**(III) Determination of Emission Reductions from the Project activity**

**Emission reductions (ERy) = Baseline emissions (BEy)- Project emissions (PEy)**

| | | |
|---|---|---|
| Baseline emissions from electricity that is displaced by the project activity - BEy | 80,200 | tCO2/annum |
| Project emissions (PEy) | 86.0 | tons CO2/annum |
| **Emission reductions (ERy)** | **80,114** | **tCO2/ annum** |

## Annex 4

## MONITORING PLAN

### THE METHODOLOGY REQUIRES MONITORING OF THE FOLLOWING

1. Net electricity generation
2. Auxiliary power consumption
3. Steam flow at the outlet of WHRB, AFBC boiler and inlet to TG
4. Steam temperature at the outlet of WHRB, AFBC boiler and inlet to TG
5. Steam pressure at the outlet of WHRB, AFBC boiler and inlet to TG
6. Feed water temperature at inlet to WHRB and AFBC boiler
7. Quantity of waste gas used for energy generation

The detailed monitoring plan is described in B.7.1 and B.7.2 respectively with respect to the monitoring of the above parameters.

The management structure at ASL for the monitoring of parameters in the project activity is detailed in Fig B.2 in Section B.7.2. The Vice President –Sponge Iron & Power (VP) is responsible for the operation and maintenance of the power plant. The VP is assisted by Senior Deputy General Manager (Sr. DGM) - Power Plant (PP), Deputy General Manager (DGM) – Electrical & Instrumentation (E&I) and Sr. Manager- Power Plant (PP). Regular shift engineers (electrical) / control desk engineers monitor the operation of the plant for all the three shifts. The VP reports to the Director and the Director would be overall responsible for the operation and maintenance of the power plant.

The Deputy General Manager (E&I) is responsible for the data of power generation at generation end. The Daily and monthly reports (data collection and gathering) stating the gross / total generation, auxiliary power requirement and net power consumed is prepared by the Electrical Engineers, checked and reported by the shift in-charge and reviewed and approved by the DGM – E&I.

The Sr. Deputy General Manager (PP) is responsible for the data recording of the steam parameters such as steam quantity (flow), steam pressure and steam temperature at the WHRB, AFBC and turbine inlet. The data collection on the steam parameters is performed by the control desk engineers, checked and reported by the shift-in-charge and reviewed and approved by the Sr. DGM (PP).

*Procedures for emergency Preparedness*

ASL has standby measuring instruments for all the required power and steam parameters. In case of failure/ malfunctioning of one instrument, the data from standby instrument is taken for monitoring purposes. The defective equipment/ instrument is immediately repaired/ replaced after calibration with master calibrator.

*Calibration of monitoring equipments /instruments*

All the monitoring equipments are calibrated as per the schedule mentioned in section B.7.1 of this document to ensure the accuracy of all the monitoring parameters. The energy meters measuring the total power generation and auxiliary consumption are calibrated by the Standard Testing Laboratory (STL) annually whereas ASL performs calibration of the flow meters, thermocouple and pressure gauges once a year and necessary records are maintained at the site.

The equipment to be calibrated is taken out of the circuit preferably during the shut down with prior information from process department. The equipment is then calibrated as per well defined calibration procedures defined by ASL[21]. Once the calibration is completed, and if the deviation is within 1%, the equipment is again put to service and if the deviation is more than 1% it is adjusted within the limit.

*Modalities and Procedures towards periodic training for the monitoring personnel*

1. The control desk engineers are responsible for collecting and recording the on-line data displayed in the Distributed Control Systems (DCS) monitor and they are experienced enough to take the responsibility. However induction training is given to them at the time of joining by their superiors. Only when they become conversant with the system they are given independent responsibility.

2. The engineers were also internally trained on operation, maintenance and calibration of the equipments involved in the project activity by the equipment supplier/ technology provider.[22]

*CDM internal audit team*

The internal audit team consisting of the following members will audit the functioning of the CDM project activity:

- Vice President (SI & P)
- Deputy General Manager (SI & W)
- Assistant Manager (Environment)

The frequency of the audit will be once a year. The outcome/ findings of the audit team will be discussed in the review meeting called by the Director/ VP (SI&P). The non-conformities, if any, will be complied within a defined time span.

[21] Reference: Calibration procedure at ASL would be provided to DOE

[22] Reference: Training document would be provided to DOE

## Annex 5

### ABBREVIATIONS

| | |
|---|---|
| AFBC | Alternate Fluidised Bed Combustion |
| ASL | Aarti Steels Limited |
| CDM | Clean Development Mechanism |
| CPP | Captive Power Plant |
| CER | Certified Emission Reduction |
| CEA | Central Electricity Authority |
| Cm | Centimeter |
| DRI | Direct Reduced Iron |
| DOE | Designated Operational Entity |
| ESP | Electrostatic Precipitator |
| GHG | Green House Gas |
| GRIDCO | Grid Corporation of Orissa Limited |
| INR | Indian Rupees |
| IPPs | Independent Power Producers |
| Kg | Kilogram |
| KWh | Kilowatt Hour |
| MW | Mega Watt |
| MWh | Megawatt hour |
| MOU | Memoranding of Understaning |
| OSPCB | Orrissa State Pollution Control Board |
| PLF | Plant Load Factor |
| PPA | Power Purchase Agreement |
| RPM | Revolutions per minute |
| TG | Turbine Generator |
| TPH | Ton Per Hour |
| UNFCCC | United Nations Framework Convention of Climate Change |
| WHRB | Waste Heat Recovery Boiler |

## Annex 6

## LIST OF REFERENCES



| Sr. No | References |
|---|---|
| 1. | Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) **www.unfccc.int/cdm** |
| 2. | Website of United Nations Framework Convention on Climate Change, **http://unfccc.int** |
| 3. | UNFCCC decision 17/CP.7: Modalities and procedures for a clean development mechanism as defined in article 12 of the Kyoto Protocol |
| 4. | Detailed project report on WHR power plant of Aarti Steels Limited |
| 5. | CEA published document "$16^{th}$ Electric Power Survey of India" |
| 6. | Website of Climate Change Cell, Ministry of Environment & Forest, Govt. of India. **www.envfor.nic.in** |