SHYAM STEEL

Shyam Steel Works Private Ltd
Regd. Office Shyam Tower, Premises No. 03-319, DH-6/11
Action Area- 1D, Street No 319, New Town, Kolkata-70015
Tel +91 33 4007 4007 / +91 33 6666 4646
Mail communication@shyamsteel.com | www.shyamsteel.
CIN : U28999WB2020PTC241046

SSWPL/23-24/Sr.GM/136 **Date: 25-11-2023**

To,
Deputy Director General of Forests (C)
Ministry of Env., Forest and Climate Change,
Integrated Regional Office, Kolkata IB – 198,
Sector-III, Salt Lake City, Kolkata – 700106

Sub: **Six-monthly Compliance to the Environment Clearance condition vide MoEF Letter No. F No. IA-J-11011/228/2021-IA-II(IND-1) dated 28/02/2023 and EC identification No. EC23A008WB145455 for integrated steel plant of Shyam Steel Works Private Limited at Parcel II of Jangal Sundari Karmanagari Project, Village- Lachhmanpur, Block- Raghunathpur-1, PS- Raghunathpur, PO-Ramkanali, Mouza- 145, DAG No - 290, District- Purulia, PIN Code - 723142, West Bengal (For the period of April 2023 to September 2023)**

Ref: Environment Clearance No. IA-J-11011/228/2021-IA-II (IND-I) dated 28/02/2023 and EC identification No. EC23A008WB145455.

Dear Sir,

This has reference to the captioned subject and cited reference. It is to inform you that we are herewith submitting six monthly compliance report for the conditions stipulated in the environmental clearance of integrated steel plant of Shyam Steel Works Private Limited comprising of Iron Ore Beneficiation Plant (2x1.5 MTPA) - 3.0 MTPA, Pellet Plant (2 x 1.2 MTPA) – 2.4 MTPA, Producer Gas Plant (14 x 5000 NM3/Hr.)- 588 MNM3 per annum, DRI Kilns (8x600 TPD) – 1.68 MTPA, WHRB Power through DRI kilns – (8 x 15 MW)-120 MW , through BF - 18 MW , through Coke Oven- 15 MW and CFBC based Power Plant of (2 x 15 MW)- 30 MW, SMS – IF (18 x 20 T) with LRF (6 X 20 T)- 1.26 MTPA, BOF (1 x 50 T) with LRF (1 x 50 T) and VD unit (1 x 50 T)- 0.525 MTPA and EAF (1 X 50 T)with LRF (1 x 50 T) - 0.175 MTPA, Rolling Mill through hot charging (3 x 1000 TPD) - 1.05 MTPA, Sinter Plant (1x 100 m2) – 1.092 MTPA ,Blast Furnace (1x750 m3) – 0.7875 MTPA, Coke Oven Plant (Non recovery) – 0.5 MTPA, Ferro Alloys (4 x 9 MVA)- 0.084 MTPA, Oxygen Plant (1x250 TPD) - 0.0875 MTPA, Lime & Dolomite Plant (1x 450 TPD) – 0.1575 MTPA, Brick Manufacturing Unit -350 Million Bricks/Year & Slag Recycling Plant (1 x 150 TPD) – 0.0525 MTPA for the period April 2023 to September 2023 along with relevant annexures for your kind consideration. The copy of above compliance report is also being sent in soft format through email to iro.kolkata-mefcc@gov.in for your kind perusal.

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Shyam Steel Works Private Ltd
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Mail communication@shyamsteel.com | www.shyamsteel.co
CIN : U28999WB2020PTC241046

Hope the above are in line with the statutory requirements.

Thanking you.

Yours faithfully,

For Shyam Steel Works Private Limited

Sr. General Manager (Commercial)

Enclosure: As above

Copy to: The Regional Officer, Asansol Regional Office, WBPCB, (KSTP), Dr. B.C. Roy Road
P.O.-Dakshin Dhadka, Asansol,Dist-Paschim Bardhaman, (WB)

29-11-23
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(Content Not Verified)
West Bengal Pollution Control Board
Asansol Regional Office
Kalyanpur Satellite Township Project
Dr. B. C Roy Road, Asansol-713302

ENVIRONMENT CLEARANCE COMPLIANCE STATUS REPORT

April 2023 to September 2023

Six Monthly Environment Clearance Compliance Status Report of Integrated Steel plant comprising of Iron Ore Beneficiation Plant (2x1.5 MTPA) - 3.0 MTPA, Pellet Plant (2 x 1.2 MTPA) – 2.4 MTPA, Producer Gas Plant (14 x 5000 NM3/Hr.)- 588 MNM3 per annum, DRI Kilns (8x600 TPD) – 1.68 MTPA, WHRB Power through DRI kilns – (8 x 15 MW)-120 MW , through BF - 18 MW , through Coke Oven- 15 MW and CFBC based Power Plant of (2 x 15 MW)- 30 MW, SMS – IF (18 x 20 T) with LRF (6 X 20 T)- 1.26 MTPA, BOF (1 x 50 T) with LRF (1 x 50 T) and VD unit (1 x 50 T)- 0.525 MTPA and EAF (1 X 50 T)with LRF (1 x 50 T) - 0.175 MTPA, Rolling Mill through hot charging (3 x 1000 TPD) - 1.05 MTPA, Sinter Plant (1x 100 m2) – 1.092 MTPA ,Blast Furnace (1x750 m3) – 0.7875 MTPA, Coke Oven Plant (Non recovery) – 0.5 MTPA, Ferro Alloys (4 x 9 MVA)- 0.084 MTPA, Oxygen Plant (1x250 TPD) -0.0875 MTPA, Lime & Dolomite Plant (1x 450 TPD) – 0.1575 MTPA, Brick Manufacturing Unit -350 Million Bricks/Year & Slag Recycling Plant (1 x 150 TPD) – 0.0525 MTPA Parcel II of Jangal Sundari Karmanagari Project, Village- Lachhmanpur, Block- Raghunathpur-1, PS- Raghunathpur, PO-Ramkanali, Mouza- 145, DAG No - 290, District- Purulia, PIN Code - 723142, West Bengal

ENVIRONMENT MANAGEMENT DEPARTMENT
SHYAM STEEL WORKS PRIVATE LIMITED

Clearance Letter No. and Date:- EC23A008WB145455 dated 28.02.2023 vide File No- IA-J-11011/228/2021-IA-II(IND-I)

Period of Compliance:- April 2023 to September 2023

Sr. No	Stipulated Conditions	Action taken / To be taken
	A. Specific Condition	
(i)	The company shall comply with all the environmental protection measures and safegnards proposed in the documents submitted to the Ministry. All the recommendations made in the EIA/EMP in respect of environmental management, and risk mitigation measures relating to the project shall be implemented.	All the recommendations made in the EIA/EMP in respect of environmental management and risk mitigation will be followed.
(ii)	The project proponent shall utilize modern technologies for capturing of carbon emitted and shall also develop carbon sink/carbon sequestration resources capable of capturing more than emitted. The implementation report shall be submitted to the IRO, MoEF&CC in this regard.	Detailed de-carbonization report has been included in EIA/EMP wherein utilization of modern technologies for capturing of carbon and development of carbon sequestration resources has been mentioned. We will submit the status of implementation of the report to the IRO, MoEF&CC as the project progresses. ***Copy of de-carbonization report is attached as Annexure- 1***
(iii)	Tailings from Iron Ore washing plant shall be dewatered in filter press and stored dry maximum for a period of 45 days inside the plant premises.	As recommended in EIA/EMP, we will ensure that tailing generation, storage and its end use at brick manufacturing unit is adhered to.
(iv)	**Solid waste utilization**	
	a. Maximum 90 days of slag storage area shall be permitted inside the plant.	All the required facilities / recommendation will be complied with respect to slag storage.
	b. PP shall install a slag crusher to convert steel slag into aggregate for use in construction industry, fine sand for use as flux in steel plant, sand in brick making and as lime in cement making.	It will be complied as per the solid waste management plan.
	c. PP shall recycle/reuse 100 % solid waste generated in the plant.	It will be complied.
	d. Carbon recovery plant to recover the elemental carbon present in GCP slurries for use in Sinter plant shall be installed.	It will be complied before the commissioning of plant.
	e. Used refractories shall be recycled as far as possible.	It will be complied.
(v)	**Sinter Plant**	
	a. Sinter cooler waste recovery system shall be installed to generate process steam or power.	It will be complied before the commissioning of plant.
	b. Equipped with MEROS technology to reduce emission of SO2, NOx and heavy metals.	It will be complied before the commissioning of plant.

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Sr. General Manager (Commercial)

(vi)	**Coke Oven Plant**	
	a. Coke Dry Quenching (CDQ) shall be installed.	It will be complied before the commissioning of plant.
	b. Coke Oven Gas shall be desulfurized.	It will be complied before the commissioning of plant.
	c. Tar sludge shall be mixed with coal and reused.	It will be complied.
(vii)	BF shall be equipped with Top Recovery Turbine, dry gas cleaning plant, stove waste heat recovery, cast house and stock house ventilation system and slag granulation facility.	It will be complied before the commissioning of plant.
(viii)	Secondary fume extraction system shall be installed on converters of Steel Melting Shop.	It will be complied before the commissioning of plant.
(ix)	Basic Oxygen Furnace (BOF) gas shall be cleaned dry.	It will be complied before the commissioning of plant.
(x)	Waste Heat Recovery system for charge preheating shall be included for Electric Arc Furnace.	It will be complied before the commissioning of plant.
(xi)	Action plan for setting up of captive railway siding for transportation of materials shall be implemented.	It will be complied.
(xii)	Submerged Arc Furnace and Electric Arc Furnace shall be closed type with 4th hole extraction system.	It will be complied before the commissioning of plant.
(xiii)	85-90 % of billets/slabs shall be rolled directly in hot stage. Only 10-15 % rolling shall be done through RHF using only Light Diesel Oil or Mixed BF/CO gas.	It will be complied.
(xiv)	Dust emission from Steel Plant stacks shall not exceed 30 mg/Nm^3.	It will be complied.
(xv)	The nearest human settlement from the site are Maharajnagar (0.02 Km, SE), Lachhmanpur (0.03 Km, E), Shikratyar (0.06 Km, S), Digardhi (0.05 Km, SE), Jarukhamar (0.54 Km, NW), Talshankra (1.7 Km, SW) and Senera (0.85 Km, S). Project Proponent shall take appropriate environmental safeguard measures to minimise the impact on the habitation of the locals. The PP shall also include some of these locations in its environmental monitoring programme.	All required environmental protection measures such as green belt development all along plant boundary, pollution control equipments such as ESP's, Bag filters, covered conveyers and dust suppression systems etc. will be provided and operated duly ensuring environmental safeguard measures to minimize the impact on the habitation of the locals. Adjoining villages are taken care and included under environmental monitoring programme. ***Copy of greenbelt development is attached as Annexure- 2***
(xvi)	30,743 KLD water will be required for the proposed project; which will be sourced from Panchet Reservoir of Damodar Valley Corporation. Necessary permission shall be obtained from the Competent Authority in this regard. No ground water extraction is permitted. SHYAM STEEL WORKS PVT. LTD. Sr. General Manager (Commercial)	Water drawl permission to draw 6.0 MGD from DVRRC has been obtained vide letter no. MD/DVRR/WA-6(145)/2022/744-48 dated 20-12-2022 and Execution of agreement with DVC, Maithon vide letter no. MRO/Tariff Cell/SSWPL/318 dated 18.04.2023 ***Copy of water drawl permission is attached as Annexure- 3*** ***Copy of agreement with DVC is attached as Annexure- 4***

(xvii)	There are 2 ponds in Digardhi village, a pond in Lachhmanpur and a pond in Siulibari village within the project site. Action plan for conservation of Digardhi Village Pond and Sikratyar village pond shall be strictly implemented.	It will be complied.
(xviii)	There is Stream passing along South West Boundary toward North direction approaching Panchet Reservoir. Apart from these UttalaNadi (3.5 Km, NW), Panchet Reservoir (8.0 Km, NNE), Panchet Dam (9.0 Km, NNE), Ramachandrapur Reservoir (10.2 Km, E), Maharajnagar Village Pond (0.4 Km, SE), Sikratyar village pond (Adjacent, S), Kelahi village pond (0.5 Km, W), Durmut Village Pond (2.9 Km, W), and Garh Panchkot Village Pond (3.8 Km, NEE) exists within the study area of the project site. A robust and full proof Drainage Conservation scheme to protect the natural drainage and its flow parameters; along with Soil conservation scheme and multiple Erosion control measures shall be implemented.	Storm water drainage report has been included in EIA/EMP wherein collection, channelization and utilization of storm water is given as per the topographical features. As the project progresses, we will implement the recommendations of storm water drainage report required to protect the natural drainage and its flow parameter along with erosion control practices. ***Copy of RWH & storm water drainage report is attached as Annexure- 5***
(xix)	PP shall undertake village adoption and formulate Village Adoption program consisting of need-based community development activities, shall be prepared to develop them into model villages. PP shall submit details of the villages to be adopted.	It will be complied considering SIA study.
(xx)	The Action Plan for the Panch-tatva (5 commitments) including fossil fuel reduction road map and net-zero carbon emissions shall be strictly implemented.	It will be complied.
(xxi)	The proposed project shall be designed as "Zero Liquid Discharge" Plant. ETP shall be installed and there shall be no discharge of effluent from the plant. Domestic effluent shall be treated in Sewage Treatment Plant. MSW waste shall be treated in digester and recovered gas shall be used in the canteen.	It will be complied.
(xxii)	The company shall also undertake rain water harvesting measures as per the plan submitted in the EIA/EMP report and reduce water dependence from the outside source.	It will be complied.
(xxiii)	All stockyards shall be having impervious flooring and shall be equipped with water spray system for dust suppression. Stock yards shall also have garland drains to trap the run off material.	It will be complied.
(xxiv)	All internal and connecting road to the Highway shall be black topped/ concreted with suitable load in term of Million Standard Axle (MSA) as per IRC guidelines.	SH-5 is adjacent to project site and is as per the IRC guidelines whereas internal roads will be made pucca to minimize the pollution caused due to vehicular

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		movement.
(xxv)	Three tier Green Belt shall be developed covering at least 33% of the total project area maximum in the 1st year with native species all along the periphery of the project site of adequate width and tree density shall not be less than 2500 per ha. Survival rate of green belt developed shall be monitored on periodic basis to ensure that damaged plants are replaced with new plants in the subsequent years. PP shall develop greenbelt in the form of shelter belt comprising of total of 6 rows of 2x2 m plantation with tall trees & broad leaves with thick canopy to act as green barrier for air pollution & noise levels towards the villages namely Maharajnagar (0.02 Kms), Lachhmanpur (0. 03 kms),Shikratyar (0.06 Kms) and Digardhi (0.05 kms) inside the plant premises. Compliance status in this regard, shall be submitted to concern Regional Office of the MoEF&CC.	The greenbelt shall be developed simultaneously with the plant construction. This will further mitigate the pollution impact. Greenbelt will be developed in a set of rows of trees planted in such a way that they form an effective barrier between the plant and the surroundings. The main purpose of greenbelt development is to contribute to the following factors: • To maintain the ecological homeostatus. • To attenuate the air emissions from the kiln and the fugitive dust emissions. • To prevent the soil erosion. • To attenuate the noise levels.
(xxvi)	Greening and Paving shall be implemented in the plant area to arrest soil erosion and dust pollution from exposed soil surface.	Plantation of grass, flowers, bushes and trees will be taken up simultaneously with the plant construction to reduce the generation of dust from the bare earth and to enhance the aesthetic value.
(xxvii)	Performance test shall be conducted on all pollution control systems every year and report shall be submitted to Regional Office of the MoEF&CC.	Performance test will be conducted on pollution control devices once we start production and reports will be furnished to IRO, MOEF&CC at regular interval with Six Monthly EC compliance report.
(xxviii)	Parking area for trucks/dumpers shall be provided within the steel plant. No truck/dumper shall be parked outside the steel plant premises.	Parking area for trucks / dumpers have been made inside plant premises. We will ensure that no trucks/ dumpers are parked outside plant premises.
(xxix)	Air Cooled condensers shall be used in the captive power plant.	It will be complied before the commissioning of plant.
(xxx)	A proper action plan must be implemented to dispose of the electronic waste generated in the industry.	E- Waste (Management) Rules, 2022 will be followed.
(xxxi)	The environmental issues arising out from the route for producing of billets shall be controlled and mitigation measures be implemented.	We will be having all the required pollution control devices at SMS to mitigate the environmental issues irrespective of route for producing billets.
(xxxii)	All the recommendations made in the risk assessment report shall be implemented and compliance status in this regard shall be furnished to the Regional Office of the MoEF&CC along with the six monthly compliance report.	It will be complied as recommended in EIA/EMP report.
(xxxiii)	All the commitments made to the public during the Public Hearing/Public Consultation shall be satisfactorily implemented. The action plan based on the social impact assessment study of the project	We will abide by all the commitments/ recommendations made to the public during the Public Hearing/Public Consultation and Social Impact Assessment Study of the project as per the

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	as per the EMP in accordance to the Ministry's OM dated 30.09.2020 shall be strictly implemented and progress shall be submitted to the Regional Office of MoEF&CC.	EMP in accordance to the Ministry's OM dated 30.09.2020. The progress report will be submitted to IRO, MOEF&CC at regular interval after commencement of production. ***Copy of action plan of SIA & Public hearing commitment report is attached as Annexure- 6***
(xxxiv)	The Plastic Waste Management Rules 2016, inter-alia, mandated banning of identified Single Use Plastic (SUP) items with effect from 01/07/2022. In this regard, CPCB has issued a direction to all the State Pollution Control Boards (SPCBs)/Pollution Control Committees (PCCs) on 30/06/2022 to ensure the compliance of Notification published by Ministry on 12/08/2021. The technical guidelines issued by the CPCB in this regard is available at https://cpcb.nic.in/technical- guidelines-3/. All the project proponents are hereby requested to sensitize and create awareness among people working within the Project area as well as its surrounding area on the ban of SUP in order to ensure the compliance of Notification published by this Ministry on 12/08/2021. A report, along with photographs, on the measnres taken shall also be included in the six monthly compliance report being submitted by the project proponents.	It is being followed. ***Copy of report on ban of SUP is attached as Annexure-7.***
(xxxv)	The project proponent shall adopt the Clean Air practices like mechanical collectors, wet scrnbbers, fabric filters (bag houses), electrostatic precipitators, combnstion systems (thermal oxidizers), condensers, absorbers, adsorbers, and biological degradation. Controlling emissions related to transportation shall include emission controls on vehicles as well as use of cleaner fuels. Sufficient numbers of additional truck mounted Fog/Mist water cannons shall be procured and operated regularly inside the project premises and also in the surrounding villages to arrest suspended dust in the atmosphere.	All required environmental protection measures such as green belt development all along plant boundary, pollution control equipment's such as ESPs, Bag filter's, covered conveyers and dust suppression systems etc. will be provided and operated duly ensuring environmental safeguard measures to minimize the impact on the surrounding ecology. Apart from that we will be deploying sufficient numbers of additional truck mounted Fog/Mist water cannons inside the project premises and also in the surrounding villages to arrest suspended dust in the atmosphere.
	B. General Condition	
	Statutory Compliance	
I	**(i)** The Environment Clearance (EC) granted to the project/ activity is strictly under the provisions of the EIA Notification, 2006 and its amendments issued from time to time. It does not tantamount/ construe to approvals/ consent/ permissions etc., required to be obtained or standards/conditions to be followed under any other	It will be complied. **SHYAM STEEL WORKS PVT. LTD.** Sr. General Manager (Commercial)

	Acts/Rules/Subordinate legislations, etc., as may be applicable to the project.	
II	**Air quality monitoring and preservation**	
	(i) The project proponent shall install 24x7 continuous emission monitoring system at process stacks to monitor stack emission as well as 06 Nos. Continuous Ambient Air Quality Station (CAAQS) for monitoring AAQ parameters with respect to standards prescribed in Environment (Protection) Rules 1986 as amended from time to time. The CEMS and CAAQMS shall be connected to SPCB and CPCB online servers and calibrate these systems from time to time according to equipment supplier specification through labs recognized under Environment (Protection) Act, 1986 or NABL accredited laboratories.	We will be installing desired nos. of CEMS & CAAQS to monitor air quality and the same will be connected to online servers of CPCB & will be calibrated time to time according to equipment supplier specification through labs recognized under Environment (Protection) Act, 1986 or NABL accredited laboratories.
	(ii) The project proponent shall monitor fugitive emissions in the plant premises at least once in every quarter through laboratories recognized under Environment (Protection) Act, 1986 or NABL accredited laboratories.	It will be complied once the plant is commissioned.
	(iii) Sampling facility at process stacks and at quenching towers shall be provided as per CPCB guidelines for manual monitoring of emissions.	It will be complied as per CPCB guidelines for manual monitoring of emission.
	(iv) Appropriate Air Pollution Control (APC) system shall be provided for all the dust generating points including fugitive dust from all vulnerable sources, so as to comply prescribed stack emission and fugitive emission standards.	It will be complied once the plant is commissioned.
	(v) The project proponent shall provide leakage detection and mechanized bag cleaning facilities for better maintenance of bags.	It will be complied.
	(vi) Sufficient number of mobile or stationery vacuum cleaners shall be provided to clean plant roads, shop floors, roofs, regularly.	It will be complied.
	(vii) Recycle and reuse iron ore fines, coal and coke fines, lime fines and such other fines collected in the pollution control devices and vacuum cleaning devices in the process after briquetting/ agglomeration.	It will be complied.
	(viii) The project proponent use leak proof trucks/dumpers carrying coal and other raw materials and cover them with tarpaulin.	We have been ensuring that vehicle carrying construction materials are covered with tarpaulin to avoid any spillage during transportation.
	(ix) Facilities for spillage collection shall be provided for coal and coke on wharf of coke oven batteries (Chain conveyors, land	It will be complied.

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	based industrial vacuum cleaning facility).	
	(x) Land-based APC system shall be installed to control coke pushing emissions.	It will be complied.
	(xi) Monitor CO, HC and O2 in flue gases of the coke oven battery to detect combustion efficiency and cross leakages in the combustion chamber.	It will be complied.
	(xii) Vapor absorption system shall be provided in place of vapour compression system for cooling of coke oven gas in case of recovery type coke ovens.	Not applicable as we have proposed non-recovery type coke oven.
	(xiii) Wind shelter fence and chemical spraying shall be provided on the raw material stock piles.	It will be complied.
	(xiv) Design the ventilation system for adequate air changes as per prevailing norms for all tunnels, motor houses, Oil Cellars.	It will be complied.
III	**Water quality monitoring and preservation**	
	(i) The project proponent shall install 24x7 continuous effluent monitoring system with respect to standards prescribed in Environment (Protection) Rules 1986 vide G.S.R 277 (E) dated 31st March 2012 (Integrated Iron & Steel); G.S.R 414 (E) dated 30th May 2008 (Sponge Iron) as amended from time to time; S.O. 3305 (E) dated 7th December 2015 (Thermal Power Plants) as amended from time to time and connected to SPCB and CPCB online servers and calibrate these system from time to time according to equipment supplier specification through labs recognized under Environment (Protection) Act, 1986 or NABL accredited laboratories.	It will be complied.
	(ii) The project proponent shall monitor regularly ground water quality at least twice a year (pre- and post-monsoon) at sufficient numbers of piezometers/sampling wells in the plant and adjacent areas through labs recognized under Environment (Protection) Act, 1986 and NABL accredited laboratories.	It will be complied.
	(iii) The project proponent shall provide the ETP for coke oven and by-product to meet the standards prescribed in G.S.R 277 (E) dated 31st March 2012 (Integrated iron & Steel); G.S.R 414 (E) dated 30th May 2008 (Sponge Iron) as amended from time to time; S.O. 3305 (E) dated 7th December 2015 (Thermal Power Plants) as amended from time to time as amended from time to time;	It will be complied. SHYAM STEEL WORKS PVT. LTD. Sr. General Manager (Commercial)

	(iv) Sewage Treatment Plant shall be provided for treatment of domestic wastewater to meet the prescribed standards.	It will be complied.
	(v) Garland drains and collection pits shall be provided for each stock pile to arrest the run-off in the event of heavy rains and to check the water pollution due to surface run off.	It will be complied.
	(vi) Tyre washing facilities shall be provided at the entrance of the plant gates.	It will be complied.
	(vii) Treated water from ETP of COBP shall not be used for coke quenching.	It will be complied.
	(viii) Water meters shall be provided at the inlet to all unit processes in the steel plants.	It will be complied.
IV	**Noise Monitoring and Prevention**	
	(i) Noise pollution shall be monitored as per the prescribed Noise Pollution (Regulation and Control) Rules, 2000 and report in this regard shall be submitted to Regional Officer of the Ministry as a part of six-monthly compliance report.	Noise Pollution (Regulation and Control) Rules, 2000 will be followed.
V	**Energy Conservation Measures**	
	(i) Use torpedo ladle for hot metal transfer as far as possible. If ladles not used, provide covers for open top ladles.	It will be complied before the commissioning of plant.
	(ii) Restrict Gas flaring to < 1%.	It will be complied once the plant is commissioned.
	(iii) Provide solar power generation on roof tops of buildings, for solar light system for all common areas, street lights, parking around project area and maintain the same regularly;	It will be complied.
	(iv) Provide LED lights in their offices and residential areas.	It will be complied.
	(v) Ensure installation of regenerative type burners on all reheating furnaces.	It will be complied.
VI	**Waste Management**	
	(i) Oil Collection pits shall be provided in oil cellars to collect and reuse/recycle spilled oil. Oil collection trays shall be provided under coils on saddles in cold rolled coil storage area.	It will be complied.
	(ii) Kitchen waste shall be composted or converted to biogas for further use.	It will be complied.
VII	**Green Belt**	
	(i) The project proponent shall prepare GHG emissions inventory for the plant and shall submit the programme for reduction of the same including carbon sequestration by trees.	GHG emission inventory has been made and details are given in the de-carbonization report. We exclusively have green belt development plan for carbon sequestration.
	(ii) Project proponent shall submit a study report on Decarbonisation program, which would essentially consist of company's	Detailed de-carbonization report has been included in EIA/EMP wherein utilization of modern technologies for capturing of

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	carbon emissions, carbon budgeting/ balancing, carbon sequestration activities and carbon offsetting strategies. Further, the report shall also contain time bound action plan to reduce its carbon intensity of its operations and supply chains, energy transition pathway from fossil fuels to Renewable energy etc. All these activities/ assessments should be measurable and monitorable with defined time frames", when PP comes for EC proposal. This study shall be formulated keeping in view of India's Net-zero commitment at the COP-26 Climate Summit.	carbon and development of carbon sequestration resources has been mentioned. We will submit the status of implementation of the report to the IRO, MoEF&CC as the project progresses.
VIII	**Public hearing and Human health issues**	
	(i) Emergency preparedness plan based on the Hazard identification and Risk Assessment (HIRA) and Disaster Management Plan shall be implemented.	It will be complied.
	(ii) The project proponent shall carry out heat stress analysis for the workmen who work in high temperature work zone and provide Personal Protection Equipment (PPE) as per the norms.	It will be complied.
	(iii) Occupational health surveillance of the workers shall be done on a regular basis and records maintained.	It is being followed.
IX.	**Environment Management**	
	(i) The project proponent shall comply with the provisions contained in this Ministry's OM vide F.No. 22-65/2017-IA.III dated 30/09/2020. As part of Corporate Environment Responsibility (CER) activity, company shall adopt nearby villages, based on the socio-economic survey and undertake community developmental activities in consultation with the village Panchayat and the District Administration as committed by the PP.	It will be complied.
	(ii) The company shall have a well laid down environmental policy duly approve by the Board of Directors. The environmental policy should prescribe for standard operating procedures to have proper checks and balances and to bring into focus any infringements/deviation/ violation of the environmental / forest / wildlife norms / conditions. The company shall have defined system of reporting infringements / deviation / violation of the environmental / forest/ wildlife norms / conditions and / or shareholders / stake holders. The copy of the board resolution	The company has well laid down Environment Policy, approved by Managing Director. Unit Head will be authorized by the Board to sign, issue & modify the Environment Policy. The organization has developed procedure detailing compliance with all aspects of Environmental norms including the process of corrective actions for its improvement. The policy provides a framework for setting and reviewing environmental objectives, which includes a commitment to fulfil its compliance obligations, to the

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	in this regard shall be submitted to the MoEF&CC as a part of six-monthly report.	protection of the environment, including prevention of pollution and other specific Commitment(s) relevant to the context of the organization. ***Copy of the corporate environment policy is attached as Annexure- 8***
	(iii) A separate Environmental Cell both at the project and company head quarter level, with qualified personnel shall be set up under the control of senior Executive, who will directly to the head of the organization.	An Environmental Officer has been appointed to look after all the environmental issues and to ensure the compliance with Environmental Clearance conditions. He will directly report to the Unit Head for statutory compliances and relevant activities
X.	**Miscellaneous**	
	(i) The project proponent shall make public the environmental clearance granted for their project along with the environmental conditions and safeguards at their cost by prominently advertising it at least in two local newspapers of the District or State, of which one shall be in the vernacular language within seven days and in addition this shall also be displayed in the project proponent's website permanently.	We have been granted environment clearance on 28.02.2023 and it has been advertised subsequently on 02.03.2023 in Aajkal (Bengali Newspaper) and Indian Express (English Newspaper) ***Copy of the environment clearance advertisement is attached as Annexure- 9***
	(ii) The copies of the environmental clearance shall be submitted by the project proponents to the Heads of local bodies, Panchayats and Municipal Bodies in addition to the relevant offices of the Government who in turn has to display the same for 30 days from the date of receipt.	We have submitted the copy of environment clearance to the heads of local bodies, panchayats and municipal bodies in addition to the relevant offices of Government. ***Copy of EC intimation to the local authority is attached as Annexure- 10***
	(iii) The project proponent shall upload the status of compliance of the stipulated environment clearance conditions, including results of monitored data on their website and update the same on half-yearly basis.	Copy of environment clearance has been uploaded at company's website i.e. https://shyamsteel.com/.
	(iv) The project proponent shall monitor the criteria pollutants level namely; PM10, SO2, NOx (ambient levels as well as stack emissions) or critical sectoral parameters, indicated for the projects and display the same at a convenient location for disclosure to the public and put on the website of the company.	It will be complied.
	(v) The project proponent shall submit six-monthly reports on the status of the compliance of the stipulated environmental conditions on the website of the ministry of Environment, Forest and Climate Change at environment clearance portal.	In compliance to this condition, compliance report is being submitted.
	(vi) The project proponent shall submit the environmental statement for each financial year in Form-V to the concerned State Pollution Control Board as prescribed under the Environment	We will submit the environmental statement for each financial year in Form-V to West Bengal Pollution Control Board as prescribed under Environment (Protection) Rule, 1986 after

SHYAM STEEL WORKS PVT. LTD.

Sr. General Manager (Commercial)

	(Protection) Rules, 1986, as amended subsequently and put on the website of the company.	commencement of production.
	(vii) The project proponent shall inform the Regional Office as well as the Ministry, the date of financial closure and final approval of the project by the concerned authorities, commencing the land development work and start of production operation by the project.	Stipulated condition has been partially complied as the project is greenfield project. ***Copy of intimation of land development is attached as Annexure- 11***
	(viii) The project proponent shall abide by all the commitments and recommendations made in the EIA/EMP report, commitment made during Public Hearing and also that during their presentation to the Expert Appraisal Committee.	It will be complied.
	(ix) The PP shall put all the environment related expenditure, expenditure related to Action Plan on the PH issues, and other commitments made in the EIA/EMP Report etc. in the company web site for the information to public/public domain. The PP shall also put the information on the left over funds allocated to EMP and PH as committed in the earlier ECs and shall be carried out and spent in next three years, in the company web site for the information to public/public domain.	It will be complied.
	x. No further expansion or modifications in the plant shall be carried out without prior approval of the Ministry of Environment, Forests and Climate Change (MoEF&CC).	It will be complied.
	xi. The Regional Office of this Ministry shall monitor compliance of the stipulated conditions. The project authorities should extend full cooperation to the officer (s) of the Regional Office by furnishing the requisite data / information/monitoring reports.	It will be complied.

SHYAM STEEL WORKS PVT. LTD.

Sr. General Manager (Commercial)

FINAL

STUDY REPORT
ON

DE-CARBONISATION PROGRAM FOR
A
GREENFIELD IRON AND STEEL PLANT

OF

SHYAM STEEL WORKS (P)LTD

At

Jangal Sundari Karmanagri- Parcel II, Lachhmanpur, Jarukhamar, Siulibari, Digardhi, Shikratyar, Senera & Talshankra Village/ Mouza, Raghunathpur-1 Tehsil/Block, Purulia District, West Bengal

PREPARED BY

RECYCLING AND ENVIRONMENT INDUSTRY ASSOCIATION OF INDIA

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NOVEMBER, 2022

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PART I

1.1 Introduction

United Nations Intergovernmental Panel on Climate Change (IPCC) has issued warning that the Climate Resilient Development is difficult at the present levels of temperature. If the global warming results in temperature increase beyond 1.5°C (2.7°F), further energy intensive development will be extremely difficult. This significant conclusion emphasizes the need for climate policy that prioritizes equity and justice, adequate finance, technology transfer and interventions, political commitment, and collaboration, which necessarily shall contribute to more successful climate change adaptation and emissions reductions.

Steel plays a crucial role in building a sustainable global economy, but its manufacturing is the fifth largest contributor to global GHG emissions. De-carbonization of the steel sector is therefore a global concern and a big challenge. This industry is under tremendous pressure to improve upon its energy intensity to reduce GHG emissions and to further utilize CO_2 captured for useful purposes or go for long term sequestration to fix it in nature's cycle.

This report describes the methods for GHG inventorisation for a green field steel plant of Shyam Steel Works Private Limited (SSWPL) at Purulia, WB, and the measures proposed to be adopted to mitigate GHG emissions from the expansion project along with the carbon capture, storage and CO_2 sequestration strategies.

1.2 Carbon Emissions: Different Scopes of Emissions

According to the Organizational Foot Printing Standard -ISO 14064-1, GHG emissions are categorized into 3 scopes:

Scope 1 emissions: This includes the direct emissions that result from activities within the organization's control, e.g., On-site electricity generation, combustion in furnaces, heating/cooling operations at site; company-owned vehicles, fugitive emissions (e.g., refrigerants, emissions from fire extinguishers, refrigerators, circuit breakers etc.).

Scope 2 emissions: This includes indirect emissions from any electricity or heat or compressed air consumed that has been imported from outside the factory.

Scope 3 emissions: This includes all of the indirect emissions that occur in the value chain, weighted according to the company's contribution. e.g., purchased goods and services, employee commuting, business travel, upstream emissions from fuel extraction, waste management, T&D losses and electricity consumption and Ozone Depleting Substances refill for Work from Home. Scope 3 emissions are a consequence of the activities of the company, but occur from sources not owned or controlled by the company. Some examples of Scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels & raw materials and use of products and services from outside. There are generally following categories of activities under Scope 3;

Category 1: Purchased goods and services,
Category 2: Capital goods purchased,
Category 3: Upstream transportation and distribution,
Category 4: Solid Waste disposal outside plant premises,

Category 5: Business travel,
Category 6: Employee commuting,
Category 7: Upstream leased assets,
Category 8: Downstream transportation and distribution,
Category 9: Processing of sold products,
Category 10: Use of sold products,
Category 11: End-of-life treatment of sold products,
Category 12: Downstream leased assets,
Category 13: Franchises,
Category 14: Investments,
Category 15: Emissions during "Work from Home", etc.

According to GHG Corporate Protocol, all organizations should quantify Scope 1 and 2 emissions when reporting and disclosing GHG emissions, while quantification of Scope 3 emissions is voluntary and may be reported by companies to identify the greatest GHG reduction opportunities across their value chain which in turn makes business activities more sustainable and competitive. Latest trend in the industry is to quantify GHG emissions for Scope 3 as far as possible.

1.3 Methodologies for GHG Emission calculations as:

Scope 1

The methodology used for GHG emissions calculations for use of fossil fuels is briefly described in IPCC emission factor guide book available on IPCC website and or GHG protocol website for different types of fuels ie, coal, coke, liquid fuels, NG, LPG, LNG etc. The emission Factors are available from the following reference attached as **Annexure I;**

https://www.epa.gov/sites/default/files/2021-04/documents/emission-factors_apr2021.pdf

Emissions due to leakage of refrigerants/usage of AC and other gazettes in tCO2e equivalent can be calculated using the emission factors; available from the following reference;

https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors -2021

Scope 2: External Electricity Consumption

This may be noted that emission factor for electricity, can be obtained from CEA web site given below (Attached as **Annexure II**); The average grid factor for India for 2020-21 is 0.790 TCO2 per MWH.

https://cea.nic.in/wp-content/uploads/tpe___cc/2022/02/User_Guide__ver_17_20_21.pdf

For imported steam and compressed air, the supplier of these utilities should provide information on CO_2 emission per NM^3 of steam or compressed air. In the present case no import of such utilities is envisaged.

Scope 3: Upstream Transportation and Distribution

Emissions due to upstream transportation in tCO_2e = "Total distance travelled * Emission Factor". The emission Factors are available from **Annexure IV**;

Downstream Transportation and Distribution: Emissions due to downstream transportation of products in tCO_2e = "Total distance travelled * Emission Factor" but the same has not been considered in present scope as the destinations for the products after leaving the factory gate are not available.

Scope 3 emissions for employees commute based on certain assumptions are presented in spreadsheets attached.

1.4 Carbon Neutrality

Carbon neutrality refers to a balance between carbon emissions and carbon absorption from the atmosphere in carbon sinks. General strategy to be adopted by project proponents to reduce GHG emissions and absorb carbon is defined below;

Scope 1 Emissions Reduction Tips (Generic)

a. Reduce fuel consumption and improve operational energy efficiency.
b. Capital investments in newer, more energy-efficient equipment/technologies to lower operating costs while also lowering emissions.
c. Conducting energy audits at workplaces where electricity consumption is high in order to identify better alternatives and save money on electricity consumption.
d. For carbon neutrality, CER may be considered to be purchased based on calculated footprint. CERs are electronic certificates issued for greenhouse gas emission reductions from CDM project activities or programmes of activities (PoAs) in accordance with CDM rules and requirements.

Scope 2 Emissions Reduction

It may be noted that when project proponents buy Renewable Energy credits (RECs), they enable more clean energy projects to supply power to the grid where they operate. Grid operators want to buy the cheapest power possible because energy from wind and solar plants is frequently less expensive than energy from coal-burning plants. As a result, by purchasing RECs, project proponents shall effectively be reducing carbon emissions by reducing brown power intake from the grid.

Scope 3 Emission Reduction

Optimization of employee commute, business travel, rail transport, local Out sourcing are some of the measures taken to reduce Scope 3 emissions. Vocal for local should be the business policy of Proponents.

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PART II PROJECT DETAILS

2.1 Introduction:

Shyam Steel is one of the leading premium branded TMT Rebar manufacturer in India having integrated steel plants in India. Shyam Steel Group was established in 1953 by the Beriwala Group. In past few decades it has focused on both forward and backward integration. Today the group on a consolidated basis has installed capacity of 1.58 MTPA Iron making. It has three manufacturing units located in Bengal, which include a state-of-the-art integratedsteel plant in Paschim Burdwan and Bankura equipped with best-in-class automation (steel melting,continuous billet casting mill, high-speed rolling mill, sophisticated microprocessor based technologies and fully-equipped NABL- accredited laboratory.

Shyam steel are now embarking upon further addition of steel making capacity by installing a green field project to install and manufacture - 3.0 MTPA, pellet plant (2 x 1.2 MTPA) – 2.4 MTPA, producer gas plant (14 x 5000 Nm3/hr.)-588 mNm3 per annum, DRI kilns (8x600 TPD)-1.68 MTPA, WHRB power through DRI kilns – (8 x 15 MW)-120 MW , through BF - 18 MW , through coke oven- 15 MW and CFBC based power plant of (2 x 15 MW)- 30 MW, SMS– IF (18 x 20 T) with LRF (6 x 20 T)- 1.26 MTPA, BOF (1 x 50 T) with LRF(1 x 50 T) and VAD unit (1 x 50 T)- 0.525 MTPA and EAF (1 x 50 T) with LRF (1 x 50 T) - 0.175 MTPA, rolling mill through hot charging (3 x 1000 TPD) - 1.05 MTPA, sinter plant (1x 100 m2) – 1.092 MTPA , Blast Furnace (1x750 m3) – 0.7875 MTPA, coke oven plant (non recovery) – 0.5 MTPA, ferro alloys (4 x 9 MVA)- 0.084 MTPA, Oxygen plant (1x250 TPD) -0.087 MTPA, lime & dolomite plant (1x 450 TPD) – 0.1575 MTPA, brick manufacturing unit -350 million bricks/year & slag recycling plant (1 x 150 TPD) – 0.0525 MTPA at Jangal Sundari Karmanagri-Parcel II, Lachhmanpur, Jarukhamar, Siulibari, Digardhi, Shikratyar, Senera & Talshankra Village/ Mouza, Raghunathpur-1 Tehsil/Block,
Purulia District, West Bengal.

2.2 Need for the Project

With the steel demand as experienced in 2019, and currently the outlook in the near term future remains upwards for the world as a whole, and for India in particular. As the world is recovering from Covid-19, steel demand will grow. A major driving force behind world demand has been the continuing rapid growth in consumption in China, and substantial growth in India, and also the activity in the other major markets of the world is also good, leading to a broad base of demand in most regions.

Steel consumption has been steadily growing in India. The main areas of consumption are construction, housing, infrastructure, auto mobiles and consumer durables, engineering goods and applications. The apparent per capita steel consumption in India grew at a CAGR of 4.12% from almost 64 kg in FY16 to nearly 77.0 kg in FY21. The National Steel Policy aims to increase per Capita steel consumption to 160 kg by FY 2030-31. These are the driving forces to motivate Shyam Steel to venture for this project.

2.3 Need for this Study

As per the practice being followed by MoEFCC at present, for all expansion projects the EC is given by Ministry only when the Environment Impact Assessment (EIA/EMP report) includes a report on Carbon Footprints of the proposed expansion or a green field project along with a strategy proposed for mitigation of GHG emissions including Carbon Sequestration.
General requirement of MoEFCC is:

"The project proponent shall submit a study report on De-carbonization program, which would essentially carbon emissions, carbon budgeting/ balancing, carbon sequestration activities and carbon capture, use and storage after offsetting strategies. Further, the report shall also contain time bound action plan to reduce its carbon intensity of its operations and supply chains, energy transition pathway from fossil fuels to renewable energy etc. All these activities/ assessments should be measurable and monitorable with defined time frames."

The green field project creates direct employment to about 8000 persons (skilled, semi skilled & unskilled). nearly 50 cars and 300 Two wheelers shall ply approximately 30 Km distance to commute to the works for 245 days a year. More than 5 million tonnes of the raw material shall also be moved to site by rail and road. Commutation of the employees to the work place and material transport to works are being considered under GHG inventorisation for this project.

2.4 Project Description

2.4.1 Type of the project

It is proposed to set up an integrated Steel Plant with the following facilities:

Unit	Description
Iron ore beneficiation	Manufacturing of Iron ore concentrate using Iron ore fines as raw materials.
Pellet plant	Manufacturing of Pellets using Iron ore concentrate, Bentonite, Limestone as raw material & Anthracite Coal, Coke breeze as fuel
Blast Furnace	Manufacturing of Hot Metal / Pig Iron using Sinter, Iron ore lump, BF coke, Quartzite, Dolomite, Limestone using as raw materials.
Sinter Plant	Manufacturing of Sinter using Iron ore fines, Limestone, Dolomite, Coke fines, Mill scales etc., as raw materials.
Coke oven	Manufacturing of Met. Coke using Coking Coal as raw material.
DRI Kilns (Sponge Iron)	Manufacturing of Sponge Iron using Iron Ore /Pellets & Dolomite as raw material and coal as fuel.
Steel Melting Shop (EAF+LRF)	Manufacturing of Hot Billets / MS billets using Sponge Iron, Pig iron, Scrap, Lime & SiMn as raw materials
Steel Melting Shop (BOF+LRF+ VD)	Manufacturing of Hot Billets / MS billets using Hot metal, Lime, Dolomite & SiMn as raw materials
Steel Melting Shop (IF + LRF)	Manufacturing of Hot Billets / MS billets using Sponge Iron, Pig iron, Melting Scrap, Slag scrap & SiMn as raw materials
Rolling Mill	Manufacturing of Rolled Products using Hot Billets / MS Ingots / MS Billets as raw materials.
Ferro Alloys Plant (Submerged Arc Furnace)	Manufacturing of Ferro Alloys using Manganese Ore, Quartz, Scrap, LAM coke, Electrode paste, etc. as raw materials.
Power Generation	The waste flue gases from the kiln will pass through WHRB for Power Generation and through FBC Power Plant using Coal & Dolochar as fuel.

Unit	Description
Brick Manufacturing Unit	Manufacturing of Bricks using Tailings, Fly ash, Bed Ash, Slag & cement as raw materials
Briquetting Plant	Manufacturing of Briquettes utilizing Ferro Chrome slag

2.4.2. Size or Magnitude of Operation

The plant configuration and production capacity of the proposed project are given below:

Plant configuration and production capacity

S. No.	Unit (product)	Unit configuration	Production capacity
1	Iron ore beneficiation plant (I/O concentrate)	2 x 1.5 MTPA	3.0 MTPA
2	Pelletization Plant (pellets)	2 x 1.2 MTPA	2.4 MTPA
3	Producer Gas Plant (Producer Gas)	14 X 5000 NM^3/HR	588 MNM^3 /annum
4	DRI Kiln (Sponge Iron)	8 x 600 TPD	1.68 MTPA
5	Power generation through WHRB from DRI Kiln	8 x 15 MW	120 MW
6	Power generation through WHRB from Blast Furnace	1 x 18 MW	18 MW
7	Power generation through WHRB from Coke Oven	1 x 15 MW	15 MW
8	Power generation through CFBC Boiler	2 x 15 MW	30 MW
9	SMS {IF+LRF} – (Hot Billets / M.S.Billets)	18 x 20 T	1.26 MTPA
10	SMS {BOF+LRF*+ VD} - (Hot Billets / M.S.Billets)	1 x 50 T	0.525 MTPA
11	SMS (EAF+LRF*) - (Hot Billets / M.S.Billets)	1 x 50 T	0.175 MTPA
12	Rolling Mill through Hot charging (Rolled products i.e. TMT bars / Angles / Channels e.t.c) 85% Hot charging + 15% through RHF	3 x 1000 TPD	1.05 MTPA
13	Blast Furnace (Pig Iron)	1 x 750 m^3	0.7875 MTPA
14	Coke oven plant (Coke)	1 x 0.5 MTPA	0.5 MTPA
15	Sinter Plant (Sinter)	1 x 100 m^2	1.092 MTPA
16	Ferro Alloy Unit (FeMn (or) SiMn (or) FeCr (or) Pig Iron)	4 x 9 MVA	0.084 MTPA
17	Oxygen Plant	1 x 250 TPD	0.0875 MTPA
18	Lime & Dolomite Plant	1 x 450 TPD	0.1575 MTPA
19	Brick Manufacturing plant	10 Lakh Bricks /day	350 Million Bricks /annum
20	Slag Recycling Plant	1 x 150 TPD	0.0525 MTPA
Note: Briquetting plant of 400 Kg/hr will be provided for effective dust emission management.			

2.5. Manufacturing Process

2.5.1. Iron Ore Beneficiation

Iron ore fines reclaimed from the blending stockpile are conveyed into a surge bin within the beneficiation plant building. Ore drawn from the surge bin by a belt weigh feeder will be fed to a spiral screw type classifier. Washed ore from spiral classifier will be screened for +4 mm and -4 mm fractions over a scalping screen. Under size fraction of -4 mm will be pumped to sizing screens for screening off -1 mm fraction. Oversize fractions of +4 mm from the scalping screen and +1 mm from the sizing screens are ground in a primary ball mill in closed circuit with sizing screens to get 100% -1 mm solids suitable for gravity separation in spirals.

Sizing screen underflow fraction of -1 mm will be pumped to dewatering cyclones. Underflow of dewatering cyclones is beneficiated by gravity separation through two stage spirals viz., rougher and cleaner spirals. Concentrate from spirals circuit is ground to a size consistency of 100% passing 100 mesh and ~70% passing 325 mesh in secondary ball mills in closed circuit with classifying cyclones. Ground concentrate from the classifying cyclones overflow as well as the overflow from dewatering cyclones ahead of spirals will be pumped to concentrate thickener.

Concentrate thickener underflow thereafter will be filtered to get a product with 8% moisture maximum. The filter cake will be conveyed to stockpile. Tailings from the spirals circuit will be pumped to a linear screen to ensure a 100% -1 mm size solids in the slurry will be fed to high gradient magnetic separators to recover feebly magnetic Fe units. Concentrate from high gradient magnetic separators will be diverted to secondary ball mill discharge pump box for grinding along with spiral concentrate to desired fineness. Tailings from high gradient magnetic separators will be fed to tailings thickener. Spiral classifier overflow will be pumped to de-sliming cyclones. Overflow from these de-sliming cyclones will be fed to the tailings thickener.

Underflow from de-sliming cyclones will be diverted to spiral tailings pump box in turn to high gradient magnetic separators to recover Fe units as much as possible. Tailings thickener underflow will be taken to a filter press and the dewatered cake obtained will be stored in a yard. Clear water from concentrate thickener, filter press flows by gravity back into the process water sump for recirculation.

After separation of the impurities from the material by this beneficiation process the final product Iron ore concentrate will be sent to filter press and their filter cake is produced.

2.5.2. Iron Ore Pelletization

Drying & Preparation of raw materials:

Generally, Lime Stone and Dolomite fines & Coal (Anthracite & Bituminous) contain more than 6-7% moisture and require drying before grinding. The drying will be carried out in separate dryers for coal & a common dryer for lime stone & dolomite. LDO along with oil fired boilers will be used for heating the air required for drying. The moisture content in the dry material will be controlled.

Grinding

Bentonite in ground form will be sent to proportioning building. A provision for the Bentonite grinder will also be there if necessary. Lime stone, Dolomite will be ground together by VRM

grinder and sent to the proportioning building. Anthracite & bituminous coal will be ground separately with the common grinder and sent to the proportioning building.

Mixing and Blending

In the proportioning room the filter cake will be blended with other raw materials i.e. Bentonite, Lime Stone, Dolomite & Bituminous Coal in desired proportion. Small quantity of water will be added during blending operation. Now the raw mix will be considered as feed for Pellet making and stored in feed hopper.

Pelletization

Controlled quantity of raw mix will be fed on disc Pelletizers. Some amount of water will be sprinkled for producing Pellets. These Pellets will pass through oversize and under size screens. Pellets produced in Pelletization sections will pass through oversize and under size screens. Reject Pellets will be sent back to raw mix silos and sized Pellets will be fed into Induration Furnace.

Travelling Grate Furnace

A Travelling Grate Furnace will be used for induration of Pellets. This will be divided into *four* sections(Up draft drying zone, down draft drying zone, Pre-heating zone-1, Pre-heating zone-2). Here the green pellets travel successively in higher temperature zones to acquire strength gradually. Hot Pellets passed through Travel Grates to Kiln at around 1000 ^{o}C to 1100 ^{o}C for further strengthening. The heat source of up draft drying zone, down draft drying zone is the waste gases of pre-heating zone of the Travelling grate. Heat source of pre-heating zone-1 is the waste gases of cooler zone-2. The heat source of pre-heating zone-2 is the kiln waste gases. Additional heat source of kiln is cooler zone-1.

Rotary Kiln

Rotary Kiln receives Pellets from the Induration Furnace where Pellets have to withstand high temperatures of approx. 1250^{o}C – 1350^{o}C. Here the Pellets gain more hardness due to high temperature. Pulverized coal / Producer Gas will be used as a fuel inside the Kiln. After passing through the Kiln, the Pellets will be hardened and acquire the desired strength. Then these pellets will pass through the Cooler.

Cooler

Annular Cooler receives hot Pellets with temperature up to 1250^{o}C coming from Rotary Kiln. Cooler has its own blowers to blast the air from bottom for cooling. The hot air from the first zone will be used as combustion air in the kiln. The hot blast of the second zone will be used in the pre-heating zone-1 of travel grate and the air from the 3rd zone will be discharged to the atmosphere through chimney as its dust concentration is well within the permissible limits of pollution norms. Volume of cooling air in all the three zones is regulated automatically through the temperature control loops as per the requirement. Cold Pellets at about 100^{o}C will be discharged on to the conveyors and then conveyed to the stock pile/ loading hoppers.The screened Pellets of required size duly cooled at air cooler and subsequently by natural cooling will be transported to Bunkers.

Recovery of Dust and Spillage

Dust from drying zones and preheating zones of travelling grate, dust from the wind boxes of travelling grate and dust collected through de-duster of technological process will be sent to dust

bins via belt conveyors. Bulk spillage (dry Pellets) produced at the discharge end of Travelling Grate and will be fed into the kiln from the feed chute of the kiln feed end by bucket elevation along with spillage from Kiln feed end. Almost all the dust and bulk spillage are re-circulated and recovered.

Pulverized Coal Preparation & Injection System:

A Pulverized Coal Preparation & Injection System (PCPIS) will be provided to prepare the fuel for the pelletization process. The fuel used will be coal. The PCPIS consists of coal crushing, drying, grinding and pulverizing system. For the purpose of drying, LDO will be used in burners to feed the hot air needed. The PCIPIS will inject the pulverized coal from the discharge end of the Kiln.

Waste Gas System:

To achieve the fuel economy, an efficient and environment friendly technology will be adopted where in the waste heat of the pelletization process will be used for successive drying of the green balls and also as heat source required in the kiln & different stages of Travelling Grate furnace. The waste gases from Pre-heating zone-1, Up draft & down draft drying zone will be cleaned in ESP and released to the atmosphere through a stack. The same ESP will be used for pre-heating zone-2 waste gases before cleaning the gases in cyclones. The outlet particulate emission will not exceed 30 mg/Nm3.

2.5.3. Coal Gasification Plant/Producer Gas Plant:

Gasification of coal is a conversion technology which converts coal into producer gas. It is a high temperature process. The temperature is optimized to produce a fuel gas with a minimum of liquid and solids. This process consists of heating the feed material coal in a vessel with or without the addition of oxygen (O2). Carbon reacts with water in the form of steam and O2 at relatively high pressure and produce produce gas. This producer gas will be used in kiln/furnace. Generated tar will be sold to the market or will be used in pellet plant. Phenolic discharge of PGP will be utilized in ABC of DRI Kiln as per the Guidelines of CPCB. The ash will be utilized in brick manufacturing plant for bricks making.

2.5.4. Sponge Iron Manufacturing

Technology and Manufacturing Process

Sponge iron is distinct due to its high metallic iron content and consistent chemical and physical characteristics. This provides secondary steel manufacturers flexibility in preparing their furnace charge to produce finer quality steels than what is possible using steel scrap only.

Coal, Iron ore and dolomite are mechanically ground/ pulverized to the desired mesh size. Each item of the raw material is then sized using vibratory screens and stored in bins for eventual use in the process. Iron ore / Pellet, coal and dolomite of the required particle size will be fed by means of conveyor systems in the predetermined ratio in the rotary kiln. Air and LDO will be injected into the kiln at the time of lighting up through air tubes and oil burner provided in the kiln. Control facilities to maintain the desired temperature profile and other operating conditions are built in the process to ensure quality products. The hot product discharge from the kiln is indirectly cooled in a rotary cooler by spraying water on the shell of the cooler. The discharge from the cooler will be taken to vibrating screen for separation of material as per size. The sized material will pass through magnetic separators so that sponge iron gets separated from Char /

Dolochar. After separation, respective products will be taken to finished yard for dispatch or directly loaded in to trucks from bunker.

The flue gases will be taken from Kiln exhaust to the inlet of Boiler where the heat of waste gases will be absorbed by the water in the water wall and steam will be generated, which will be heated in super-heaters. The super-heated steam will be fed to steam receiver near TG Set. The feed water will be taken from feed line installed. The flue gases will be emitted from Chimney through ESP. The outlet emission from ESP will be less than 30 mg/Nm3.

Material will be discharged in the Rotary Cooler (Length 52 M and diameter 4.0 M) from Kiln is around 10000C. The Drive Unit consists of Main gearbox and Auxiliary gearbox. The cooler will be supported by Tyres and Support rollers. This will be cooled by indirect cooling system. The hot water will be collected and passed through the cooling tower. The same water will be recirculated. Makeup water will be added to compensate for evaporation loss.

Waste Gas Cleaning System

The flue gas coming out from the Rotary Kiln will pass through a Dust Settling Chamber, in which the heavier dust will settle down. The bottom of the dust settling chamber will be immersed in the wet scrapper water which is working as the sealing to avoid the gas leakage and false air entry.

The waste gas passes through the after Burning Chamber in which the Carbon Monoxide and unburnt carbon burns completely by air supplied through A.B.C. fans.

The hot gases will be taken to the Waste Heat Recovery Boiler of 60 TPH capacity. The heat will be transferred to the boiler coil and the steam is generated. Then the flue gases will pass through an electro static precipitator in which the gases will be treated to bring down the particulate emission to less than 30 mg/Nm3. The stack height will be in accordance with the CPCB norms.

The dust collected from E.S.P. will be sent to dust bin by pneumatic conveying system. Finally the stored dust in the dust bin is taken to the brick manufacturing plant.

Waste Heat Recovery Facility and generation of Power

The major facilities for 60 TPH Waste Heat Steam generation are as under:

- 60 TPH WHR Boiler and Accessories - 8 Nos.
- Electrical equipment & power distribution system - 8 Sets
- Steam pipe for steam from boiler to steam receiver near TG Set -8 Sets
- Feed water pipe for feed water from discharge line of feed – 8 Sets

The steam will be taken from Boiler to the steam receiver installed at Power Plant through dedicated pipeline of boiler quality pipes.

2.5.5. Power Generation process through WHRB & CFBC

The Power Plant will consist of 10 WHR Boilers and 02 CFBC Boilers Turbine Generator set with their auxiliaries. Compatible turbine will be provided as per the WHRB capacity.

Boilers (Steam Generation):

- 10 Nos. of WHR Boilers - Steam at 540^0C and 105 Kg/cm^2
- 2 Nos. of CFBC Boilers – Steam at 540^0C and 105 Kg/cm^2

Dolochar received from the DRI plant having a size of less than 10 mm will be used in the boiler. For handling of fly ash of the steam generator, dense phase, pneumatic conveying system is provided. The ash collected in the hoppers located in economizer, air pre-heated sections of SG and ESP hoppers will be pneumatically conveyed and collected in a silo from where the ash will be disposed off for brick manufacturing and selling to cement plants.

2.5.6 Steel Melting Shop

a. Induction furnace

Induction furnace works on the principle of Induction melting of scrap, pig iron and sponge iron with the help of electric power. An alternating electromagnetic field induces eddy current in the metal so that the electrical energy converts into heat whose quantity depends on the resistively of the charge. If the charge consists of metal scrap, chips and other metal rejections then the eddy currents arise between separate pieces of charge because of high contact resistance. So small charge pieces required increase frequency of current that feeds the induction heater in order to speed up melting of the charge. Induction furnaces are beneficial in steel making for low melting loss. An induction furnace constitutes a single larger primary coil made of water-cooled copper tube. The working voltage is impressed across the terminals of the coil. These furnaces have a great much application for melting of Iron, Steel and Nonferrous.

The blower sucks the flue gases through hood along with pipe, which will connect to the bag filters. The blower sucks the flue gases through hood along with pipe, which connects to the Bag filters. The cool and fresh air will be exhausted through a common Stack of 30 M height for each Three furnaces. Hence, there will be total 6 nos. stacks in Induction furnace area for 18 furnaces. The outlet dust concentration will be < 30 mg/Nm3.

b. Electric Arc Furnace – 1 x 50 T

Electric arc furnace (EAF) steel making technology is more than hundred years old. During charging andnmelting of material, oxygen is injected for foamy slag operation and de-decarbonisation of melt. The foamy slag shields the arcs promoting better heat transfer to bath as well as to arrest radiation to the side walls. Lime will be charged to maintain the slag basicity. Dolomite is charged to maintain certain level of MgO in slag as well as for slag door maintenance. As soon as the charge is melted, bath sample is taken and the steel temperature measured. The steel at this stage is ready for tapping. Liquid slag will be poured into the slag dump from where, it will be disposed off by using pay loaders and dumpers. During the treatment, temperature is measured and samples are taken periodically. Ferro-alloys are added in the ladle and then transported to the caster with the help of EOT crane for casting.

Flue gases from EAF are cleaned in Bag Filer and let out to atmosphere.

c. Basic Oxygen Furnace – 1 X 50 MT

Steel making operation in the basic oxygen furnace (BOF) is also sometimes called basic oxygen steel making (BOS). The BOF process is auto genous, or self-sufficient in energy, converts liquid iron (hot metal) into steel using gaseous oxygen (O2) to oxidise the unwanted impurities in hot metal (HM). The O2 used must be of high purity, usually 99.5% minimum, otherwise the steel may absorb harmful nitrogen (N2).

d. Continuous Casting Machine (CCM) Billet caster:

The billet caster shall be complete with ladle stand, mould assembly, Strand guide segments and supports withdrawal and straightening system, mould cooling system, Cut-off equipment incl. length measuring device, marking machine etc. Requisite dummy bar and facilities for Dummy bar disconnecting and a dummy bar receiver will be included. The billet casting will be done through 4 Nos. of casters to be installed having three strands each.

2.5.7 Rolling Mill to Produce Finished Steel

Rolling mill of 3 x 3,50,000 TPA capacity will be installed. Hot Billets from CCM (hot charging) will be used in Rolling Mill for production of long products i.e. TMT bars/Angles/Channels, etc.

The mill will be designed to produce TMT bars of size 8 mm to 40 mm / wire rod of 5.5 mm to 8 mm. 85% of production from Rolling mill will be through hot charging and 15% will be through Reheating furnace with LDO / LSHS as fuel.

2.5.8 Manufacturing Ferro Alloys

[4 X 9 MVA SAF (FeMn – 84,000 TPA (or) SiMn – 71,080 TPA (or) FeCr – 79,800 TPA (or) Pig Iron – 84,000 TPA)]

Ferro -Alloys are produced by reducing oxides from their ores by using a suitable reduction under conditions created to ensure a higher recovery of the valuable elements from the input materials.

In the sub-merged arc furnaces Ferro Manganese (or) Silico Manganese (or) Ferro Chrome (or) Pig Iron will be produced. The Furnaces will be operated on continuous basis with continuous input of power and raw materials.

Mn ore (different grade of manganese ore), Fluxes (Dolomite, Quartz) and reductant (Coke/ Coal) and iron ores / iron bearing materials are feed to a refractory lined sub-merged arc furnace. Electricity will be fed to the furnaces through three numbers of self-backing carbon electrode and the heat generated by the electricity will be utilized for the reduction process. Metal and slag are formed in the process at ratio 1: (0.9 to 1.2). Liquid hot Metal and slag are being tapped out at regular interval. Metal and slag are tapped out from the same tap hole and collected in a long launder. The launder arrangement is being done for gravity separation of Liquid metal and slag. Cast metals are broken on to sizes as per the customer requirement / specification. SiMn slag is being used in the road construction or will be given to cement plant bricks and FeMn slag is recycled in to SiMn manufacturing process.

For Ferro Chrome Process Chrome Ore is the major raw material. Chrome Ore is in the form of Cr2 O3, Fe2O3, SiO2, Al2O3, CaO and MgO. These oxides react with carbon in the coke and reduced to Fe, Cr, Si, C etc. Other oxides i.e Al2O3, SiO2, CaO, MgO are removed in the form of Slag.

The flue gases from submerged arc furnaces will be extracted through 4th hole and treated in bag filters and the particulate emission at the outlet will be < 30 mg/Nm3. The treated gases will be discharged to air through stack of 30 m height. There will be one common stack for two Submerged arc furnaces.

2.5.9 Ferro Chrome recovery (Zigging plant)

Ferro chrome recovery process involves the following steps:

i. Crushing & screening: In this, slag is crushed to smaller size particles as close as possible
ii. Coarse jigging: In this, particles having coarse fraction (approximately -32 to -3mm) is separated through two stage air pulsated jig for recovery of metal.
iii. Fine jigging: In this, particles of fine fraction (-3mm) is separated through diaphragmpulsed (through the bed' jigs for recovery of metal.)
iv. The recovered metal will be reused in the process.

2.5.10 Sinter Manufacturing

The proposed sinter plant complete will consist of one sinter Machine of 100m2 grate area along with associated services facilities. The sinter plant is rated for a total production of 10,92,000 TPA of BF Sinter at a rated productivity of 1.3 t/m2/hr. The raw materials received in the sinter plant are iron ore fines, mill scales, fluxes (limestone, dolomite), coke fines, dust of Plants & sinter return fines. These will be stored in a number of bins in the sinter plant building.

A modern Sinter Plant has been designed to full fill all aspects of environmental protection. Appropriate de-dusting units will be provided for cleaning the waste gas, cooling air and the ambient atmosphere of the plant by sucking dust laden air from the transfer points with in the sinter plant. Further, state of art process control systems will be incorporated to ensure the product quality and plant availability.

2.5.11. Pig Iron Through Blast Furnace (pig iron of 7,87,500 TPA)

The blast furnace shop will comprise of one no. of furnace of 750 m3 working volume. The blast furnace is envisaged to operate with sized lump iron ore, Sinter, coke, fluxes and additives. The liquid slag will be granulated at cast house granulation unit and sold to the cement plants for converting into slag cement. The BF top gas will be cleaned in dust catcher and gas cleaning system and distributed to the stoves, burners for runner drying and process steam supply. Part of this gas will be used for power generation. The excess gas will be flared through flare stack. HBT is considered as 1050 Deg C with a coke rate of 560 kgs/Thm and top pressure of 0.4 kg/cm2.

Pig Iron / molten metal will be made with its state-of-the-art facilities conforming to National & International standards. The process of manufacturing of Pig Iron is furnished below. Slag is a bi-product from blast furnace, which will be granulated by means of slag granulation system. Granulated slag will be sold to cement plants. The blast furnace gas coming-out from the furnace will be used as fuel for power generation. Dry gas cleaning in dust catcher. Wet gas cleaning in Annular gap scrubber GCP will be designed to ensure outlet dust emission of 5 mg/Nm3.

2.5.12. Coke Oven Plant (Non-Recovery)

Metallurgical coke is a hard carbon material produced in the process of the 'destructive distillation' of various blends of bituminous coal. It is produced by carbonization of coal at high temperatures (around 1100 deg C) in an oxygen deficient atmosphere in a coke oven.

The technology of non-recovery coke ovens has arisen from the classic beehive ovens which supplied since the eighteenth century the coke for the industrial revolution. The beehive ovens were manually operated, with small heat recovery, just for heating the oven. Now, non-recovery

ovens are modern construction, with highly mechanized operation, and automated to a certain degree. Gases generated by the combustion of the volatile matter are sent through down comers and further burnt to heat the oven bottom and sides.

In the process of coke making in the non-recovery ovens, volatiles evolved during coal carbonization are not recovered as by-products but are combusted in the oven itself in the presence of controlled quantity of air and the heat of the volatiles of evolving gases is utilized for coking of the coal mass into coke and thus no external heating is required. The heat is generated by the combustion of volatile matter which is then penetrated into the coal mass through radiation from the oven top and also by conduction. The higher level of heat importantly is used to break up the potentially polluting hydro-carbons into the constituent combustible compounds and to burn them thus avoiding the potentially hazardous pollution. The heat consequent to combustion is only partially utilized during the process and the balance heat in the waste flue gas is recovered for energy generation.

The flue gas coming out of the coke oven carries a significant quantity of sensible heat in addition to some combustibles. As nothing other than coke is recovered from the coke ovens incorporating this technology, the coke ovens are called non-recovery coke ovens. When the combustibles present in the waste gas are burned and the generated heat along with the sensible heat of the flue gases is used for the production of steam and generation of power, the coke ovens are called heat recovery coke ovens or energy recovery coke ovens.

The key elements of the non-recovery coke oven technology are (i) coke is produced by heating coal, in a controlled atmosphere, thus liberating volatile matter (gas and moisture), (ii) the gas is combusted in an environmentally ‘smart’ way so as to produce the heat to make the coke, (iii) excess heat which is produced in the process is used to generate electricity, (iv) the process does not rely on the combustion of coal, only the gas liberated from the coal.

Non recovery coke ovens produce a quality coke suitable for blast furnace. These ovens are useful to obtain high quality coke for blast furnace operation with high pulverized coal injection, where better properties of coke are needed, or to obtain standard quality based on blends with some proportion of non-coking coals

2.5.13 Lime/Dolomite Plant

Lime/Dolomite plant will be provided to meet the respective requirement for plant operations. The gases emissions will be extracted and treated in bag filters to ensure particulate matter of less than 30 mg/Nm3.

2.5.14 Brick Manufacturing Plant

Raw material for bricks manufacturing are mainly Cement, tailings, fly ash, bed ash & non magnetic slag dust. These materials are fed to the mixture through weighing and batching system.

2.5.15 Oxygen Plant

Atmospheric air mainly consists of Oxygen and Nitrogen gases along with small quantities of water vapour, Carbon Dioxide, Argon, Helium, etc. Oxygen and Nitrogen from the Air are separated due to difference in boiling points by distillation through a fractional column.

Atmospheric Air is sucked in by a multi stage Compressor through a filter and is compressed to

the design pressure. The compressed Air is then passed through inter-coolers, Industrial Refrigerator, Moisture Separators, and then to the Molecular Sieve Battery for removal of Carbon Dioxide, Hydrocarbons and Moisture from the process Air. This pure Air then passes through the 1st Heat Exchanger, where it is cooled by the outgoing Nitrogen and Oxygen. Part of this cooled Air is passed through Expansion Engine and the other part through the 2nd Heat Exchanger. Both the Expansion Engine and 2nd Heat Exchanger help in further cooling down the Air, which is finally released to the bottom of the column through an expansion valve. The Air becomes liquid at this stage.

Both Nitrogen and Oxygen are removed through separate paths in Heat Exchangers, for cooling the incoming air. Oxygen is compressed to a prescribed settled pressure by a liquid pump and is directly filled into cylinders. Nitrogen is however available at a pressure of approximately 0.5 kg/cm^2 andthe same can be compressed into cylinders with help of an independent high- pressure compressor.

2.6 Raw material required along with estimated quantity, likely source, mode of transport of raw material and finished product distance travelled

The following will be the raw material requirement for the proposed project:

Raw Material Requirement, Source & Mode of Transport

Raw Material	Quantity (TPA)	Sources	Mode of Transport	Distance travelled Km
Beneficiation Plant - 30,00,000 TPA				
Iron Ore Fines	31,68,000	Odisha, Jharkhand & Chhattisgarh	By Rail, Road	3.5
Pellet Plant – 24,00,000 TPA				
I/O Concentrate	26,40,000	Own generation	Through Conveyor	0
Anthracite Coal	48,000	Jharkhand, Odisha, WB & Imported	By Rail & Road (Covered trucks) & Through vessel.	257
Bentonite	21,600	Gujarat	By Road (Covered trucks) & Rail	2100
Limestone	60,000	M.P. & Odisha	By Rail & Road (Covered trucks)	645
Coke breeze	12000	Own generation, WB & Jharkhand	Internal Transfer & By Road (Covered trucks)	100
Dust from Pellet Plant	48,000	Own generation	Re-used through close circuit	0
Producer Gas Plant- 58,80,00,000 NM^3				
Domestic Coal	3,60,000	Odisha, Jharkhand & WB	By Rail & Road (Covered trucks)	188
DRI Kilns (Sponge Iron) – 16,80,000 TPA				
Pellet/ Iron Ore	24,00,000	Own generation, Odisha, Chhattisgarh, Jharkhand & Imported	By Conveyers & Rail and Through vessel	0
Imported Coal	14,28,000	South Africa,	Through vessel &	300

Raw Material	Quantity (TPA)	Sources	Mode of Transport	Distance travelled Km
		Indonesia & Australia	Road	
Dolomite	84,000	M.P., Chhattisgarh & Imported from Bhutan	By Rail & Road (Covered trucks) and Internal Transfer	542
CFBC Boilers [Power Generation-2 X 15 MW- 30 MW]				
Dolochar	3,70,000	Own generation	Through Conveyer	0
Domestic Coal	30,240	Odisha, Jharkhand & WB	By Rail & Road (Covered trucks)	188
Steel Melting Shop (IF+LRF) – 12,60,000 TPA				
Sponge Iron	12,60,000	Own generation	Through Conveyers	0
Pig Iron	2,28,000	Own generation	Internal Transfer (Covered trucks)	0
Melting Scrap (end cuttings also)	30,000	Own generation, Odisha, Chhattisgarh, Jharkhand, WB & Imported	Internal transfer (Covered Trucks), By Rail & Road (Covered trucks) & Through vessel.	0
Slag Scrap	52,500	Own generation	Internal Transfer (Covered trucks)	0
SiMn.	18,900	Own generation	Internal Transfer (Covered trucks)	627
Steel Melting Shop (BOF+LRF+VD) – 5,25,000 TPA				
Hot Metal	5,60,000	Own generation	Through Ladle	0
Lime	28,900	Odisha, Chhattisgarh, Jharkhand / Own Generation	By Rail & Road (Covered trucks) / Internal Transfer (Covered trucks)	0
Dolomite	13,100	M.P., Chhattisgarh & Imported from Bhutan/ Own Generation	By Rail & Road (Covered trucks) /Internal Transfer (Covered trucks)	542
SiMn	7900	Own generation	Internal Transfer (Covered trucks)	627
Steel Melting Shop (EAF + LRF) - 1,75,000 TPA				
Sponge Iron	87,500	Own generation	Through Conveyers	0
Pig Iron	17,500	Own generation	Internal Transfer (Covered trucks)	0
Lime	26,400	Odisha, Chhattisgarh, Jharkhand / Own Generation	By Rail & Road (Covered trucks) / Internal Transfer (Covered trucks)	0

Raw Material	Quantity (TPA)	Sources	Mode of Transport	Distance travelled Km
Melting Scrap	87,500	Own generation, Odisha, Chhattisgarh, Jharkhand, WB & Imported	Internal Transfer, By Rail & Road (Covered trucks) & Through vessel.	0
SiMn	2600	Own generation	Internal Transfer (Covered trucks)	0
Rolling Mills – 10,50,000 TPA with 85% hot charging + 15% with RHF (LDO/LSHS as fuel)				
MS Billet/ Ingots/ Bloom	11,02,500	Own generation	Roller Conveyers	0
LDO /LSHS	5200 KL	Nearby IOCL, BPCL & HPCL Depot	By Road (Through tankers)	100
Blast Furnace- 7,87,500 TPA				
Iron Ore	3,15,000	Odisha, Chhattisgarh, Jharkhand & Imported	By Rail & Through vessel.	3.5
Sinter	10,92,000	Own Generation	Roller Conveyers	0
Coke	4,41,000	Own generation	Internal Transfer (Covered trucks)	0
Quartz	15,750	WB	Covered trucks	60
Dolomite	43,000	Odisha, Chhattisgarh, Jharkhand/ Own Generation	By Rail & Road (Covered trucks) / Own Generation	542
Lime Stone	51,000	Odisha, Chhattisgarh, Jharkhand/ Own Generation	By Rail & Road (Covered trucks) / Own Generation	645
Coke Oven Plant – 5,00,000 TPA				
Coking Coal	7,50,000	Jharkhand & Imported from Australia	By Rail & Road (Covered trucks)& Through vessel.	200
Sinter Plant – 10,92,000 TPA				
I/O Fines	9,82,800	Odisha, Chhattisgarh & Jharkhand	By Rail & Road (Covered trucks)	0
Mill Scales	27,300	Own Generation	Internal Transfer (Covered trucks)	0
Lime Stone	1,40,000	Odisha, Chhattisgarh, Jharkhand/Own Generation	By Road (Covered trucks))/ Internal Transfer (Covered trucks)	645
Dolomite	98,000	Odisha, Chhattisgarh, Jharkhand / Own Generation	By Road (Covered trucks)/ Internal Transfer (Covered trucks)	542
Coke Fines	93,000	WB, Odisha &	By Road	0

Raw Material	Quantity (TPA)	Sources	Mode of Transport	Distance travelled Km
		Jharkhand	(Covered trucks)	
Dust from SMS, BF, Coke Oven	1,08,200	Own generation	Internal Transfer (Covered trucks)	0
Return fines from Sinter Plant	2,29,320	Own generation	Internal Transfer (Covered trucks)	0
For Ferro Alloys : 4 x 9 MVA [SiMn (or) FeMn (or) FeCr (or) Pig Iron]				
(i) For manufacturing Silico Manganese - 71,080 TPA				
Manganese Ore	1,15,860	MOIL, OMC & Imported from South Africa & Indonesia	By Rail & Road (Covered trucks) & Through vessel.	627
FeMn Slag	57,140	Own Generation	Through Conveyor	0
Coke	27,360	Own Generation	Internal Transfer (Covered trucks)	100
Quartz	14,200	WB	By Road (Covered trucks)	60
Dolomite	21,000	Odisha, Chhattisgarh, Jharkhand & WB/ Own Generation	By Rail & Road (Covered trucks)/ Internal Transfer (Covered trucks)	542
(OR)				
(ii) For manufacturing Ferro Manganese – 84,000 TPA				
Manganese Ore	1,91,100	MOIL, OMC & Imported from South Africa & Indonesia	By Rail & Road (Covered trucks) & Through vessel.	627
Coke	30,660	Jharkhand, Assam,Meghalaya & Imported	By Rail & Road (Covered trucks) & Through vessel.	100
Quartz	2520	WB	By Road (Covered trucks)	60
Dolomite	25,200	Odisha, Chhattisgarh, Jharkhand & WB	By Rail & Road (Covered trucks)	542
(OR)				
(iii) For manufacturing Pig Iron – 84,000 TPA				
HG Iron ore	1,23,900	Chhattisgarh, Odisha ,Jharkhand & Imported	By Rail & Road (Covered trucks) & Through vessel.	3.5
Coke	41,160	Jharkhand, Assam, Meghalaya & Imported	By Rail & Road (Covered trucks) & Through vessel.	100
Lime stone	34,440	Chhattisgarh, Madhya Pradesh & Odisha	By Rail & Road (Covered trucks)	645
(OR)				
(iv) For manufacturing Ferro chrome – 79,800 TPA				
Chrome Ore	1,59,600	Odisha & Imported from	By rail, road (Covered trucks)	627

Raw Material	Quantity (TPA)	Sources	Mode of Transport	Distance travelled Km
		South Africa	& Through vessel.	
Coke	26,334	Jharkhand, Assam, Meghalaya & Imported	By rail, road (Covered trucks) & Through vessel.	100
Quartz	1596	WB	By Road (Covered trucks)	60
Lime	1996	Chhattisgarh, Madhya Pradesh & Odisha	By rail, road (Covered trucks)	0
Bag filter dust	2794	Own Generation	Through Pipeline	0
Lime & Dolomite Plant- 1,57,500 TPA				
Lime/Dolo Stone	2,83,500	Chhattisgarh, Madhya Pradesh & Odisha	By Rail & Road (Covered trucks)	645/542
Composite Brick Plant- 350 Million Bricks/Year				
IOBP Tailing	5,28,000	Own generation	Covered trucks	0
Cement	1,10,000	WB	By rail & road (Covered trucks)	100
Bed Material	88,200	Own Generation	In covered trucks	0
Fly Ash/ash	5,95,800	Own Generation	In covered trucks	0
Slag Dust	3,72,765	Own Generation	In covered trucks	0
Wet scrapper sludge	57,231	Own Generation	In covered trucks	0
Slag Recycling Plant-52,500 TPA				
Slag	4,05,000	Own Generation	In covered trucks	0
Note: Own Railway siding is proposed upto the plant from Bero R.S.				

2.7 Water Requirement

- Water required for the proposed project will be **30,743 KLD.**
- Water required for proposed project will be sourced from Panchet Reservoir of Damodar Valley Corporation (which is at a distance ranging from 8.0 Kms. from the project site).
- Air cooled condensers will be provided to Power plant. The following is the breakup of water requirement.
- Power required to pup the water from Panchet Reservoir to the plant is 300 KW and that to run STP is 75 KW.

2.8 Green Belt

200 acres of greenbelt will be developed.

2.9 Power Requirement

Power required for the proposed project will be 258 MW and same will be sourced from Captive Power Plant 183 MW and remaining 75 MW from the WBSEDCL/WBSETCL.

Break up of Power Demand

S. No	Plant Name	Power Requirement in MW
1.	Iron Ore Beneficiation & Pellet Plant	20
2.	Producer Gas Plant	1.5
3.	Sponge Iron Plant	15
4.	Induction Furnaces with BOF, LRF,VD & CCM facilities	120
5.	EAF	15
6.	Rolling Mill	13
7.	Sinter Plant	6.5
8.	Blast Furnace	14
9.	Coke oven plant	0.6
10.	Power Plant (Aux. consumption)	15
11.	Ferro Alloys	35
12.	Brick plant & Slag Recycling Plant	1
13	Pumping Station at Panchet Reservoir	0.300
14	Power required to run STP	0.075
15	Plant Lighting and other utilities (assumed)	1 MW
Total		**258 approx**

2.10. Refrigeration Load

- **Air Conditioners:**

DETAILS OF AIR CONDITIONER TO BE INSTALLED IN PROPOSED PROJECT				
Sl.No	Capacity (Ton)	Quantity	Name of Refrigerant	Remarks
1	12	27	R- 407	
2	5.5	81	R- 407	
3	3	60	R- 407	
4	2	18	R- 407	
5	1.5	111	R- 407	
6	1	60	R- 407	

- **Fire Extinguishers:**

a) 5 kg – 150 Nos (Dry Powder Type)
b) 10 kg – 200 Nos (Mechanical Foam Type)
c) 50 Litres – 10 Nos (Mechanical Foam Type)

- **SF6 installations**

Approximately 200 kg of SF6 shall be used in Cicuit Breakers.

It is assumed that at leat 2 % of SF6 shall be topped up every year.

2.11 Solid Waste Generation and Utilisation

Following solid waste / by product will be generated from plant and its disposal method:

SOLID WASTE GENERATION AND ITS BREAK UP

S.No.	Waste / By product	Quantity (TPA)	Proposed method of disposal
1.	Tailings from I/O Beneficiation	5,28,000	Tailings will be dewatered in filter press and subsequently the cake will be utilized in proposed Brick Manufacturing Unit.
2.	Ash/dust from Pellet plant	48,000	Will be utilized in the proposed Pellet Plant.
3.	Ash from PGP	93,600	Will be utilized in the proposed Brick Manufacturing Unit
4.	Tar from PGP	3600	Will be sold to local market or utilized in pellet plant
5.	Ash from DRI	2,35,200	Will be utilized in the proposed Brick Manufacturing Unit
6.	Dolochar from DRI	3,70,000	Will be used in proposed CFBC power plant as fuel.
7.	Kiln Accretion Slag	20,160	Will be utilized in the proposed Brick Manufacturing Unit
8.	Ash from PowerPlant	2,35,632	Will be utilized in the proposed Brick manufacturing unit
9.	Bed material from Power Plant	88,200	Will be utilized in the proposed Brick manufacturing unit
10.	SMS Slag (IF)	1,26,000	Slag from IF will be crushed and iron will be recovered &then remaining non-magnetic material being inert by nature will be utilized in the proposed Brick Manufacturing Unit.
11.	SMS Slag (BOF)	52,500	Slag from BOF will be crushed and iron will be recovered & then remaining non-magnetic material being inert by nature will be utilized in the proposed Brick Manufacturing Unit.
12.	SMS slag (EAF)	37,625	Slag from EAF will be crushed and iron will be recovered & then remaining non-magnetic material being inert by nature will be utilized in the proposed Brick Manufacturing Unit.
13.	Dust from SMS	39,200	Will be utilized in the proposed Sinter Plant.
14.	End Cuttings from Rolling Mill	31,500	Will be reused in the SMS
15.	Mill scales from Rolling Mill	3150	Will be reused in the sinter plant
16.	Miss Roll from Rolling Mill	15,750	To be sold to local market
17.	Wet scrapper sludge	57,231	Will be utilized in the proposed Brick Manufacturing Unit
18.	Slag from Blast furnace	2,36,000	Granulated slag will be given to cement plants

19.	Dust from Blast Furnace	40,000	Will be reused in the sinter plant
20.	Dust from Coke Oven Plant	22,500	Will be reused in the sinter plant
21.	Fines from Sinter Plant	2,29,320	Will be reused in the sinter plant
22.	Slag from FeMn or	57,140	Will be reused in manufacture of SiMn as it contains high SiO_2 and Silicon.
	Slag from SiMn or	64,460	Will be used for Road construction/will be given to slag cement manufacturing
	Slag from FeCr	39,140	Will be processed in jigging plant for Chrome recovery. If Chrome content exceeds the permissible limits, it will be sent to nearest TSDF.
23.	Slag dust from Slag Recycling Plant	3,52,625	Will be utilized in the proposed Brick Manufacturing Unit

2.12 CONNECTIVITY

The proposed site is well connected with Road network. The following table gives brief regarding connectivity of the proposed site:

Component		**Description**
Road	:	Site is well connected to SH # 5 which is adjacent to the site. NH # 2 is at a distance of 26 Kms. from the project site.
Rail	:	Nearest railway siding @ chourashi station – 9.5 Kms.
Air	:	Andal Airport (Paschim Bardhaman) – 82 Kms.

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PART III - GHG INVENTORISATION AND MITIGATION STRATEGY

3.1 Identification of GHG Sources in the Plant

3.1.1 The GHG emission and removal activities of the proposed plan in general, are presented in the table below:

S. No.	GHG Emission related Activity	Scope
1	Coal, LPG, FO, LDO, Diesel consumption in furnaces and Diesel/Petrol consumption in internal vehicles.	Scope 1
2	Coke and other reducing agents and raw materials consumption in process	Scope 1
3	Coal used in Thermal Power generation at site	Scope 1
4	Diesel Consumption in DG Sets and start up for Boilers	Scope 1
5	Fugitive emissions from chillers	Scope 1
6	CO2 type fire extinguishers refilled	Scope 1
7	Use of Refrigerants in AC and Refrigerators.	Scope1
8	HF6 consumption	Scope 1
9	Electricity purchased from grid	Scope 2
10	Steam, Compressed air purchased from outside	Scope 2
11	Employees Commute	Scope 3
12	Transportation of Raw materials from nearest Source to the Plant	Scope 3
13	Any other activity from Section 2 Scope 3 of Part I of this report	Scope 3
14	Renewable Energy Purchase	Scope 2
15	Green Belt credits	Scope 1
16	Plantation outside	Scope 3

3.1.2 Likely Credits/Removal Activities

a) Green Belt.
b) Solid Waste utilisation.
c) Use of Renewable Energy (5% REC credits)
d) Hot charging of billets
e) Plantation out side the factory premises.

3.2 Selection of GHG Quantification Methodology

The methodologies used are based on factors presented in the Intergovernmental Panel on Climate Change (IPCC) 2006 “Guidelines for National Greenhouse Gas Inventories, 2006” and subsequent revisions. The report is based on the calculation “GHG activity data multiplied by GHG emission factor”. The Plant has identified its GHG sources and sinks according to scope of emissions i.e. Scope 1, Scope 2 and Scope 3 from its organisation boundary which are categorised as follows:

The links for accessing the emission factors are given in Part I of this report.

3.3 Summary of GHG Emissions from the proposed project

SUMMARY OF GHG EMISSIONS UNDER DIFFERENT SCENARIOS		
A	Scope I Emissions- Process	8207819
B	Scope I Emissions for manufacture of Ferro Alloys	
B1	Case-1 Silico Manganese	106890
or		
B2	Case-2 Ferro Manganese	106890
or		
B3	Case-3 PIG Iron	142750
or		
B4	Case-4 Ferro Chrome	81635
C	Combustion of Liquid Fuel in Rolling Mills	13814.231
D	Refrigeration Scope I	2296.285
	SCOPE II EMISSIONS	
A	External Power Scope II	441531
B	Credits	822131
C	Green Belt	500
A	Production MTPA	1.96
B	CO2 Emissions T /T of Steel	510
C	Ton/Ton of Crude Steel	2.6
	Scope III Emissions	
A	Employees Commute	21.197
B	Transportation of raw materials to site	181.606
	Sub-Total Scope III Emissions	202.803
C	Ferro Alloys Scope III Emissions	
C1	Case-1 Silico Manganese	22.664
C2 or	Case-2 Ferro Manganese	22.562
C3 or	Case-3 PIG Iron	7.459
C4 or	Case-4 Ferro Chrome	17.251

3.4 GHG Emission Reduction Strategy

A. The facilities for GHG mitigation by resource conservation, energy recovery and GHG reduction are suggested as follows;

a. Heat Recovery from flue gases of Pellet Plant for heating of the combustion air.
b. Sinter Cooler Waste heat recovery to preheat the combustion air or to generate low pressure steam or to recover power from the waste heat is widely practiced to reduce coke breeze consumption or to generate power in sinter plants.
c. Installation of TRT on 750 Cum Blast Furnace (This can generate at least 1.5 to 2.0 MW of Power). A TRT unit can produce around 15 to 60 kWh/t of hot metal (HM). Its output can meet around 30 % of the power needed by the all equipment (including the air blower) of the BF. The BF gas leaving the TRT unit can still be used as fuel in the steel plant.
d. Dry gas Cleaning of BF gas will save energy in running the wet GCP and handling of wet sludge. Dry material collected from flue gases can be directly sent to Sinter or Pellet Plant.
e. Stove Waste Gas Heat Recovery system can improve the hot blast temperature up to 12000 C even in small furnaces, This results in enormous saving of coke rate.
f. Oxygen Enrichment of the blast and stem injection in the hot blast air reduces the coke rate further and improves the productivity of the Blast Furnace.
g. Dry gas cleaning of BOF gas and its recovery as fuel to be used in Boilers/RHF helps to reduce over all energy consumption in steel plants
h. Energy recovery by installing scrap preheating at EAF,
i. Producer Gas Plant modules are too small. Larger modules increase gas yield, reduced pollution and waste generation, there by getting more gas per kg of coal.
j. 4th Hole extraction system in the SAF help increase the energy efficiency of the furnaces.
k. Increased hot charging of billets to minimize the heat requirement for rolling.
l. Installation of regenerative type limestone/dolomite kilns save sizeable energy in calcination.
m. 100 % solid waste utilization to conserve resources by installation of briquetting and micro pelletising facilities for fines collected from PCDs and road /floor sweeping. Carbon capture shall be explored subject to end user/ identification of storage locations and collaboration.

An example for energy saving is given below;

B. WHR at EAF - If WHR is installed on EAF -

1) EAF capacity- 1x 50 T
2) Total Production Planned- 175000 TPA
3) Enthalpy of EAF Flue gases-- 113 kwh/ts (Reference paper attached)
4) Maximum recovery through WHRB and Turbine 25%.
5) Power recovered= 113kwh /T steelx25%x 175000 T Steel/year/1000 = 4944 MWH (Reference paper Attached as annexure III)
6) CO2 factor 790 Kg/MWH
7) CO2 saving = 0.790 /MWH x 4944 MWH= 3905 T/year

C. Green Belt Credit

The plantation and green belt development will also be taken care in the plant and the space reserved for plantation will be more than 33% of the total plant area i.e. 200 Acres. Shyam Steel will take-up extensive green belt development by planting about 1000 trees per Ac. it has been proposed to develop 15 meters wide green belt along the periphery inside the factory premises.

On an average, one acre of new forest can sequester about 2.5 tons of carbon annually. Young trees absorb CO2 at a rate of 6 kg per tree each year. Trees reach their most productive stage of carbon storage at about 10 years at which point they are estimated to absorb 22 kg of CO2 per year. At that rate, they release enough oxygen back into the atmosphere to support two human beings. Planting 100 million trees could reduce an estimated 18 million tons of carbon per year and consequently save American consumers $4 billion each year on utility bills.

http://urbanforestrynetwork.org/benefits/air%20quality.htm

- Nos of trees in Green Belt - 200 x 1000 = 200,000 Nos.
- Carbon sequestration in green belt - 200 x 2.5 = 500 TPY

D. Energy Transition from Fossil Fuel to Green Energy

The use of green hydrogen as fuel could help phase out coal, and enable India to move towards net-zero emissions. India has announced its commitment to reach net-zero greenhouse gas (GHG) emissions by 2070. SSWPL will take necessary steps to adopt hydrogen based steel making technology as soon as the same is available at affordable cost.

E. GHG Emission Reduction, Carbon Capture & Storage and Utilisation of CO2.

a. GHG Emission Reduction

The proposed project would be implemented using state-of-the art technologies for optimum consumption of fossil fuel based energy and other resources. In addition, a very compact layout has been planned for the project to minimise in plant transportation and handling of raw materials and products. All raw materials and utilities shall be purchased from vendors/partners after ensuring that they also follow sustainable environment and energy management practices. SSWPL plant shall be certified to ISO 14001 and ISO 50001 Management Systems.

The fines and scrap generated during the process are being recycled within the plant for use in the production process. Water consumption would also be optimised to reduce pumping energy consumption. Energy conservation and energy recovery facilities to be installed along with main plant and equipment shall be commissioned with the main plant. These facilities are summarised below:

1. Hot charging of slabs to minimise the heat requirement for rolling.
2. Waste heat recovery from EAF
3. Use of high pressure steam from WHRB to maximise power recovery.
4. Installation of LED lights and solar power generation on Roof Tops.
5. Use of variable speed drives to reduce power consumption in units operating on variable

loads.

6. Use of large capacity loaders, dumpers, ladles and transport vehicles to reduce fuel consumption.
7. Maximum solid waste utilisation to conserve resources by installation of briquetting and pelletising facilities for fines collected from PCDs and road /floor sweeping.
8. Use of Slag in cement plants to enhance circular economy and reduce the emissions in cement sector (thereby SSWPL can claim credits for such sold quantities as per applicable emission factors).
9. Additional measures planned to reduce carbon dioxide emissions are elaborated in Section below;

b. Carbon Capture and Use

Carbon Capture practice is picking up in steel industry. Blast Furnace and Steel melting flue gases could be explored for CO_2 recovery using absorption or adsorption technologies and potentially used in downstream industry and also in the steel plant for following purposes;

1. Conditioning of SMS slag in presence of steam to convert the slag into concrete or slag sand for use in construction industry.
2. Conditioning of SMS slag with CO_2 to make it suitable for use in Cement making.
3. Sale to companies manufacturing CO_2 extinguishers.
4. Sale to companies making precipitated Calcium Carbonate used as base for most of the medicine tablets.
5. Synthesis of CO_2 into ethanol (This technology has been studied and pilot facility being set up by ArcelorMittal, Europe. Upon successful demonstration and commercial scale up, can be explored by SSWPL)

c. Carbon Sequestration

Carbon sequestration offers greater hope for addressing the issue of controlling Global Warming. The following practices shall be adopted by SSWPL to initiate carbon sequestration:

1. In immediate future 33 % percent of the plant area shall be covered under green belt with tree density of 2500 trees per ha.
2. In collaboration with local forest department trees shall be planted by SSWPL in degraded forest land.

SSWPL remains committed to the nation's pledge of achieving carbon neutrality by 2070. Even after 2030, we will continue our efforts to bring down the emission intensity at the same or much faster rate.

3.5 Quality Assurance /Quality Control

To ensure the credibility of the inventory, rigorous QA/QC procedures shall be followed to ensure the accuracy, transparency, and verifiability of the estimates.

The following issues shall be addressed:

1. SSWPL shall ensure that the best and most accurate emission factors are being used. Custom

emission factors shall be calculated as far as possible. The methodology used to compute the company or plant specific custom emission factors shall be documented and strictly followed with necessary QA/QC checks, in line with IPCC guidelines.

2. If plant-specific information on the amount of coke used as reducing agent is available, this information shall be used. However, if this is not available, coke and petroleum consumption on a company-wide basis shall be used to estimate the mass of reducing agent.
3. Plant and company-wide activity data shall be checked to ensure that there is no double accounting.
4. Experts involved in GHG accounting shall be trained to account for energy consumption as per WSA and BEE guidelines.

3.6 Reporting and Documentation

SSWPL is interested in auditing and certifying their GHG emissions. In order to ensure that estimates are verifiable, quantitative input data used to develop emission estimates shall be clearly documented, including listing of the relevant year. Records shall be maintained. Standard Operating Procedure shall be developed for calculations and data collection for verification and auditing of GHG inventory.

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Emission Factors for Greenhouse Gas Inventories

Last Modified: 1 April 2021

Red text indicates an update from the 2020 version of this document.

Typically, greenhouse gas emissions are reported in units of carbon dioxide equivalent (CO_2e). Gases are converted to CO_2e by multiplying by their global warming potential (GWP). The emission factors listed in this document have not been converted to CO_2e. To do so, multiply the emissions by the corresponding GWP listed in the table below.

Gas	100-Year GWP
CH_4	25
N_2O	298

Source: Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007. See the source note to Table 11 for further explanation.

Table 1 Stationary Combustion

Fuel Type	Heat Content (HHV)	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 Factor	CH_4 Factor	N_2O Factor
	mmBtu per short ton	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per short ton	g CH_4 per short ton	g N_2O per short ton
Coal and Coke							
Anthracite Coal	25.09	103.69	11	1.6	2,602	276	40
Bituminous Coal	24.93	93.28	11	1.6	2,325	274	40
Sub-bituminous Coal	17.25	97.17	11	1.6	1,676	190	28
Lignite Coal	14.21	97.72	11	1.6	1,389	156	23
Mixed (Commercial Sector)	21.39	94.27	11	1.6	2,016	235	34
Mixed (Electric Power Sector)	19.73	95.52	11	1.6	1,885	217	32
Mixed (Industrial Coking)	26.28	93.90	11	1.6	2,468	289	42
Mixed (Industrial Sector)	22.35	94.67	11	1.6	2,116	246	36
Coal Coke	24.80	113.67	11	1.6	2,819	273	40
Other Fuels - Solid							
Municipal Solid Waste	9.95	90.70	32	4.2	902	318	42
Petroleum Coke (Solid)	30.00	102.41	32	4.2	3,072	960	126
Plastics	38.00	75.00	32	4.2	2,850	1,216	160
Tires	28.00	85.97	32	4.2	2,407	896	118
Biomass Fuels - Solid							
Agricultural Byproducts	8.25	118.17	32	4.2	975	264	35
Peat	8.00	111.84	32	4.2	895	256	34
Solid Byproducts	10.39	105.51	32	4.2	1,096	332	44
Wood and Wood Residuals	17.48	93.80	7.2	3.6	1,640	126	63
	mmBtu per scf	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per scf	g CH_4 per scf	g N_2O per scf
Natural Gas							
Natural Gas	0.001026	53.06	1.0	0.10	0.05444	0.00103	0.00010
Other Fuels - Gaseous							
Blast Furnace Gas	0.000092	274.32	0.022	0.10	0.02524	0.000002	0.000009
Coke Oven Gas	0.000599	46.85	0.48	0.10	0.02806	0.000288	0.000060
Fuel Gas	0.001388	59.00	3.0	0.60	0.08189	0.004164	0.000833
Propane Gas	0.002516	61.46	3.0	0.60	0.15463	0.007548	0.001510
Biomass Fuels - Gaseous							
Landfill Gas	0.000485	52.07	3.2	0.63	0.025254	0.001552	0.000306
Other Biomass Gases	0.000655	52.07	3.2	0.63	0.034106	0.002096	0.000413
	mmBtu per gallon	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per gallon	g CH_4 per gallon	g N_2O per gallon
Petroleum Products							
Asphalt and Road Oil	0.158	75.36	3.0	0.60	11.91	0.47	0.09
Aviation Gasoline	0.120	69.25	3.0	0.60	8.31	0.36	0.07
Butane	0.103	64.77	3.0	0.60	6.67	0.31	0.06
Butylene	0.105	68.72	3.0	0.60	7.22	0.32	0.06
Crude Oil	0.138	74.54	3.0	0.60	10.29	0.41	0.08
Distillate Fuel Oil No. 1	0.139	73.25	3.0	0.60	10.18	0.42	0.08
Distillate Fuel Oil No. 2	0.138	73.96	3.0	0.60	10.21	0.41	0.08
Distillate Fuel Oil No. 4	0.146	75.04	3.0	0.60	10.96	0.44	0.09
Ethane	0.068	59.60	3.0	0.60	4.05	0.20	0.04
Ethylene	0.058	65.96	3.0	0.60	3.83	0.17	0.03
Heavy Gas Oils	0.148	74.92	3.0	0.60	11.09	0.44	0.09
Isobutane	0.099	64.94	3.0	0.60	6.43	0.30	0.06
Isobutylene	0.103	68.86	3.0	0.60	7.09	0.31	0.06
Kerosene	0.135	75.20	3.0	0.60	10.15	0.41	0.08
Kerosene-Type Jet Fuel	0.135	72.22	3.0	0.60	9.75	0.41	0.08
Liquefied Petroleum Gases (LPG)	0.092	61.71	3.0	0.60	5.68	0.28	0.06
Lubricants	0.144	74.27	3.0	0.60	10.69	0.43	0.09
Motor Gasoline	0.125	70.22	3.0	0.60	8.78	0.38	0.08
Naphtha (<401 deg F)	0.125	68.02	3.0	0.60	8.50	0.38	0.08
Natural Gasoline	0.110	66.88	3.0	0.60	7.36	0.33	0.07
Other Oil (>401 deg F)	0.139	76.22	3.0	0.60	10.59	0.42	0.08
Pentanes Plus	0.110	70.02	3.0	0.60	7.70	0.33	0.07
Petrochemical Feedstocks	0.125	71.02	3.0	0.60	8.88	0.38	0.08
Propane	0.091	62.87	3.0	0.60	5.72	0.27	0.05
Propylene	0.091	67.77	3.0	0.60	6.17	0.27	0.05
Residual Fuel Oil No. 5	0.140	72.93	3.0	0.60	10.21	0.42	0.08
Residual Fuel Oil No. 6	0.150	75.10	3.0	0.60	11.27	0.45	0.09
Special Naphtha	0.125	72.34	3.0	0.60	9.04	0.38	0.08
Unfinished Oils	0.139	74.54	3.0	0.60	10.36	0.42	0.08
Used Oil	0.138	74.00	3.0	0.60	10.21	0.41	0.08
Biomass Fuels - Liquid							
Biodiesel (100%)	0.128	73.84	1.1	0.11	9.45	0.14	0.01
Ethanol (100%)	0.084	68.44	1.1	0.11	5.75	0.09	0.01
Rendered Animal Fat	0.125	71.06	1.1	0.11	8.88	0.14	0.01
Vegetable Oil	0.120	81.55	1.1	0.11	9.79	0.13	0.01
Biomass Fuels - Kraft Pulping Liquor, by Wood Furnish							
North American Softwood		94.4	1.9	0.42			
North American Hardwood		93.7	1.9	0.42			
Bagasse		95.5	1.9	0.42			
Bamboo		93.7	1.9	0.42			
Straw		95.1	1.9	0.42			

Source:

Federal Register EPA; 40 CFR Part 98; e-CFR, (see link below). Table C-1, Table C-2 (as amended at 81 FR 89252, Dec. 9, 2016), Table AA-1 (78 FR 71965, Nov. 29, 2013).

https://www.ecfr.gov/cgi-bin/text-idx?SID=ae265d7d6f98ec86fcd8640b9793a3f6&mc=true&node=pt40.23.98&rgn=div5#ap40.23.98_19.1

Note: Emission factors are per unit of heat content using higher heating values (HHV). If heat content is available from the fuel supplier, it is preferable to use that value. If not, default heat contents are provided.

Table 2 Mobile Combustion CO_2

Fuel Type	kg CO_2 per unit	Unit
Aviation Gasoline	8.31	
Biodiesel (100%)	9.45	gallon
Compressed Natural Gas (CNG)	0.05444	scf
Diesel Fuel	10.21	gallon
Ethanol (100%)	5.75	gallon
Kerosene-Type Jet Fuel	9.75	gallon
Liquefied Natural Gas (LNG)	4.50	gallon
Liquefied Petroleum Gases (LPG)	5.68	gallon
Motor Gasoline	8.78	gallon
Residual Fuel Oil	11.27	gallon

Source:
Federal Register EPA; 40 CFR Part 98; e-CFR, (see link below). Table C-1 (as amended at 81 FR 89252, Dec. 9, 2016).
https://www.ecfr.gov/cgi-bin/text-idx?SID=ae265d7d6f98ec86fcd8640b9793a3f6&mc=true&node=pt40.23.98&rgn=div5#ap40.23.98_19.1
LNG: The factor was developed based on the CO_2 factor for Natural Gas factor and LNG fuel density from GREET1_2020.xlsx Model, Argonne National Laboratory.

Table 3 Mobile Combustion CH_4 and N_2O for On-Road Gasoline Vehicles

Vehicle Type	Year	CH_4 Factor (g / mile)	N_2O Factor (g / mile)
Gasoline Passenger Cars	1973-74	0.1696	0.0197
	1975	0.1423	0.0443
	1976-77	0.1406	0.0458
	1978-79	0.1389	0.0473
	1980	0.1326	0.0499
	1981	0.0802	0.0626
	1982	0.0795	0.0627
	1983	0.0782	0.0630
	1984-93	0.0704	0.0647
	1994	0.0617	0.0603
	1995	0.0531	0.0560
	1996	0.0434	0.0503
	1997	0.0337	0.0446
	1998	0.0240	0.0389
	1999	0.0215	0.0355
	2000	0.0175	0.0304
	2001	0.0105	0.0212
	2002	0.0102	0.0207
	2003	0.0095	0.0181
	2004	0.0078	0.0085
	2005	0.0075	0.0067
	2006	0.0076	0.0075
	2007	0.0072	0.0052
	2008	0.0072	0.0049
	2009	0.0071	0.0046
	2010	0.0071	0.0046
	2011	0.0071	0.0046
	2012	0.0071	0.0046
	2013	0.0071	0.0046
	2014	0.0071	0.0046
	2015	0.0068	0.0042
	2016	0.0065	0.0038
	2017	0.0054	0.0018
	2018	0.0052	0.0016
Gasoline Light-Duty Trucks (Vans, Pickup Trucks, SUVs)	1973-74	0.1908	0.0218
	1975	0.1634	0.0513
	1976	0.1594	0.0555
	1977-78	0.1614	0.0534
	1979-80	0.1594	0.0555
	1981	0.1479	0.0660
	1982	0.1442	0.0681
	1983	0.1368	0.0722
	1984	0.1294	0.0764
	1985	0.1220	0.0806
	1986	0.1146	0.0848
	1987-93	0.0813	0.1035
	1994	0.0646	0.0982
	1995	0.0517	0.0908
	1996	0.0452	0.0871
	1997	0.0452	0.0871
	1998	0.0412	0.0787
	1999	0.0333	0.0618
	2000	0.0340	0.0631
	2001	0.0221	0.0379
	2002	0.0242	0.0424
	2003	0.0221	0.0373
	2004	0.0115	0.0088
	2005	0.0105	0.0064
	2006	0.0108	0.0080
	2007	0.0103	0.0061
	2008	0.0095	0.0036
	2009	0.0095	0.0036
	2010	0.0095	0.0035
	2011	0.0096	0.0034
	2012	0.0096	0.0033
	2013	0.0095	0.0035
	2014	0.0095	0.0033
	2015	0.0094	0.0031
	2016	0.0091	0.0029
	2017	0.0084	0.0018
	2018	0.0081	0.0015
Gasoline Heavy-Duty Vehicles	<1981	0.4604	0.0497
	1982-84	0.4492	0.0538
	1985-86	0.4090	0.0515
	1987	0.3675	0.0849
	1988-1989	0.3492	0.0933
	1990-1995	0.3246	0.1142
	1996	0.1278	0.1680
	1997	0.0924	0.1726
	1998	0.0655	0.1750
	1999	0.0648	0.1724
	2000	0.0630	0.1660
	2001	0.0577	0.1468
	2002	0.0634	0.1673
	2003	0.0602	0.1553
	2004	0.0298	0.0164
	2005	0.0297	0.0083
	2006	0.0299	0.0241
	2007	0.0322	0.0015
	2008	0.0340	0.0015
	2009	0.0339	0.0015
	2010	0.0320	0.0015
	2011	0.0304	0.0015
	2012	0.0313	0.0015
	2013	0.0313	0.0015
	2014	0.0315	0.0015
	2015	0.0332	0.0021
	2016	0.0321	0.0061
	2017	0.0329	0.0084
	2018	0.0326	0.0082
Gasoline Motorcycles	1960-1995	0.0899	0.0087
	1996-2018	0.0672	0.0069

Source: EPA (2020) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018. All values are calculated from Tables A-106 through A-110.

Table 4 Mobile Combustion CH_4 and N_2O for On-Road Diesel and Alternative Fuel Vehicles

Vehicle Type	Fuel Type	Vehicle Year	CH_4 Factor (g / mile)	N_2O Factor (g / mile)
Passenger Cars	Diesel	1960-1982	0.0006	0.0012
		1983-1995	0.0005	0.0010
		1996-2006	0.0005	0.0010
		2007-2018	0.0302	0.0192
Light-Duty Trucks	Diesel	1960-1982	0.0011	0.0017
		1983-1995	0.0009	0.0014
		1996-2006	0.0010	0.0015
		2007-2018	0.0290	0.0214
Medium- and Heavy-Duty Vehicles	Diesel	1960-2006	0.0051	0.0048
		2007-2018	0.0095	0.0431
Light-Duty Cars	Methanol		0.0080	0.0060
	Ethanol		0.0080	0.0060
	CNG		0.0820	0.0060
	LPG		0.0080	0.0060
	Biodiesel		0.0300	0.0190
Light-Duty Trucks	Ethanol		0.0120	0.0110
	CNG		0.1230	0.0110
	LPG		0.0120	0.0130
	LNG		0.1230	0.0110
	Biodiesel		0.0290	0.0210
Medium-Duty Trucks	CNG		4.2000	0.0010
	LPG		0.0140	0.0340
	LNG		4.2000	0.0430
	Biodiesel		0.0090	0.0010
Heavy-Duty Trucks	Methanol		0.0750	0.0280
	Ethanol		0.0750	0.0280
	CNG		3.7000	0.0010
	LPG		0.0130	0.0260
	LNG		3.7000	0.0010
	Biodiesel		0.0090	0.0430
Buses	Methanol		0.0220	0.0320
	Ethanol		0.0220	0.0320
	CNG		10.0000	0.0010
	LPG		0.0340	0.0170
	LNG		10.0000	0.0010
	Biodiesel		0.0090	0.0430

Source: EPA (2020) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018. All values are calculated from Tables A-109 through A-112.

Table 5 Mobile Combustion CH_4 and N_2O for Non-Road Vehicles

Vehicle Type	Fuel Type	CH_4 Factor (g / gallon)	N_2O Factor (g / gallon)
Ships and Boats	Residual Fuel Oil	0.55	0.55
	Gasoline (2 stroke)	9.54	0.06
	Gasoline (4 stroke)	4.88	0.23
	Diesel	0.31	0.50
Locomotives	Diesel	0.80	0.26
Aircraft	Jet Fuel	0	0.30
	Aviation Gasoline	7.06	0.11
Agricultural Equipment[A]	Gasoline (2 stroke)	12.96	0.06
	Gasoline (4 stroke)	7.24	0.21
	Diesel	0.28	0.49
	LPG	2.19	0.39
Agricultural Offroad Trucks	Gasoline	7.24	0.21
	Diesel	0.13	0.49
Construction/Mining Equipment[B]	Gasoline (2 stroke)	12.42	0.07
	Gasoline (4 stroke)	5.58	0.20
	Diesel	0.20	0.47
	LPG	1.05	0.41
Construction/Mining Offroad Trucks	Gasoline	5.58	0.20
	Diesel	0.13	0.49
Lawn and Garden Equipment	Gasoline (2 stroke)	15.57	0.06
	Gasoline (4 stroke)	5.84	0.18
	Diesel	0.33	0.47
	LPG	0.35	0.41
Airport Equipment	Gasoline	2.58	0.25
	Diesel	0.17	0.49
	LPG	0.33	0.41
Industrial/Commercial Equipment	Gasoline (2 stroke)	15.14	0.06
	Gasoline (4 stroke)	5.48	0.20
	Diesel	0.23	0.47
	LPG	0.44	0.41
Logging Equipment	Gasoline (2 stroke)	12.03	0.08
	Gasoline (4 stroke)	6.71	0.18
	Diesel	0.10	0.49
Railroad Equipment	Gasoline	5.78	0.19
	Diesel	0.44	0.42
	LPG	1.20	0.41
Recreational Equipment	Gasoline (2 stroke)	7.81	0.03
	Gasoline (4 stroke)	8.45	0.19
	Diesel	0.41	0.41
	LPG	2.98	0.38

Source: EPA (2020) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018. All values are calculated from Tables A-113 through A-114.

Notes:

[A] Includes equipment, such as tractors and combines, as well as fuel consumption from trucks that are used off-road in agriculture.

[B] Includes equipment, such as cranes, dumpers, and excavators, as well as fuel consumption from trucks that are used off-road in construction.

Table 6 Electricity

eGRID Subregion	Total Output Emission Factors			Non-Baseload Emission Factors		
	CO_2 Factor (lb / MWh)	CH_4 Factor (lb / MWh)	N_2O Factor (lb / MWh)	CO_2 Factor (lb / MWh)	CH_4 Factor (lb / MWh)	N_2O Factor (lb / MWh)
AKGD (ASCC Alaska Grid)	1,114.4	0.098	0.013	1,333.0	0.123	0.017
AKMS (ASCC Miscellaneous)	549.3	0.026	0.004	1,520.2	0.067	0.012
AZNM (WECC Southwest)	952.3	0.068	0.010	1,445.3	0.100	0.014
CAMX (WECC California)	453.2	0.033	0.004	964.0	0.058	0.007
ERCT (ERCOT All)	868.6	0.057	0.008	1,277.2	0.083	0.012
FRCC (FRCC All)	861.0	0.055	0.007	1,029.5	0.054	0.007
HIMS (HICC Miscellaneous)	1,185.6	0.143	0.022	1,549.5	0.107	0.018
HIOA (HICC Oahu)	1,694.5	0.185	0.028	1,704.1	0.158	0.025
MROE (MRO East)	1,502.6	0.147	0.022	1,577.7	0.145	0.021
MROW (MRO West)	1,098.4	0.119	0.017	1,806.8	0.188	0.027
NEWE (NPCC New England)	488.9	0.077	0.010	839.9	0.089	0.012
NWPP (WECC Northwest)	715.2	0.068	0.010	1,617.5	0.156	0.022
NYCW (NPCC NYC/Westchester)	553.8	0.021	0.002	1,016.2	0.022	0.002
NYLI (NPCC Long Island)	1,209.0	0.157	0.020	1,300.6	0.044	0.005
NYUP (NPCC Upstate NY)	232.3	0.017	0.002	890.2	0.047	0.006
New Region PRMS (Puerto Rico Miscellaneous)	1,537.3	0.084	0.013	1,587.9	0.055	0.010
RFCE (RFC East)	695.0	0.053	0.007	1,237.9	0.089	0.012
RFCM (RFC Michigan)	1,189.3	0.114	0.016	1,766.9	0.177	0.025
RFCW (RFC West)	1,067.7	0.099	0.014	1,831.6	0.178	0.026
RMPA (WECC Rockies)	1,242.6	0.117	0.017	1,578.8	0.126	0.018
SPNO (SPP North)	1,070.0	0.112	0.016	1,958.6	0.200	0.029
SPSO (SPP South)	1,002.0	0.070	0.010	1,543.7	0.108	0.015
SRMV (SERC Mississippi Valley)	806.8	0.043	0.006	1,200.1	0.068	0.010
SRMW (SERC Midwest)	1,584.4	0.169	0.025	1,960.9	0.216	0.031
SRSO (SERC South)	969.2	0.071	0.010	1,389.5	0.101	0.015
SRTV (SERC Tennessee Valley)	949.7	0.087	0.013	1,565.2	0.139	0.020
SRVC (SERC Virginia/Carolina)	675.4	0.058	0.008	1,349.2	0.118	0.017
US Average	884.2	0.075	0.011	1,420.2	0.114	0.016

Source: EPA eGRID2019, February 2021

Note: Total output emission factors can be used as default factors for estimating GHG emissions from electricity use when developing a carbon footprint or emissions inventory. Annual non-baseload output emission factors should not be used for those purposes, but can be used to estimate GHG emissions reductions from reductions in electricity use.

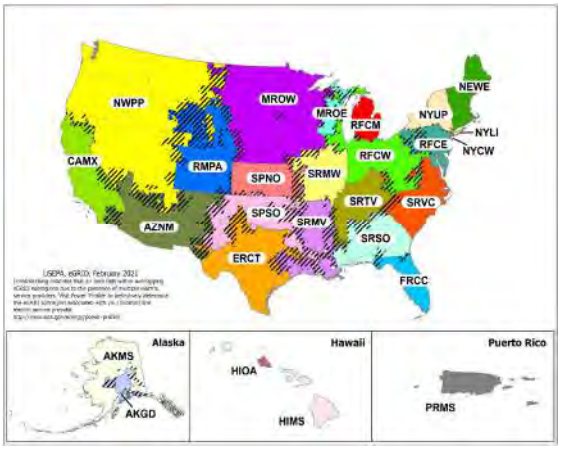

Table 7 Steam and Heat

	CO_2 Factor (kg / mmBtu)	CH_4 Factor (g / mmBtu)	N_2O Factor (g / mmBtu)
Steam and Heat	66.33	1.250	0.125

Note: Emission factors are per mmBtu of steam or heat purchased. These factors assume natural gas fuel is used to generate steam or heat at 80 percent thermal efficiency.

Scope 3 Emission Factors

Scope 3 emission factors provided below are aligned with the Greenhouse Gas Protocol Technical Guidance for Calculating Scope 3 Emissions, version 1.0 (Scope 3 Calculation Guidance). Where applicable, the specific calculation method is referenced. Refer to the Scope 3 Calculation Guidance for more information (http://www.ghgprotocol.org/scope-3-technical-calculation-guidance).

Table 8 Scope 3 Category 4: Upstream Transportation and Distribution and Category 9: Downstream Transportation and Distribution

These factors are intended for use in the distance-based method defined in the Scope 3 Calculation Guidance. If fuel data are available, then the fuel-based method should be used, with factors from Tables 2 through 5.

Vehicle Type	CO_2 Factor (kg / unit)	CH_4 Factor (g / unit)	N_2O Factor (g / unit)	Units
Medium- and Heavy-Duty Truck	1.407	0.013	0.033	vehicle-mile
Passenger Car [A]	0.341	0.009	0.008	vehicle-mile
Light-Duty Truck [B]	0.464	0.012	0.010	vehicle-mile
Medium- and Heavy-Duty Truck	0.211	0.0020	0.0049	ton-mile
Rail	0.022	0.0017	0.0005	ton-mile
Waterborne Craft	0.036	0.0116	0.0016	ton-mile
Aircraft[C]	1.160	0.0000	0.0357	ton-mile

Source:
CO_2, CH_4, and N_2O emissions data for road vehicles are from Table 2-13 of the EPA (2020) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018.
Vehicle-miles and passenger-miles data for road vehicles are from Table VM-1 of the Federal Highway Administration Highway Statistics 2018.
CO2e emissions data for non-road vehicles are based on Table A-124 of the EPA (2020) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018, which are distributed into CO2, CH4, and N2O emissions based on fuel/vehicle emission factors.
Freight ton-mile data for non-road vehicles are from Table 1-50 of the Bureau of Transportation Statistics, National Transportation Statistics for 2020 (Data based on 2018).

Notes:
Vehicle-mile factors are appropriate to use when the entire vehicle is dedicated to transporting the reporting company's product. Ton-mile factors are appropriate when the vehicle is shared with products from other companies.
[A] Passenger car: includes passenger cars, minivans, SUVs, and small pickup trucks (vehicles with wheelbase less than 121 inches).
[B] Light-duty truck: includes full-size pickup trucks, full-size vans, and extended-length SUVs (vehicles with wheelbase greater than 121 inches).
[C] Aircraft: updates due to a methodology change.

Table 9 Scope 3 Category 5: Waste Generated in Operations and Category 12: End-of-Life Treatment of Sold Products

These factors are intended for use in the waste-type-specific method or the average-data method defined in the Scope 3 Calculation Guidance for category 5 and category 12. Choose the appropriate material and disposal method from the table below. For the average-data method, use one of the mixed material types, such as mixed MSW.

	Metric Tons CO_2e / Short Ton Material					
Material	**Recycled[A]**	**Landfilled[B]**	**Combusted[C]**	**Composted[D]**	**Anaerobically Digested (Dry Digestate with Curing)**	**Anaerobically Digested (Wet Digestate with Curing)**
Aluminum Cans	0.06	0.02	0.01	NA	NA	NA
Aluminum Ingot	0.04	0.02	0.01	NA	NA	NA
Steel Cans	0.32	0.02	0.01	NA	NA	NA
Copper Wire	0.18	0.02	0.01	NA	NA	NA
Glass	0.05	0.02	0.01	NA	NA	NA
HDPE	0.21	0.02	2.80	NA	NA	NA
LDPE	NA	0.02	2.80	NA	NA	NA
PET	0.23	0.02	2.05	NA	NA	NA
LLDPE	NA	0.02	2.80	NA	NA	NA
PP	NA	0.02	2.80	NA	NA	NA
PS	NA	0.02	3.02	NA	NA	NA
PVC	NA	0.02	1.26	NA	NA	NA
PLA	NA	0.02	0.01	0.17	NA	NA
Corrugated Containers	0.11	0.90	0.05	NA	NA	NA
Magazines/Third-class mail	0.02	0.42	0.05	NA	NA	NA
Newspaper	0.02	0.35	0.05	NA	NA	NA
Office Paper	0.02	1.25	0.05	NA	NA	NA
Phonebooks	0.04	0.35	0.05	NA	NA	NA
Textbooks	0.04	1.25	0.05	NA	NA	NA
Dimensional Lumber	0.09	0.17	0.05	NA	NA	NA
Medium-density Fiberboard	0.15	0.07	0.05	NA	NA	NA
Food Waste (non-meat)	NA	0.58	0.05	0.15	0.14	0.11
Food Waste (meat only)	NA	0.58	0.05	NA	0.14	0.11
Beef	NA	0.58	0.05	0.15	0.14	0.11
Poultry	NA	0.58	0.05	0.15	0.14	0.11
Grains	NA	0.58	0.05	0.15	0.14	0.11
Bread	NA	0.58	0.05	0.15	0.14	0.11
Fruits and Vegetables	NA	0.58	0.05	0.15	0.14	0.11
Dairy Products	NA	0.58	0.05	0.15	0.14	0.11
Yard Trimmings	NA	0.33	0.05	0.19	0.11	NA
Grass	NA	0.26	0.05	0.19	0.09	NA
Leaves	NA	0.26	0.05	0.19	0.13	NA
Branches	NA	0.53	0.05	0.19	0.16	NA
Mixed Paper (general)	0.07	0.80	0.05	NA	NA	NA
Mixed Paper (primarily residential)	0.07	0.77	0.05	NA	NA	NA
Mixed Paper (primarily from offices)	0.03	0.75	0.05	NA	NA	NA
Mixed Metals	0.23	0.02	0.01	NA	NA	NA
Mixed Plastics	0.22	0.02	2.34	NA	NA	NA
Mixed Recyclables	0.09	0.68	0.11	NA	NA	NA
Food Waste	NA	0.58	0.05	0.15	NA	NA
Mixed Organics	NA	0.48	0.05	0.17	NA	NA
Mixed MSW	NA	0.52	0.43	NA	NA	NA
Carpet	NA	0.02	1.68	NA	NA	NA
Desktop CPUs	NA	0.02	0.40	NA	NA	NA
Portable Electronic Devices	NA	0.02	0.89	NA	NA	NA
Flat-panel Displays	NA	0.02	0.74	NA	NA	NA
CRT Displays	NA	0.02	0.64	NA	NA	NA
Electronic Peripherals	NA	0.02	2.23	NA	NA	NA
Hard-copy Devices	NA	0.02	1.92	NA	NA	NA
Mixed Electronics	NA	0.02	0.87	NA	NA	NA
Clay Bricks	NA	0.02	NA	NA	NA	NA
Concrete	0.01	0.02	NA	NA	NA	NA
Fly Ash	0.01	0.02	NA	NA	NA	NA
Tires	0.10	0.02	2.21	NA	NA	NA
Asphalt Concrete	-	0.02	NA	NA	NA	NA
Asphalt Shingles	0.03	0.02	0.70	NA	NA	NA
Drywall	NA	0.02	NA	NA	NA	NA
Fiberglass Insulation	0.05	0.02	NA	NA	NA	NA
Vinyl Flooring	NA	0.02	0.29	NA	NA	NA
Wood Flooring	NA	0.18	0.08	NA	NA	NA

Source: EPA, Office of Resource Conservation and Recovery (February 2016) Documentation for Greenhouse Gas Emission and Energy Factors used in the Waste Reduction Model (WARM). Factors from tables provided in the Management Practices Chapters and Background Chapters. WARM Version 15, November 2020 Update. Additional data provided by EPA, WARM-15 Background Data.

Notes: These factors do not include any avoided emissions impact from any of the disposal methods. All the factors presented here include transportation emissions, which are optional in the Scope 3 Calculation Guidance, with an assumed average distance traveled to the processing facility. AR4 GWPs are used to convert all waste emission factors into CO_2e.

[A] Recycling emissions include transport to recycling facility and sorting of recycled materials at material recovery facility.
[B] Landfilling emissions include transport to landfill, equipment use at landfill and fugitive landfill CH_4 emissions. Landfill CH_4 is based on typical landfill gas collection practices and average landfill moisture conditions.
[C] Combustion emissions include transport to combustion facility and combustion-related non-biogenic CO_2 and N_2O
[D] Composting emissions include transport to composting facility, equipment use at composting facility and CH_4 and N_2O emissions during composting.

Table 10 Scope 3 Category 6: Business Travel and Category 7: Employee Commuting

These factors are intended for use in the distance-based method defined in the Scope 3 Calculation Guidance. If fuel data are available, then the fuel-based method should be used, with factors from Tables 2 through 5.

Vehicle Type	CO_2 Factor (kg / unit)	CH_4 Factor (g / unit)	N_2O Factor (g / unit)	Units
Passenger Car [A]	0.341	0.009	0.008	vehicle-mile
Light-Duty Truck [B]	0.464	0.012	0.010	vehicle-mile
Motorcycle	0.189	0.070	0.007	vehicle-mile
Intercity Rail - Northeast Corridor [C]	0.058	0.0055	0.0007	passenger-mile
Intercity Rail - Other Routes [C]	0.150	0.0117	0.0038	passenger-mile
Intercity Rail - National Average [C]	0.113	0.0092	0.0026	passenger-mile
Commuter Rail [D]	0.143	0.0119	0.0029	passenger-mile
Transit Rail (i.e. Subway, Tram) [E]	0.106	0.0095	0.0013	passenger-mile
Bus	0.054	0.0206	0.0009	passenger-mile
Air Travel - Short Haul (< 300 miles)	0.206	0.0071	0.0065	passenger-mile
Air Travel - Medium Haul (>= 300 miles, < 2300 miles)	0.131	0.0006	0.0042	passenger-mile
Air Travel - Long Haul (>= 2300 miles)	0.161	0.0006	0.0051	passenger-mile

Source:
CO_2, CH_4, and N_2O emissions data for highway vehicles are from Table 2-13 of the EPA (2020) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2018.
Vehicle-miles and passenger-miles data for highway vehicles are from Table VM-1 of the Federal Highway Administration Highway Statistics 2018.
Fuel consumption data and passenger-miles data for rail are from Tables A.14 to A.16 and C.9 to C.11 of the Transportation Energy Data Book: Edition 39. Fuel consumption was converted to emissions by using fuel and electricity emission factors presented in the tables above.
Intercity Rail factors from personal communication with Amtrak (Laura Fotiou), March 2020. These are based on 2019 values.
Air Travel factors from 2020 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting. Version 1.0 July 2020.

Notes:
[A] Passenger car: includes passenger cars, minivans, SUVs, and small pickup trucks (vehicles with wheelbase less than 121 inches).
[B] Light-duty truck: includes full-size pickup trucks, full-size vans, and extended-length SUVs (vehicles with wheelbase greater than 121 inches).
[C] Intercity rail: Amtrak long-distance rail between major cities. Northeast Corridor extends from Boston to Washington D.C. Other Routes are all routes outside the Northeast Corridor.
[D] Commuter rail: rail service between a central city and adjacent suburbs (also called regional rail or suburban rail).
[E] Transit rail: rail typically within an urban center, such as subways, elevated railways, metropolitan railways (metro), streetcars, trolley cars, and tramways.

Global Warming Potentials

Table 11 Global Warming Potentials (GWPs)

Gas	100-Year GWP
N_2O	298
HFC-23	14,800
HFC-32	675
HFC-41	92
HFC-125	3,500
HFC-134	1,100
HFC-134a	1,430
HFC-143	353
HFC-143a	4,470
HFC-152	53
HFC-152a	124
HFC-161	12
HFC-227ea	3,220
HFC-236cb	1,340
HFC-236ea	1,370
HFC-236fa	9,810
HFC-245ca	693
HFC-245fa	1,030
HFC-365mfc	794
HFC-43-10mee	1,640
SF_6	22,800
NF_3	17,200
CF_4	7,390
C_2F_6	12,200
C_3F_8	8,830
c-C_4F_8	10,300
C_4F_{10}	8,860
C_5F_{12}	9,160
C_6F_{14}	9,300
$C_{10}F_{18}$	>7,500

Source:
100-year GWPs from IPCC Fourth Assessment Report (AR4), 2007. IPCC AR4 was published in 2007 and is among the most current and comprehensive peer-reviewed assessments of climate change. AR4 provides revised GWPs of several GHGs relative to the values provided in previous assessment reports, following advances in scientific knowledge on the radiative efficiencies and atmospheric lifetimes of these GHGs and of CO_2. Because the GWPs provided in AR4 reflect an improved scientific understanding of the radiative effects of these gases in the atmosphere, the values provided are more appropriate for supporting the overall goal of organizational GHG reporting than the Second Assessment Report (SAR) GWP values previously used in the Emission Factors Hub.
While EPA recognizes that Fifth Assessment Report (AR5) GWPs have been published, in an effort to ensure consistency and comparability of GHG data between EPA's voluntary and non-voluntary GHG reporting programs (e.g. GHG Reporting Program and National Inventory), EPA recommends the use of AR4 GWPs. The United States and other developed countries to the UNFCCC have agreed to submit annual inventories in 2015 and future years to the UNFCCC using GWP values from AR4, which will replace the current use of SAR GWP values. Utilizing AR4 GWPs improves EPA's ability to analyze corporate, national, and sub-national GHG data consistently, enhances communication of GHG information between programs, and gives outside stakeholders a consistent, predictable set of GWPs to avoid confusion and additional burden.

Table 12 Global Warming Potentials (GWPs) for Blended Refrigerants

ASHRAE #	100-year GWP	Blend Composition
R-401A	16	53% HCFC-22 , 34% HCFC-124 , 13% HFC-152a
R-401B	14	61% HCFC-22 , 28% HCFC-124 , 11% HFC-152a
R-401C	19	33% HCFC-22 , 52% HCFC-124 , 15% HFC-152a
R-402A	2,100	38% HCFC-22 , 6% HFC-125 , 2% propane
R-402B	1,330	6% HCFC-22 , 38% HFC-125 , 2% propane
R-403B	3,444	56% HCFC-22 , 39% PFC-218 , 5% propane
R-404A	3,922	44% HFC-125 , 4% HFC-134a , 52% HFC 143a
R-406A	0	55% HCFC-22 , 41% HCFC-142b , 4% isobutane
R-407A	2,107	20% HFC-32 , 40% HFC-125 , 40% HFC-134a
R-407B	2,804	10% HFC-32 , 70% HFC-125 , 20% HFC-134a
R-407C	1,774	23% HFC-32 , 25% HFC-125 , 52% HFC-134a
R-407D	1,627	15% HFC-32 , 15% HFC-125 , 70% HFC-134a
R-407E	1,552	25% HFC-32 , 15% HFC-125 , 60% HFC-134a
R-408A	2,301	47% HCFC-22 , 7% HFC-125 , 46% HFC 143a
R-409A	0	60% HCFC-22 , 25% HCFC-124 , 15% HCFC-142b
R-410A	2,088	50% HFC-32 , 50% HFC-125
R-410B	2,229	45% HFC-32 , 55% HFC-125
R-411A	14	87.5% HCFC-22 , 11 HFC-152a , 1.5% propylene
R-411B	4	94% HCFC-22 , 3% HFC-152a , 3% propylene
R-413A	2,053	88% HFC-134a , 9% PFC-218 , 3% isobutane
R-414A	0	51% HCFC-22 , 28.5% HCFC-124 , 16.5% HCFC-142b
R-414B	0	5% HCFC-22 , 39% HCFC-124 , 9.5% HCFC-142b
R-417A	2,346	46.6% HFC-125 , 5% HFC-134a , 3.4% butane
R-422A	3,143	85.1% HFC-125 , 11.5% HFC-134a , 3.4% isobutane
R-422D	2,729	65.1% HFC-125 , 31.5% HFC-134a , 3.4% isobutane
R-423A	2,280	47.5% HFC-227ea , 52.5% HFC-134a ,
R-424A	2,440	50.5% HFC-125, 47% HFC-134a, 2.5% butane/pentane
R-426A	1,508	5.1% HFC-125, 93% HFC-134a, 1.9% butane/pentane
R-428A	3,607	77.5% HFC-125 , 2% HFC-143a , 1.9% isobutane
R-434A	3,245	63.2% HFC-125, 16% HFC-134a, 18% HFC-143a, 2.8% isobutane
R-500	32	73.8% CFC-12 , 26.2% HFC-152a , 48.8% HCFC-22
R-502	0	48.8% HCFC-22 , 51.2% CFC-115
R-504	325	48.2% HFC-32 , 51.8% CFC-115
R-507	3,985	5% HFC-125 , 5% HFC143a
R-508A	13,214	39% HFC-23 , 61% PFC-116
R-508B	13,396	46% HFC-23 , 54% PFC-116

Source:
100-year GWPs from IPCC Fourth Assessment Report (AR4), 2007. See the source note to Table 11 for further explanation. GWPs of blended refrigerants are based on their HFC and PFC constituents, which are based on data from http://www.epa.gov/ozone/snap/refrigerants/refblend.html.

CO_2 Baseline Database for the Indian Power Sector

User Guide

Version 17.0

OCTOBER 2021

Government of India
Ministry of Power
Central Electricity Authority
Sewa Bhawan, R.K.Puram,
New Delhi-66

Revision History of the Database

Version No.	Date of Publication	Main Revisions Compared to Previous Version
1.0 Draft	October 2006	- Draft for Stakeholder Consultation
1.0	November 2006	- Added data on 10 stations which had been in exclusion worksheet of draft database - Adjusted values to latest IPCC Guidance (IPCC 2006 Guidelines for National Greenhouse Gas Inventories) where IPCC defaults are used
1.1	December 2006	- Adjusted fuel emission factor of lignite to be in line with Initial National Communication figures
2.0	June 2007	- Added data for FY 2005-06, including new stations and units commissioned during 2005-06 - Some retroactive changes to data for FY 2000-01 to 2004-05
3.0	December 2007	- Added data for FY 2006-07, including new stations and units commissioned during 2006-07 - Adapted calculations and User Guide to ensure consistency with new CDM methodologies: ACM0002 Version 07, and Tool to Calculate the Emission Factor for an Electricity System (Version 01.1, EB 35 Annex 12)
4.0	October 2008	- Added data for FY 2007-08, including new stations and units commissioned during 2007-08 - Adjusted delineation of regional grids - Adjusted IPCC-based fuel emission factors to account for uncertainty in line with EB 35 Annex 12
5.0	November 2009	- Added data for FY 2008-09, including new stations and units commissioned during 2008-09
6.0	March 2011	- Added data for FY 2009-10, including new stations and units commissioned during 2009-10
7.0	January 2012	- Added data for FY 2010-11, including new stations and units commissioned during 2010-11
8.0	January 2013	- Added data for FY 2011-12, including new stations and units commissioned during 2011-12 - From FY 2011-12, scope of database is restricted to stations exceeding 25 MW - Retroactive changes: Three units in NEWNE region identified as CDM units, leading to minor change in build margin for FY 2010-11
9.0	December 2013	- Added data for FY 2012-13, including new stations and units commissioned during 2012-13 - Retroactive changes: Nine units identified as CDM units, leading to changes in build margins back to FY 2009-10 - Updated GCVs of five stations back to FY 2008-09
10.0	December 2014	- Added data for FY 2013-14, including new stations and units commissioned during 2013-14 - Introduced distinction between Indian and imported coal as from FY 2013-14 - Retroactive changes to previous FY due to: identification of CDM units, identification of waste heat recovery steam turbines, harmonization of GCV for oil used as secondary fuel - One station was reclassified from SR to NEWNE region
11.0	April 2016	- Added data for FY 2014-15, including new stations and units commissioned during 2014-15 - Introduced integrated Single Indian Grid (NEWNE and Southern are now synchronized) - Export of power to Bangladesh also considered in the Import/Export data.
12.0	May 2017	- Added data for FY 2015-16, including new stations and units commissioned during 2015-16
13.0	June 2018	- Added data for FY 2016-17, including new stations and units commissioned during 2016-17 - Export of power to Myanmar also considered in the Import/Export data.
14.0	December 2018	- Added data for FY 2017-18, including new stations and units commissioned during 2017-18
15.0	December 2019	- Added data for FY 2018-19, including new stations and units commissioned during 2018-19
16.0	March 2021	- Added data for FY 2019-20, including new stations and units commissioned during 2019-20 - Some retroactive changes to data for FY 2018-19
17.0	October 2021	- Added data for FY 2020-21, including new stations and units commissioned during 2020-21

Expert Team Contributing to the Database

Central Electricity Authority:

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Contents

Summary

Since the emergence of the Kyoto Protocol and its Clean Development Mechanism (CDM), energy projects lowering the carbon intensity of the electricity grid can generate additional revenues from carbon credits. Methodologies approved by the CDM Executive Board have to be applied to determine the resulting emission reductions, using the "baseline" CO_2 emission factor of the relevant geographical area.

In order to facilitate adoption of authentic baseline emissions data and also to ensure uniformity in the calculations of CO_2 emission reductions by CDM project developers, Central Electricity Authority (CEA) has compiled a database containing the necessary data on CO_2 emissions for all grid-connected power stations in India.

All regional grids have been integrated as a single Indian Grid covering all the states in December 2013. Small power exchanges also take place with the neighbouring countries Bhutan, Nepal, Bangladesh and Myanmar. For the unified grid, the main emission factors are calculated in accordance with the relevant CDM methodologies. CEA will continue updating the database at the end of each fiscal year.

1. The prevailing baseline emissions based on the data for the FY 2020-21 are shown in Table S-1. The calculations are based on generation, fuel consumption and fuel quality data obtained from the power stations. Typical standard data were used only for a few stations where information was not available from the station. Cross-border electricity transfers were also taken into account for calculating the CO_2 emission baseline.

Table S-1: Weighted average emission factor, simple operating margin (OM), build margin (BM) and combined margin (CM) of the Indian Grid for FY 2020-21 (adjusted for cross-border electricity transfers), in t CO_2/MWh

Average	OM	BM	CM
0.79	**0.94**	**0.87**	**0.90**

Average is the average emission of all stations in the grid, weighted by net generation.

OM is the average emission from all stations excluding the low cost/must run sources.

BM is the average emission of the 20% (by net generation) most recent capacity addition in the grid.

CM is a weighted average of the OM and BM (here weighted 50: 50).

1 Background and Objective

Purpose of the CO_2 Database

The Clean Development Mechanism (CDM) under the Kyoto Protocol to United Nations Framework Convention on Climate Change (UNFCCC) provides an opportunity for the Indian power sector to earn revenue through the reduction of greenhouse gas emissions (GHG), particularly carbon dioxide (CO_2). India has tremendous potential for CDM projects. Power generation based on higher efficiency technologies such as supercritical technology, integrated gasification combined cycle, and renovation and modernisation of old thermal power plants, co-generation along with renewable energy sources are some of potential candidates for CDM in the power sector. Energy efficiency and conservation projects also present themselves as eligible CDM projects, as these would also result in energy savings and displace associated CO_2 emissions which otherwise would be produced by grid-connected power stations.

The CDM has by now become an established mechanism for crediting climate friendly projects. Projects involving displacement or saving of grid electricity must calculate their emission reductions based on a grid emission factor, which needs to be determined in accordance with the rules set by the CDM Executive Board. Central Electricity Authority (CEA) accordingly took up to compile a database for all grid-connected power stations in India. The purpose of the database is to establish authentic and consistent quantification of the CO_2 emission baseline, which can be readily used by CDM project developers in the Indian power sector. This would enhance the acceptability of Indian projects and would also expedite the clearance/approval process. The baseline emissions for the Indian Grid are given in Section 5 (Results) of this User Guide. The complete updated CO_2 Database (Microsoft Excel File) and this User Guide along with all previous versions is available on the website of Central Electricity Authority: www.cea.nic.in.

The purpose of this User Guide is to provide a ready reference to the underlying calculations and assumptions used in the CO_2 database and to summarise the key results.

Official Status of the Database

The database is an official publication of the Government of India for the purpose of CDM baselines. It is based on the most recent data available with the Central Electricity Authority.

Consistency of the Database with CDM Methodologies

Under the CDM, emission reductions must be quantified using an approved methodology. Key examples of such methodologies include AMS-I.D and ACM0002 for grid-connected power generation from renewable sources in small- and large-scale projects, respectively. The latest versions of all approved CDM methodologies are available at the official CDM website, http://cdm.unfccc.int.

In addition, the CDM Executive Board has adopted a methodological tool to facilitate the calculation of baseline emission factors for electricity grids.[1] This tool, which is referred to as the Grid Tool in this user guide, has become the main reference for CDM methodologies involving baseline emission factors for power grids, such as ACM0002.

This version of the database is designed to be consistent with version 7.0 of the Tool to calculate the emission factor for an electricity system published by the CDM Executive Board.

Installed Capacity

As a result of the impressive growth attained by the Indian Power Sector, the installed capacity has grown from mere 1,713 MW in 1950 to 382,151.22 MW as on 31.03.2021. Sector-wise details of installed capacity are shown in Table 1.

Table 1: Sector- wise installed capacity (MW) as on 31.03.2021

Sector	Thermal					Nuclear	Hydro	RES	Total
	Coal	Lignite	Gas	Diesel	Total				
State	65931.50	1150.00	7087.36	236.01	74404.86	0.00	27069.50	2395.27	103869.64
Central	62570.00	3640.00	7237.91	0.00	73447.91	6780.00	15646.72	1632.30	97506.93
Private	74173.00	1830.00	10598.74	273.70	86875.45	0.00	3493.00	90406.21	180774.66
All India	202674.50	6620.00	24924.01	509.71	234728.22	6780.00	46209.22	94433.79	382151.22

Note: These capacities are not identical with those listed in the Excel database, because the database excludes renewable, few small diesel and steam units.

It is evident from Table 1 that the installed capacity is predominantly coal based and therefore, is a major source of carbon dioxide emissions in India. Hence, there exists scope for reducing the CO_2 emissions in the country by way of fuel substitution, increased use of renewable energy sources, and also by improving the thermal efficiency of power generation.

[1] Tool to calculate the emission factor for an electricity system (Version 7.0). See http://cdm.unfccc.int

Indian Grids

Historically, the Indian power system was divided into five independent regional grids, namely Northern, Eastern, Western, Southern, and North-Eastern. Each grid covered several states (see Table 2). Since August 2006, however, all regional grids except the Southern Grid had been integrated and were operating in synchronous mode, i.e. at same frequency. Consequently, the Northern, Eastern, Western and North-Eastern grids were treated as a single grid named as NEWNE grid from FY 2007-08 onwards for the purpose of this CO_2 Baseline Database. As of 31 December 2013, the Southern grid has also been synchronised with the NEWNE grid, hence forming one unified Indian Grid.

Power generation and supply within the Indian Grid is managed by Regional Load Dispatch Centres (RLDC). The National Power Committee (NPC) and Regional Power Committees (RPCs) provide a common platform for discussion and solution to the national and regional problems relating to the grid. Each state meets their demand with their own generation facilities and also with allocation from power plants owned by the central sector such as NTPC and NHPC etc. and IPP's being operated by private sector. Specific quotas are allocated to each state from the central sector power plants. Depending on the demand and generation, there are cross-border electricity exports and imports (e.g. from Bhutan, Nepal, Bangladesh and Myanmar).

Table 2: Geographical scope of the Indian electricity grid

INDIAN GRID				
Northern	**Eastern**	**Western**	**North-Eastern**	**Southern**
Chandigarh Delhi Haryana Himachal Pradesh Jammu & Kashmir Punjab Rajasthan Uttar Pradesh Uttarakhand	Bihar Jharkhand Orissa West Bengal Sikkim Andaman-Nicobar*	Chhattisgarh Gujarat Daman & Diu Dadar & Nagar Haveli Madhya Pradesh Maharashtra Goa	Arunachal Pradesh Assam Manipur Meghalaya Mizoram Nagaland Tripura	Andhra Pradesh Karnataka Kerala Tamil Nadu Puducherry Lakshadweep* Telengana

**The union territories Andaman and Nicobar Islands and Lakshadweep islands are not connected to the National grid. The power generation and distribution systems of these territories is served by standalone systems.*

2 How to Use the Database

Structure of the Database

Emission reductions from CDM projects in the power sector are calculated based on the net electricity generated by the project and the difference between the emissions factors (in t CO_2/MWh) of the baseline and the project activity. The baseline emission factor reflects the carbon intensity of the displaced grid electricity. This baseline emission factor can be derived from the data provided in the CO_2 Database.

Specifically, the database contains the following elements:

- Worksheet "Data" provides the net generation and the absolute and specific CO_2 emissions of each grid-connected power station (see Section 4 for exceptions). It also indicates which stations and units were included in the operating margin and build margin, respectively.
- Worksheet "Results" provides the most commonly used aggregate emission factors. These are calculated from the station data in accordance with the most recent Grid Tool.[2] The emission factors are explained in more detail in the next section.
- Worksheet "Abbreviations" explains the abbreviations used in the "Data" worksheet.
- Worksheet "Assumptions" shows the assumptions that were used for the calculation of the CO_2 emissions at station and unit level, where the information was not provided by the station.
- Worksheet "Transfers" shows the cross-border power transfers.

Different Types of Emission Factors

The CDM methodologies which have been approved to date by the CDM Executive Board distinguish a range of different emission factors. In the Indian context, the following four are most relevant, and were therefore calculated for the Indian Grid based on the underlying station data:

Weighted average:
The weighted average emission factor describes the average CO_2 emitted per unit of electricity generated in the grid. It is calculated by dividing the absolute CO_2 emissions of all power stations by the total net generation. Net generation from so-called low-cost/must-run sources is included in the denominator. In India, hydro and nuclear stations qualify as low-cost/must-run sources.

Simple operating margin (OM):
The operating margin describes the average CO_2 intensity of the existing stations in the grid which are most likely to reduce their output if a CDM project supplies electricity to the grid (or reduces consumption of grid electricity). "Simple" denotes one out of four possible variants listed in the Grid Tool for calculating the operating margin.[3] Furthermore, option A has been selected as the required disaggregated data is available in India.

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[2] *Tool to calculate the emission factor for an electricity system* (Version 7.0). See http://cdm.unfccc.int

[3] The two variants "Simple adjusted operating margin" and "Dispatch data analysis operating margin" cannot currently be applied in India due to lack of necessary data.

The simple operating margin is the weighted average emissions rate of all generation sources *except* so-called low-cost or must-run sources (hydro and nuclear stations) and are excluded). The operating margin, therefore, can be calculated by dividing the grid's total CO_2 emissions by the net generation of all thermal stations. In other words, it represents the weighted average emissions rate of all thermal stations.

Values for operating margins given in this User Guide and the Database are always based on the "ex post" option as set out in the Grid Tool.[4]

Build margin (BM):
The build margin reflects the average CO_2 intensity of newly built power stations that will be (partially) replaced by a CDM project. In accordance with the Grid Tool, the build margin is calculated in this database as the average emissions intensity of the 20% most recent capacity additions in the grid based on net generation. The build margin generally covers units commissioned in the last five years.

Combined margin (CM):
The combined margin is a weighted average of the simple operating margin and the build margin. By default, both margins have equal weights (50%). However, CDM project developers may choose to argue for different weights. In particular, for intermittent and non-dispatchable generation types such as wind and solar photovoltaic, the Grid Tool allows to weigh the operating margin and build margin at 75% and 25%, respectively. However, the combined margins shown in the database are calculated based on equal weights.

In line with the Grid Tool, if a station is registered as a CDM activity, it is excluded from the build margin but not from the operating margin.[5]

[4] See *Tool to calculate the emission factor for an electricity system* (Version 7.0).

[5] See *Tool to calculate the emission factor for an electricity system* (Version 7.0), pp. 16 and pp 25 point (f)

3 Scope of Database

The database includes all grid-connected power stations having an installed capacity above 25 MW.[6] The data covers power stations of both public utilities and independent power producers (IPPs).

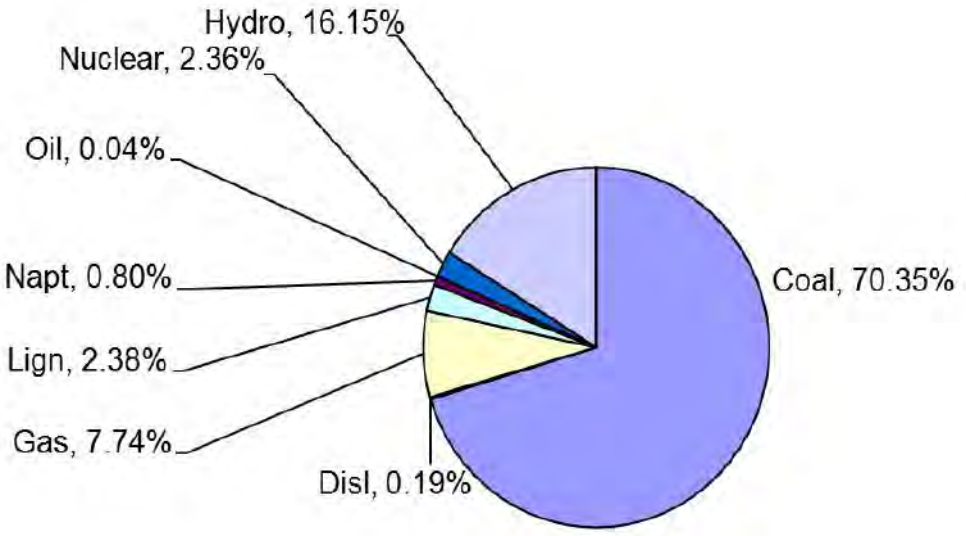

Figure 1: Breakdown of generation capacity covered by the database. The total corresponds to 287,783 MW as on 31.03.2021

The following power stations are currently not accounted for in the database:

- Small decentralised generation sets;
- Stations or units installed in Andaman and Nicobar Islands and Lakshadweep;
- Captive power stations: As on 31 March 2021, the aggregate installed capacity of captive stations in industries having demand of 1 MW and above was 77,000 MW (provisional figure). The generation of these stations in FY 2020-21 was 200,000 GWh (provisional figure). The data of captive plants could not be added in this database in absence of the data availability.
- Non-conventional renewable energy stations: These include hydro stations up to 25 MW, as well as all wind, biomass and solar photovoltaic stations. The installed, grid-connected capacity of these sources was 94,433.79 MW as on 31.03.2021.[7] The generation from these non-conventional renewable energy sources in FY 2020-21 was 144,247.51GWh.

[6] Previously, the database covered grid-connected power stations having an installed capacity above 3 MW in case of hydro and above 10 MW for all other plant types. Monitoring of stations up to 25 MW was discontinued from FY 2011-12. For archiving and consistency reasons, 70 of these small stations will remain in the database without new data entries.

[7] Ministry of New and Renewable Energy. The capacity figure may differ from CEA reported figure of installed capacity.

4 Data and Calculation Approach

This section gives an overview on the base data, annual data as well as the approaches used to calculate station-level and unit-level CO_2 emissions.

4.1 Base Data

The following base data parameters were collected for all the stations listed in the CO_2 database:

- **S No:**

  The Station Numbers start at 1 and proceed alphabetically for all stations. All units of a station have the same station number. Numbers may change in future database versions due to insertion of new stations.

- **Station Name:**

  Name of the power station. The station names have been arranged in alphabetical order.

- **Unit Number:**

  The units of a station are numbered serially starting with 1. Stations are attributed with unit number 0 for the purpose of calculations.

- **Commissioning Date:**

  The commissioning date is provided for each unit. Commissioning dates are important for the determination of the build margin.

- **Capacity:**

  Capacity data is based on declared rated capacities in MW for each unit as of 31st March 2021.

- **State:**

  State where the power station is located.

- **Sector:**

  This denotes whether the station is operated by the central sector, the state authorities, or the private sector.

- **System:**

  A list of the systems including abbreviations and full names is provided in Appendix A.

- **Type:**

  Indicates the type of the station, viz. thermal, nuclear, and hydro.

- **Fuel:**

  Fuel 1 and Fuel 2 indicates the main fuels used for power generation at each station. For example, in coal-based stations, Coal is indicated as Fuel 1 and Oil as Fuel 2.

4.2 Annual Data

The annual data columns in the database provide the following: net generation in GWh of the station, absolute carbon dioxide emissions in metric tonnes, and specific carbon dioxide emissions in t CO_2/MWh, for the five fiscal years 2016-17 to 2020-21. In addition, there are columns to indicate whether the station is included in the operating margin in the respective year, and an additional column indicating which units are included in the build margin. If a unit is part of a registered CDM activity, it is excluded from the build margin, and the CDM registration number is indicated in the respective column.

CEA has compiled the CO_2 Database based upon generation, fuel consumption and fuel gross calorific value (GCV) data furnished by each power station. In cases where the station could not provide reliable data for all the relevant parameters, assumptions were made as described below. Further details on the assumptions made are provided in Appendix B.

a) Assumptions at Station Level

At the station level, the following assumptions were made where the relevant data could not be provided by a station:

Net generation:
For hydro stations, only gross generation was available, but not net generation data. Therefore, the CEA standard value for auxiliary power consumption in hydro units (0.5%) was applied to derive the net generation from the gross generation data reported by the stations. Likewise, CEA standard values for auxiliary power consumption had to be applied for some thermal stations.

Gross Calorific Value (GCV):
Default values were used for some thermal stations where station-specific GCVs were not available.

If the station consists just of one unit, the assumptions at unit level were applied to the station level.

b) Assumptions at Unit Level

At unit level, the following assumptions were made for those units falling into the build margin (i.e. the most recently built units comprising 20% of net generation):

Gross generation:
For some stations, gross generation data were not available at unit level. Therefore, the plant load factor of the respective station was used to derive the gross generation of the units. For units commissioned after the start of the relevant fiscal year, the gross generation was further adjusted pro rata the number of days since commissioning.

Net generation:
Net generation data is increasingly being reported at unit level by thermal stations. Two distinct approaches were applied to estimate net generation where unit level data was not available.

1. The auxiliary consumption (in % of gross generation) of the unit was assumed to be equal to that of the respective stations in the following cases:

i. All units of a station fall into the build margin; or

ii. All units of a station have the same installed capacity; or

iii. The units in the station have different capacities but do not differ with respect to the applicable standard auxiliary consumption; or

iv. If the default auxiliary power consumption for that type of generation unit is higher than the observed auxiliary power consumption of the station concerned, and the relevant unit is among the largest in that station.

2. In a few other cases, standard values for auxiliary consumption adopted by CEA were applied.

Fuel consumption and GCV:
In case fuel consumption and GCV are not reported at unit level by thermal stations, the specific CO_2 emissions of the units coming in the build margin could usually be assumed to be equal to the values of the respective station. See Section 4.3 for details.

4.3 Calculation of CO_2 Emissions

Calculation Approach – Station Level

CO_2 emissions of thermal stations were calculated using the formula below:

$$AbsCO_2(station)_y = \sum_{i=1}^{2} FuelCon_{i,y} \times GCV_{i,y} \times EF_i \times Oxid_i \qquad (1)$$

Where:

$AbsCO_{2,y}$	Absolute CO_2 emission of the station in the given fiscal year 'y'
$FuelCon_{i,y}$	Amount of fuel of type i consumed in the fiscal year 'y'
$GCV_{i,y}$	Gross calorific value of the fuel i in the fiscal year 'y'
EF_i	CO_2 emission factor of the fuel i based on GCV
$Oxid_i$	Oxidation factor of the fuel i

The emission and oxidation factors used in the CO_2 Database are provided in Appendix B.

The emission factors for Indian coal and lignite were based on the values provided in India's Initial National Communication under the UNFCCC (Ministry of Environment & Forests, 2004). The emission factor for coal is supported by the results of an analysis of approx. 120 coal samples collected from different Indian coal fields. Since the values in the National Communication are based on the NCV (Net Calorific Value), they were converted to GCV basis using a formula also furnished in the National Communication. For all other fuels as well as for imported coal, default emission factors were derived from the IPCC 2006 Guidelines.[8] In line with the Grid Tool, the low end values of the 95% confidence intervals indicated by IPCC were used.[9] The IPCC default factors were converted to GCV basis using IEA default conversion factors.

The oxidation factor for Indian coal and lignite was derived from an analysis performed with data on the unburnt carbon content in the ash from various Indian coal-fired power stations. The value of 98% is consistent with the default value provided in the IPCC 1996 Guidelines.[10] For all other fuels as well as imported coal, default values provided in the more recent IPCC 2006 Guidelines were used.

Specific CO_2 emissions of stations ($SpecCO_2\ (station)_y$) were computed by dividing the absolute emissions ($AbsCO_2\ (station)_y$) estimated above by the station's net generation ($NetGen(station)_y$).

$$SpecCO_2(station)_y = \frac{AbsCO_2(station)_y}{NetGen(station)_y} \qquad (2)$$

[8] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Table 1.4

[9] In accordance with the *Tool to calculate the emission factor for an electricity system, Version 7.0*

[10] IPCC 1996 Revised Guidelines for National Greenhouse Gas Inventories, Volume 3 (Reference Manual), p.1.13

In FY 2020-21, fuel consumption was not available for few stations. In these cases, conservative standard values have been applied for calculation of specific emissions of the respective station.

Calculation Approach – Unit Level

Unit-level CO_2 emissions were calculated only for the units falling in the build margin.

Wherever reliable fuel consumption data was available at unit level, it was used for determining the emissions of units falling in the build margin, in the same way as for the station emissions. This applies for an increasing number of thermal units, especially new and large coal-fired stations.

In the remaining cases where unit-level fuel consumption was not available, the absolute CO_2 emissions of thermal units ($AbsCO_2\ (unit)_y$) were derived by multiplying the specific emissions ($SpecCO_2\ (unit)_y$) with the net generation of each unit ($NetGen(unit)_y$), where net generation was obtained as described in Section 4.2:

$$AbsCO_2(unit)_y = SpecCO_2(unit)_y \times NetGen\ (unit)_y \qquad (3)$$

Two distinct approaches were applied for determining the specific emissions of these units:

1. A unit was assumed to have the same specific emissions as the corresponding station in the following three cases:

   i. If all units of a station fall into the build margin;

   ii. If all units of a station have the same installed capacity;

   iii. If the default specific emissions for the respective unit is higher than the corresponding station's specific emissions, and the concerned unit is capacity-wise among the largest of the station.

The large majority of units for which fuel consumption was not reported fall in one of the above-mentioned three categories.

2. In the remaining cases, the specific emissions of the units were derived from conservative standard heat rate values (see Appendix B).

4.4 Adjustment for Cross-Border Electricity Transfers

The weighted average emission factors and operating margins of the Indian Grid were adjusted for cross-border electricity imports and exports, in line with the Grid Tool:

- The relevant amounts of electricity imported and exported are listed in the database work-sheet “Transfers”;
- The CO_2 emissions associated with these imports were quantified based on the simple operating margin of the exporting grid.[11]

4.5 Conservativeness

The need to ensure conservativeness of calculations in situations of uncertainty is a fundamental principle in the CDM. Assumptions are conservative if they tend to reduce the number of emission reductions being credited to a CDM project activity. The following approaches and assumptions contribute to the conservativeness of the database:

- The quality of station-level data was ensured through extensive plausibility testing and interaction with the station operators.
- In cases of data gaps at station level, standard data from CEA were used. For example, standard auxiliary power consumption was assumed for few coal-fired stations. Comparison with monitored values shows that these standard values are rather conservative, i.e. they lead to a somewhat lower heat rate and hence lower emissions than observed in many stations.
- The fuel emission factors and oxidation factors used are generally consistent with IPCC defaults and relevant EB guidance. For Indian coal, the emission factor provided in India’s Initial National Communication was used (95.8 t CO_2/TJ on NCV basis). The oxidation factor of 0.98 used for Indian coal appears to be conservative in light of recent efficiency improvements in coal-fired generation. All other fuel emission factors represent the lower limits of the respective 95% confidence intervals indicated by IPCC, as required by the CDM Executive Board.[12]
- The scope of the database remains conservative because of the exclusion of captive power stations, which are generally thermal stations. As detailed in Section 3, generation from these captive stations remains far greater than the generation from non-conventional renewable energy stations, which are also excluded. The overall effect of these restrictions in scope is that the weighted average emission factor will tend to be slightly understated.

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[11] This corresponds to Options a)+b) listed in the Grid Tool, (Version 7.0), p. 10 & 11

[12] See *Tool to calculate the emission factor for an electricity system* (Version 7.0), p.35

5 Results

Worksheet “Results” in the database provides the net generation and CO_2 emissions data and the resulting emission factors for the Indian Grid in the fiscal years 2016-17 to 2020-21. The emission factors are also reproduced in Appendix C. The values are rounded off at two decimals. See database file for additional decimals.

5.1 Results for Fiscal Year 2020-21

Table 3 indicates the development of total emissions over the last five years covered by the database.

Table 3: Total emissions of the power sector for the FY 2016-17 to 2020-21, in million tonnes CO_2

2016-17	2017-18	2018-19	2019-20	2020-21
888.34	922.18	960.90	928.14	910.02

Percent Increase or Decrease as compared to previous year:

2016-17	2017-18	2018-19	2019-20	2020-21
4.97%	3.81%	4.20%	-3.41%	-1.95%

Table 4 shows the emission factors for FY 2020-21 both excluding and including cross-border power transfers.

Table 4: Weighted average emission factor, simple operating margin (OM), build margin (BM) and combined margin (CM) of the Indian Grid for FY 2020-21 (not adjusted and adjusted for cross-country electricity transfers), in t CO_2/MWh

	Average	OM	BM	CM
Excluding cross-border power transfers	**0.79**	**0.95**	**0.87**	**0.91**
Including cross-border power transfers	**0.79**	**0.94**	**0.87**	**0.90**

Percent Increase or Decrease as compared to previous year:

	Average	OM	BM	CM
Excluding cross-border power transfers	**-0.63%**	**-1.26%**	**-0.34%**	**-0.82%**
Including cross-border power transfers	**-0.90%**	**-1.57%**	**-0.34%**	**-0.98%**

A comparison of both cases in Table 4 shows that cross border electricity transfers did not have a significant influence on the emission factors in 2020-21.

Table 5 shows the weighted average specific emissions for fossil fuel-fired power stations in the Indian Grid.

Table 5: Weighted average specific emissions for fossil fuel-fired stations in FY 2020-21, in t CO_2/MWh

Coal	Diesel	Gas*	Lignite	Oil
0.97	**0.58**	**0.42**	**1.30**	**-**

Percent Increase or Decrease as compared to previous year:

Coal	Diesel	Gas*	Lignite	Oil
-0.86%	**0.08%**	**-2.75%**	**-4.64%**	**-**

* Only gas-fired stations that do not use any other fuel. Stations that use naphtha, diesel or oil as a second fuel are excluded from the weighted average.

Note: Stations for which assumptions had to be made are included in this analysis (see Section 4 for details).

5.2 Developments over Time

Figure 2 shows the capacity additions from FY 2000-01 to FY 2020-21. The yearly additions of coal-based capacity increased significantly over the period from FY 2000-01 to FY 2015-16, whereas it decreased significantly over the period from FY 2016-17 to FY 2020-21. Hydro, & Gas-based capacity addition also decreased significantly from 2017-18 onwards in the Indian Grid, while the additions in other generation capacities is zero.

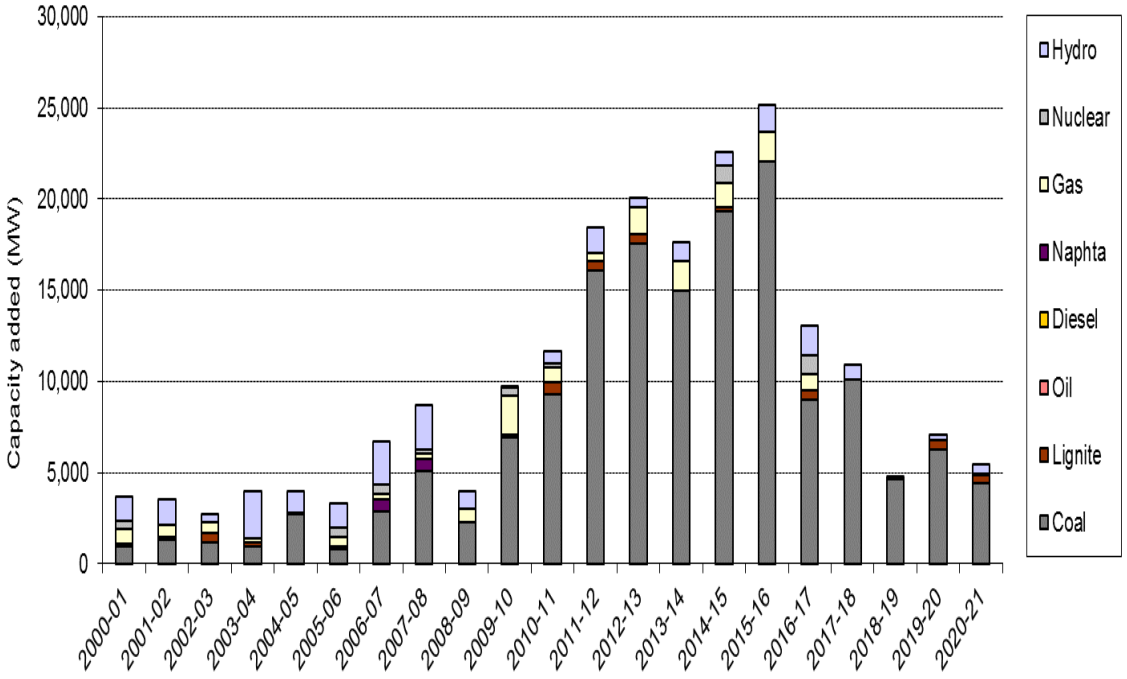

Figure 1: Breakdown of new added capacity covered by the database over the period 2000-01 to 2020-21.

Figure 2 shows the development of the weighted average emission factor over the period from FY 2016-17 to FY 2020-21 (see Appendix C for values before import adjustment). The weighted average has reduced marginally in FY 2020-21. This was mainly due to the decrease in lignite and naphtha-based generation in FY 2020-21.

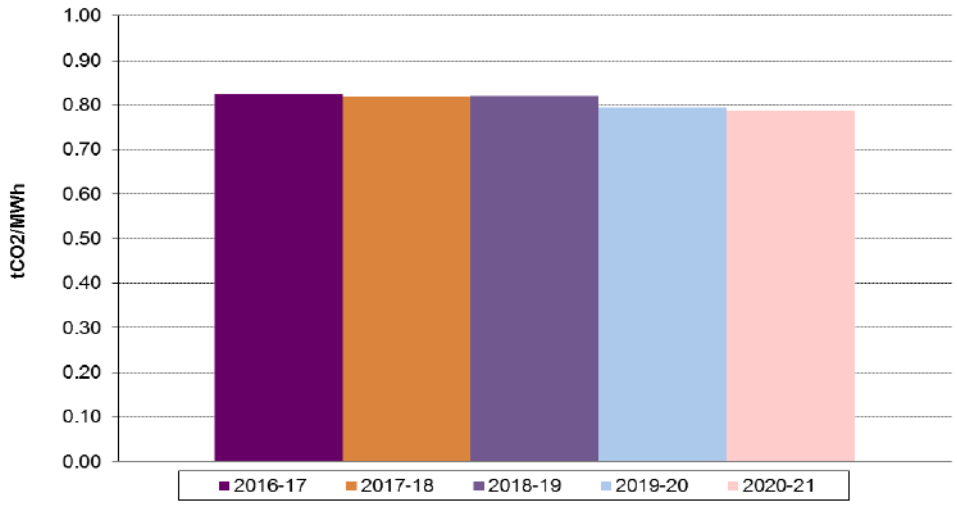

Figure 2: Development of the weighted average emission factor (adjusted for electricity transfers) for the Indian Grid over the period 2016-17 to 2020-21

Figure 4 illustrates the development of the import-adjusted operating margins over the period from FY 2016-17 to FY 2020-21 (see Appendix C for values before import adjustment). In 2020-

21 the import-adjusted operating margin decreased marginally due to operationalization of many high efficiency super-critical thermal power plants.

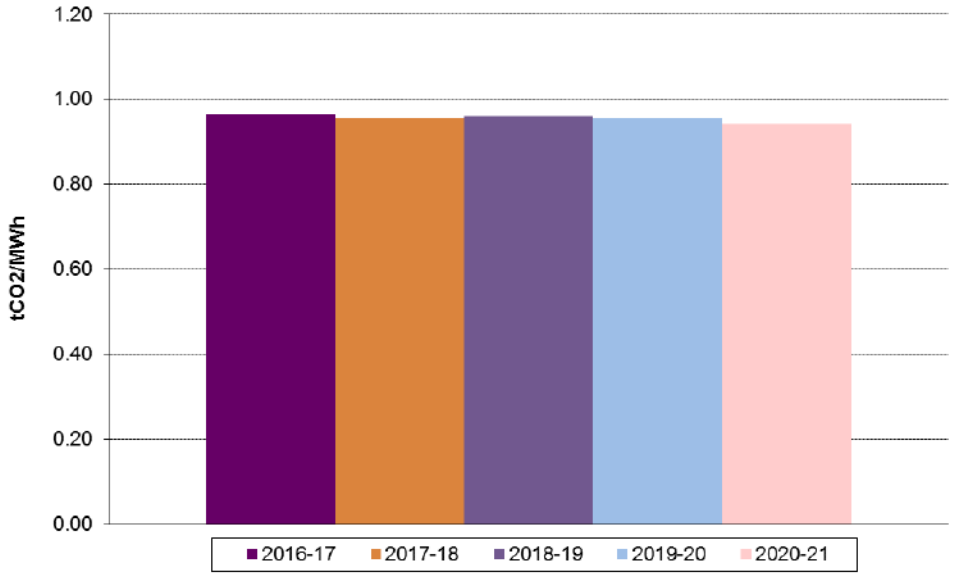

Figure3: Development of the operating margin (adjusted for electricity transfers) for the Indian Grid over the period 2016-17 to 2020-21.

Figure 4 shows the build margins for the five fiscal years 2016-17 to 2020-21. The distinction between Indian and imported coal introduced from FY 2013-14 onwards led to a slight decrease in the build margin till 2017-18, due to the lower emission factor applied to imported coal in accordance with the CDM rules.

The build margin which was showing a decreasing trend till 2017-18 has increased marginally during 2018-19 due to more share of domestic coal and less share of imported coal. During 2019-20 and 2020-21 the build margin decreased marginally again due to the increase in the share of imported coal (see figure 6).

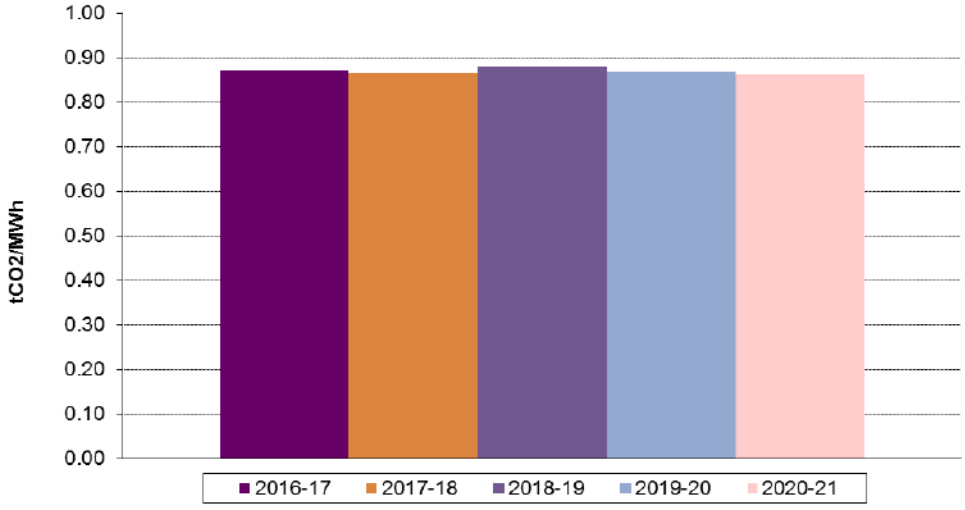

Figure 4: Development of the build margins over the period 2016-17 to 2020-21.

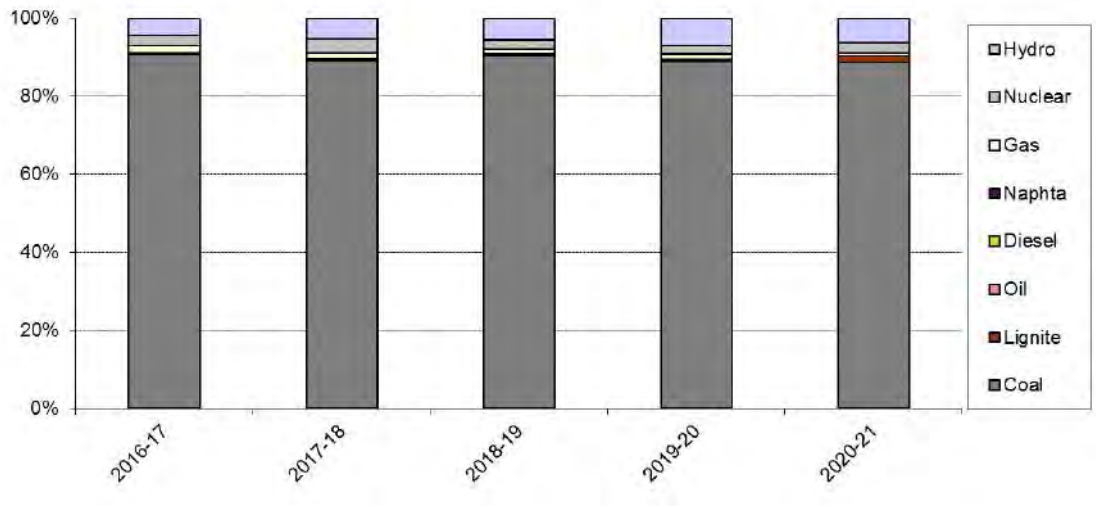

Figure 5: Breakdown of the build margins by fuel type (shares based on net generation)

Figure 6 shows the trends in the import-adjusted combined margins in the period 2016-17 to 2020-21. The combined margin decreased during 2016-17, 2017-18 and 2019-20 and 2020-21. It was mainly due to decrease in operating margin and build margin. The combined margin increased marginally during 2018-19 due to increase in both the operating and build margins

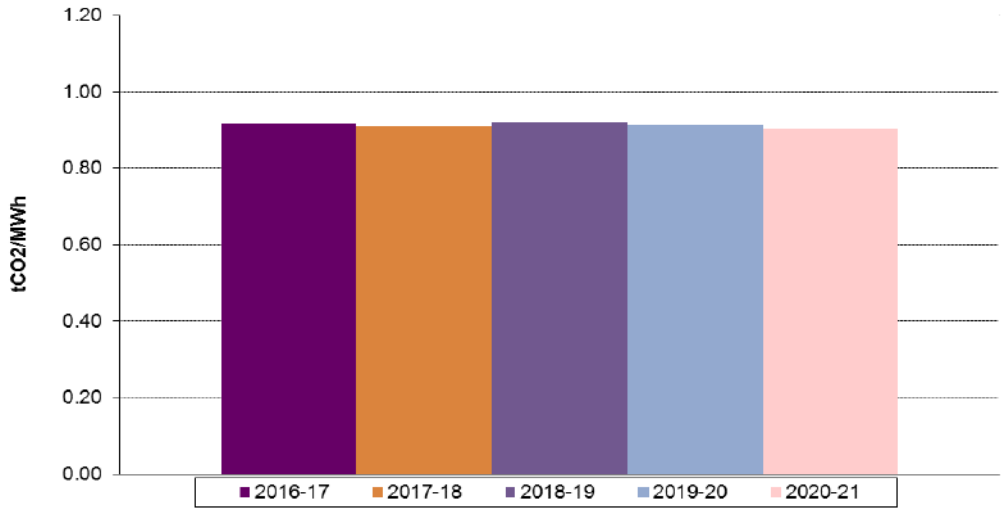

Figure 6: Development of the combined margin (adjusted for electricity transfers) for the Indian Grid over the period 2016-17 to 2020-21

5.3 Changes compared to Previous Database Versions

In comparison with the previous version of the Database (Version 16.0), this updated Version 17.0 includes the following changes:

- Added data for FY 2020-21, including new stations and units commissioned during 2020-21.
- The revised emission factors are provided in Appendix C and in the Database file.

6 User Examples

This section provides two illustrative examples of how the CO_2 Database can be applied. The examples are based on hypothetical renewable energy projects

Project A is a grid-connected 5 MW small hydropower station located in the State of Assam. The station will be commissioned in 2022. Annual net generation is projected at approx. 17'500 MWh.

- The project qualifies as a small-scale CDM activity since its capacity is below the 15 MW threshold. Hence it will use the latest version of CDM methodology AMS-I.D for grid-connected renewable electricity generation.
- Methodology AMS-I.D gives two options for determining the baseline emission factor: Either the weighted average emissions, or the combined margin of the grid. In this example, it is assumed that the promoters choose the weighted average option. In addition, it is assumed that the promoters choose to adjust the weighted average emission factor for electricity imports, despite the fact that this is not mandatory under AMS-I.D.
- In the PDD, the expected emission reductions achieved by the hydro station are projected based on the expected annual generation, and the import-adjusted weighted average emission factor for the Indian Grid in the most recent year for which data is available (2020-21). The corresponding value is 0.79 t CO_2/MWh. Hence the absolute emission reductions are projected at 0.79 * 17'500 = 13,766 t CO_2/yr. The emission reductions are equal to the baseline emissions, since the project does not result in greenhouse gas emissions of its own.
- In accordance with AMS-I. D, the promoters will determine the *actual* baseline emission factor *ex post.* The actual emission reductions will then be calculated in each year of the crediting period based on the observed net generation and the weighted average emission factor for the respective year.[13] The latter would be published annually by CEA.

Project B is a 100 MW grid-connected wind farm located in the State of Tamil Nadu. The project will be commissioned in 2022. Average net supplies to the grid are projected at 312,500 MWh per year.

- The project exceeds the 15 MW threshold and thus qualifies as a large-scale CDM activity. Hence it is eligible to use the latest version of methodology ACM0002 for grid-connected power generation from renewable energy sources.
- Under ACM0002, the combined margin approach is mandatory.
- In contrast to the first example, the promoters decide to fix the baseline emission factor *ex ante.* That is, the baseline emission factor is determined based on the most recent data available, and remains fixed for the duration of the crediting period. The actual emission reductions will be calculated in each year based on the observed net generation and the predefined baseline emission factor.
- For this *ex ante*-option, the Grid Tool referred to in the methodology ACM0002 requires that the operating margin be calculated as the generation-weighted average of the three most recent years (here 2018-19 to 2020-21).[14] The operating margin to be applied thus works out to 0.953 t CO_2/MWh.

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[13] The emission factor of the previous year may be used instead. See *Tool to calculate the emission factor for an electricity system* (Version 7.0), p.16

[14] See *Tool to calculate the emission factor for an electricity system* (Version 7.0), p.16

- Since wind is an intermittent energy source, the promoter is allowed to assign a weight of 75% to the operating margin, and 25% to the build margin. The resulting combined margin is 0.931 t CO_2/MWh (75% x 0.953 + 25% x 0.865) for the FY 2020-21). This value is used for projecting the emission reductions in the PDD as well as for calculating the actual emission reductions.

The two CDM project activities are summarised in Table 6 below.

Table 6: Illustration on how to use the CO_2 Database for calculating the emission reductions of CDM projects

	Project A	**Project B**
Project Info		
Type:	Hydro station	Wind park
Size:	5 MW (small-scale according to CDM criteria)	100 MW (large-scale according to CDM criteria)
Projected Generation (net):	17’500 MWh /yr	312’500 MWh/yr
Commissioning year:	2022	2022
Year of CDM registration:	2022	2022
Grid :	Indian	Indian
CDM methodology:	AMS-I.D / Version 19	ACM0002 / Version 19.0
Baseline Emission Factor Calculation		
Calculation method:	Weighted average	Combined margin
Data vintage for projection of emission reductions:	2020-21 (most recent available at time of PDD validation)	For OM: 2018-19, 2019-20, 2020-21 (most recent 3 years available at time of PDD validation) For BM: 2020-21
Data vintage for verification of emission reductions:	Actual year of generation, i.e., 2022-23, 2023-24 etc. (emission factor fixed *ex post*)	Same as for projection (emission factor fixed *ex ante*)
Accounting of imports:	Not mandatory, but done	Mandatory
Weights for combined margin:	Not applicable	Operating margin: 75% Build margin: 25% (default for intermittent sources)
Emission Reduction Calculations		
Values in t CO_2/MWh:	0.79 Weighted average	0.953 Operating margin 0.865 Build margin 0.931 Combined margin
Projected emission reductions:	13,766 t CO_2 per year	290,938 t CO_2 per year
Actual emission reductions:	Monitored net generation x monitored weighted average	Monitored net generation x fixed combined margin

7 Updating Procedure

The CO_2 Database will be updated annually by CEA and made available on its website: www.cea.nic.in. Previous versions will be archived by CEA and the main changes relative to previous database versions will be documented.

8 Further Information

For any further information, contact by email:

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Appendix A – Systems in India's Grids

Abbreviation	Full name
ABAN	ABAN Power Company
ADHPL	AD Hydro Power Limited
APCPL	Aravali Power Company Limited
APGCL	Assam Power Generation Corporation Limited
APGENCO	Andhra Pradesh Power Generation Co Limited
APPDCL	Andhra Pradesh Power Development Corporation Ltd.
ASEB	Assam State Electricity Board
BBMB	Bhakra Beas Management Board
BECL	Bhavnagar Energy Co. Ltd.
BSEB	Bihar State Electricity Board
BALCO	Bharat Aluminum Co. India Pvt. Ltd.
CESC	Calcutta Electric Supply Company Limited
CSEB	Chattisgarh State Electricity Board
CSPGCL	Chattisgarh State Power Generation Co Ltd
D.B. Power Ltd	Diligent Power Limited
DANS EPL	DANS Energy Pvt. Ltd.
DPL	Durgapur projects Limited
DVC	Damodar Valley Corporation
DVC Tata JV	Damodar Valley Corporation-Tata Joint Venture
GAMA	Gama Infraprop
GIPCL	Gujarat Industries Power Company Ltd
GMDCL	Gujarat Mineral Development Corporation Limited
GMR Chattisgarh	GMR Chattisgarh
GMR Energy	GMR Energy
GMR K Ltd	GMR Kamlanga Energy Ltd.
GPEC	Gujarat Paguthan Energy Corporation Pvt. Limited
GSECL	Gujarat State Electricity Corporation Limited
GSEGL	Gujarat State Energy Generation Limited
GTE Corp	GTE Corporation

Abbreviation	Full name
GVK Ind.	GVK Power & Infrastructure Limited
GVK	GVK Group
HEGL	HEG Limited
HNPCL	Hinduja National Power Corp. Ltd.
HPGCL	Haryana Power Generation Corporation Limited
HPPCL	Himachal Pradesh Power Corporation Ltd.
HPSEB	Himachal Pradesh State Electricity Board
HIRANMAYE	Hiranmaye Energy Ltd.
IEPL	Ideal Energy Pvt. Ltd.
IL&FS TN PC Ltd.	IL&FS Tamil Nadu Power Co. Ltd.
INDSIL	Indsil Electrosmelt Ltd
IPPGCL	Indraprastha Power Generation Co Ltd
JINDAL	JSW Energy Limited
JIPL	Jas Infrastructure and Power Ltd.
JKEB	Jammu & Kashmir Electricity Board
JKPDC	Jammu & Kashmir Power Development Corp. Ltd.
JPHPL	Jai Prakash Hydro Power Limited
JPL	Jhabua Power Ltd.
JSEB	Jharkhand State Electricity Board
JSW Energy	JSW Energy Limited
JV NTPC & BSEB	Joint Venture NTPC & Bihar State Electricity Board
KPCL	Karnataka Power Corporation Limited
KSEB	Kerala State Electricity Board
KSK Ventures	KSK Energy Ventures Ltd.
LPG CO	Lalitpur Power Generation Co. Ltd.
LVS Power	LVS Power Limited
M B Power (M P)	M B Power Madhya Pradesh
Madurai P	Madurai Power Corporation Limited
MAHAGENCO	Maharashtra State Power Generation Company Limited
MAPS	Madras Atomic Power Station

Abbreviation	Full name
MEECL	Meghalaya Energy Generation Corporation Ltd.
MEGEB	Meghalaya State Electricity Board
MPDC	Manipur Power Development Corporation
MEECL	Meghalaya Energy Corporation Ltd.
MPDC	Manipur Power Development Corporation
MPGPCL	Madhya Pradesh Power Generating Co. Ltd.
NAPS	Narora Atomic Power Station
NCTPP	National Capital Thermal Power Plant
NDPL	North Delhi Power Ltd.
NEEPCO	North Eastern Electric Power Corporation Ltd
NHDC	Narmada Hydro Electric Development Corporation
NHPC	National Hydro Electric Corporation
NLC	Neyvelli Lignite Corporation Ltd
NPC	Nuclear Power Corporation of India Ltd.
NTPC	NTPC Ltd
NTPC/NTECL	NTPC Tamilnadu Energy Company Limited
OHPC	Orissa Hydro Power Corporation
OPGC	Orissa Power Generation Corporation
PPCL	Puducherry Power Corporation Limited
PPGCL	Prayagraj Generation Co. Ltd.
PPNPG	PPN Power Generating Company Pvt. Limited
PSEB	Punjab State Electricity Board
RAPS	Rajasthan Atomic Power Station
RATANAGIRI	Ratnagiri Gas & power Pvt Ltd
REL	Reliance Energy Ltd
RKM PPL	RKM Powergen Pvt. Ltd.
RPG	RP Goenka Group
RRVUNL	Rajasthan Rajya Vidyut Utpadan Nigam
Samalpatti	Samalpatti Power Company Limited
SHIRPUR	Shirpur Power Pvt. Ltd.

Abbreviation	Full name
SCPL Ltd.	Spectrum Power Limited
SJVNL	Sutluj Jal Vidyut Nigam Ltd
SKS Power	SKS Power Generation
SKPL	Sneha Kinetic Power Projects Pvt. Ltd.
SPECT. IND	Spectrum Power Generation Limited
SP&ML	Subhash Projects and Marketing Co. Ltd.
SSVNL	Sardar Sorovar Vidyut Nigam Limited
STPS	Super Thermal Power Station
Tata MAH	Tata Power Company Limited
Tata PCL	Tata Power Company Limited
THDC	Tehri Hydroelectric Development Corporation
TNEB	Tamilnadu Electricity Board
Torr. Power	Torrent Power Limited
TSECL	Tripura State Electricity Corporation Limited
TSGENCO	Telangana Power Generation Corp. Ltd.
TVNL	Tenughat Vidyut Nigam Limited
UJVNL	Uttarakhand Jal Vidyut Nigam Limited
UPCL	Uttarakhand Power Corporation Limited
UPHPC	Uttar Pradesh Hydro Power Corporation Limited
UPRVUNL	Uttar Pradesh Rajya Vidyut Utpadan Nigam
VVNL	Visvesarya Vidyut Nigam Ltd
WBPDC	West Bengal Power Development Corporation Ltd
WBSEB	West Bengal State Electricity Board

Appendix B – Assumptions for CO_2 Emission Calculations

Fuel Emission Factors (EF) (Source: for Indian Coal/Lignite - Initial National Communication; for Imported Coal Gas/Oil/Diesel/Naphtha - IPCC 2006; for Corex - own assumption)

	Unit	Coal	Imported Coal	Lignite	Gas	Oil	Diesel	Naphtha	Corex
EF based on NCV	gCO_2 /MJ	95.8	89.5	106.2	54.3	75.5	72.6	69.3	0.0
Delta GCV NCV	%	3.6%	5.0%	3.6%	10%	5%	5%	5%	n/a
EF based on GCV	gCO_2 /MJ	92.5	85.2	102.5	49.4	71.9	69.1	66.0	0.0
Oxidation Factor	-	0.98	1.00	0.98	1.00	1.00	1.00	1.00	n/a
Fuel Emission Factor	gCO_2 /MJ	90.6	85.2	100.5	49.4	71.9	69.1	66.0	0.0

n/a = not applicable (i.e. no assumptions were needed)

Assumptions at Station Level (only where data was not provided by station)

	Unit	Coal	Lignite	Gas-CC	Gas-OC	Oil	Diesel-Eng	Diesel-OC	Naphtha	Hydro	Nuclear
Auxiliary Power Consumption	%	8.0	10.0	3.0	1.0	3.5	3.5	1.0	3.5	0.5	10.5
Gross Heat Rate	kcal /kWh (gross)	2,500	2,713	2,013	3150	2,117	1,975	3,213	2,117	n/a	n/a
Net Heat Rate	kcal /kWh (net)	2,717	3,014	2,075	3,182	2,193	2,047	3,330	2,193	n/a	n/a
Specific Oil Consumption	ml /kWh (gross)	2.0	3.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
GCV	kcal /kg (or m3)	3,755	n/a	8,800	n/a	10,100	10,500	10,500	11,300	n/a	n/a
Density	t /1,000 lt	n/a	n/a	n/a	n/a	0.95	0.83	0.83	0.70	n/a	n/a
Specific CO_2 emissions	tCO_2 /MWh	1.04	1.28	0.43	0.66	0.66	0.59	0.96	0.61	n/a	n/a

n/a = not applicable (i.e. no assumptions were needed)

Assumptions at Unit Level (by capacity; only for units in the BM, where data was not provided by station)

Coal	Unit	67.5 MW	120 MW	200-250 MW	300 MW	500 MW Type 1	500 MW Type 2	600 MW	660 MW Type 1	660 MW Type 2	800 MW
Gross Heat Rate	kcal /kWh	2,750	2,500	2,500	2,350	2,425	2,380	2,380	2,178	2,126	2126
Auxiliary Power Consumption	%	12.0	9.0	9.0	9.0	7.5	6.5	6.5	6.5	6.5	5.25
Net Heat Rate	kcal /kWh	3,125	2,747	2,747	2,582	2,622	2,545	2,545	2,329	2,274	2,244
Specific Oil Consumption	ml /kWh	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.5
Specific CO_2 Emissions	tCO_2 /MWh	1.19	1.05	1.05	0.99	1.00	0.97	0.97	0.89	0.87	0.85

Lignite	Unit	75 MW	125 MW	210/250 MW	500 MW
Gross Heat Rate	kcal /kWh	2,750	2,560	2,713	2713
Auxiliary Power Consumption	%	12.0	12.0	10.0	8.5
Net Heat Rate	kcal /kWh	3,125	2,909	3,014	2965
Specific Oil Consumption	ml /kWh	3.0	3.0	3.0	3.0
Specific CO_2 Emissions	tCO_2 /MWh	1.32	1.23	1.28	1.25

Gas	Unit	0-49.9 MW	50-99.9 MW	>100 MW
Gross Heat Rate	kcal /kWh	1,950	1,910	1,970
Auxiliary Power Consumption	%	3.0	3.0	3.0
Net Heat Rate	kcal /kWh	2,010	1,969	2,031
Specific CO_2 Emissions	tCO_2 /MWh	0.42	0.41	0.42

Diesel	Unit	0.1-1 MW	1-3 MW	3-10 MW	>10 MW
Gross Heat Rate	kcal /kWh	2,350	2,250	2,100	1,975
Auxiliary Power Consumption	%	3.5	3.5	3.5	3.5
Net Heat Rate	kcal /kWh	2,435	2,332	2,176	2,047
Specific CO_2 Emissions	tCO_2 /MWh	0.70	0.67	0.63	0.59

Naphtha	Unit	All sizes
Increment to Gas Heat Rate	%	2%
Gross Heat Rate	kcal /kWh	2,117
Auxiliary Power Consumption	%	3.5
Net Heat Rate	kcal /kWh	2,193
Specific CO_2 Emissions	tCO_2 /MWh	0.61

Combined Margin	Unit	
Weight OM	%	50%
Weight BM	%	50%

Conversion Factors	Unit	
Energy	kJ /kcal	4.1868
	MJ /kWh	3.6

Oil		
Specific Emission	gCO_2 /ml	2.89

Appendix C – Grid Emission Factors

Note: Values are rounded off at two decimals here. See Database (Excel File, Worksheet "Results") for additional decimals.

Table A: Values for FY 2016-17 to 2020-21, excluding cross-border electricity transfers.

Emission Factors (tCO_2/MWh) (excl. Imports)	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**
Weighted Average Emission Rate	0.83	0.82	0.82	0.80	0.79
Simple Operating Margin (1)	0.97	0.96	0.96	0.96	0.95
Build Margin	0.87	0.87	0.88	0.87	0.87
Combined Margin (1)	0.92	0.91	0.92	0.92	0.91

(1) Operating margin is based on the data for the same year. This corresponds to the *ex post option* given in "Tool to Calculate the Emission Factor for an Electricity System", Ver. 7.0 (p.16)

Table B: Values for FY 2016-17 to 2020-21, including cross-border electricity transfers.

Emission Factors (tCO_2/MWh) (incl. Imports)	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**
Weighted Average Emission Rate (2)	0.82	0.82	0.82	0.79	0.79
Simple Operating Margin (1) (2)	0.96	0.95	0.96	0.96	0.94
Build Margin (not adjusted for imports)	0.87	0.87	0.88	0.87	0.87
Combined Margin (1) (2)	0.92	0.91	0.92	0.91	0.90

(1) Operating margin is based on the data for the same year. This corresponds to the *ex post option* given in "Tool to Calculate the Emission Factor for an Electricity System", Ver. 7.0 (p.16)

(2) For Adjustments of imports from other countries, an emission factor of zero is used. See "Tool to Calculate the Emission Factor for an Electricity System", Ver. 7.0 (p.10 & 11), options a+b

Appendix D – Summary of Methodology ACM0002 / Version 20.0

Download ACM0002 at: http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

ACM0002 is a consolidated CDM methodology for grid-connected power generation from renewable energy sources. It covers grid-connected renewable power generation project activities that involve retrofitting, rehabilitation (or refurbishment), replacement or capacity addition of an existing power plant or construction and operation of a Greenfield power plant... Examples of eligible project types include hydro power plants with or without reservoir; wind energy; geothermal energy; solar energy; and wave and tidal energy.

The methodology requires the calculation of the baseline emission factor following the combined margin (CM) approach. The combined margin consists of a weighted average of:

- Operating margin (OM);
- Build margin (BM).

The relative weights used to determine the combined margin are by default the same, i.e. 50%. Alternative weights can be used for intermittent power sources.

There are four options to calculate the operating margin, depending on local conditions:

- *Simple operating margin*. This is the preferred approach for India.
- The other three approaches are: (i) *simple adjusted operating margin*; (ii) *dispatch data analysis operating margin*; and (iii) *average operating margin*.

The build margin is the generation-weighted average emission factor of the most recent power plants, consisting of the larger of (i) the five power plants that have been built most recently; or (ii) the capacity additions that represent 20% of the system generation that have been built most recently. In India, the latter approach generally yields the larger sample and hence must be followed. CDM projects must be excluded from the build margin, as long as the build margin does not contain generation units older than 10 years.

The operating margin must be adjusted for electricity transfers (imports) from connected electricity systems (other states/regions, other countries) to the project electricity system. Generally, no such adjustments are required for the build margin.

The actual emission reductions achieved by a CDM project are calculated based on the monitored electricity production in each year, and the combined margin (baseline emission factor). The combined margin is initially calculated from the most recent data available at the time of PDD submission. It can then either remain fixed for the duration of the project's crediting period *(ex-ante approach)*, or be updated annually *(ex-post approach)*. The two approaches have different requirements in terms of data vintage.

Appendix E – Abbreviations

Abbreviation	Full Name
ACM0002	Approved Consolidated Methodology by CDM Executive Board for grid connected large scale renewable project
ACM0013	Approved Consolidated Methodology by CDM Executive Board for new grid connected fossil fuel fired power plants using a less GHG intensive technology.
AMS-I.D	Approved Methodology for small scale grid connected renewable projects
BM	Build margin
CDM	Clean Development Mechanism
CEA	Central Electricity Authority
CER	Certified Emission Reduction
CM	Combined margin
CO_2	Carbon Dioxide
FY	Fiscal year
GCV	Gross Calorific Value
GHG	Greenhouse Gases
GWh	Gigawatt hour
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
MW	Megawatt
NEWNE	Integrated Northern, Eastern, Western and North Eastern Grid
OM	Operating margin
PDD	Project Design Document
RLDC	Regional Load Dispatch Centre
RPC	Regional Power Committee
SR	Southern Grid
UNFCCC	United Nations Framework Convention on Climate Change

Preliminary Results from Electric Arc Furnace Off-Gas Enthalpy Modeling

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Keywords: Electric Arc Furnace, EAFs, Waste Heat Recovery, Scrap Preheating

ABSTRACT

This article describes electric arc furnace (EAF) off-gas enthalpy models developed at Oak Ridge National Laboratory (ORNL) to calculate overall heat availability (sensible and chemical enthalpy) and recoverable heat values (steam or power generation potential) for existing EAF operations and to test ORNL's new EAF waste heat recovery (WHR) concepts. ORNL's new EAF WHR concepts are: Regenerative Drop-out Box System and Fluidized Bed System. The two EAF off-gas enthalpy models described in this paper are:

1. Overall Waste Heat Recovery Model that calculates total heat availability in off-gases of existing EAF operations
2. Regenerative Drop-out Box System Model in which hot EAF off-gases alternately pass through one of two refractory heat sinks that store heat and then transfer it to another gaseous medium

These models calculate the sensible and chemical enthalpy of EAF off-gases based on the off-gas chemical composition, temperature, and mass flow rate during tap to tap time, and variations in those parameters in terms of actual values over time. The models provide heat transfer analysis for the aforementioned concepts to confirm the overall system and major component sizing (preliminary) to assess the practicality of the systems.

Real-time EAF off-gas composition (e.g., CO, CO_2, H_2, and H_2O), volume flow, and temperature data from one EAF operation was used to test the validity and accuracy of the modeling work. The EAF off-gas data was used to calculate the sensible and chemical enthalpy of the EAF off-gases to generate steam and power. The article provides detailed results from the modeling work that are important to the success of ORNL's EAF WHR project. The EAF WHR project aims to develop and test new concepts and materials that allow cost-effective recovery of sensible and chemical heat from high-temperature gases discharged from EAFs.

BACKGROUND

Oak Ridge National Laboratory (ORNL), in collaboration with E3M, Inc., and Toledo Engineering Company (TECO), is conducting research aimed at developing and testing new concepts and materials that allow cost-effective recovery of sensible and chemical heat from high-temperature gases discharged from electric arc furnaces (EAFs). The EAF melting process discharges a large amount of heat as high-temperature (>3,000°F) exhaust gases, or off-gases, that contain large amounts of condensable and non-condensable vapors, particulate matter, and corrosive gases (see Figure 1). EAFs use a batch or periodic process, so the mass flow and

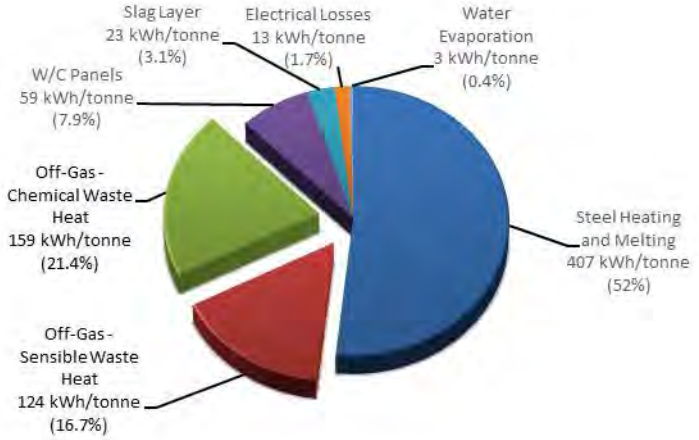

Figure 1: A large percentage (25–35%) of the total energy input for the EAF is lost as chemical and sensible heat.

composition of the off-gases vary during a cycle. At this time, not only is the energy contained in the gases wasted, but also much energy is used to handle and treat the gases before they are discharged into the atmosphere. Currently, for all EAFs used in the US steel industry, this loss is equivalent to approximately 31 trillion Btu/year, or approximately 3% of the total energy used by the US steel industry. The economic value of these losses is approximately $182 million US dollars per year. Existing waste heat recovery (WHR) systems (e.g., recuperators) have very short lives—usually 6 to 12 months—even if they are made of specially selected alloys, because of the highly corrosive, high-temperature operating environment.

The project goal is to develop a WHR system that uses appropriate innovative technology to enable the conversion of waste heat into usable energy. We aim to develop and/or improve a WHR system, equipment designs, and operating practices that can be applied to a large population of EAFs and in other areas of the primary and secondary steel melting industry where high-temperature contaminated gases are exhausted. The purpose of the project is to reduce the energy intensity of the US steel industry.

INTRODUCTION

During the 2014 AISTech conference in Indianapolis, ORNL researchers presented a study and review of available waste heat in high-temperature EAF off-gases and techniques/methods of recovering heat from these gases [1]. The 2014 paper detailed the quality and quantity of the sensible and chemical waste heat in a typical EAF exhaust gas; the energy savings potential from recovering part of the heat; a comprehensive review of currently used WHR methods; and the potential for using advanced designs to increase the level of heat recovery, including scrap preheating, steam production, and electric power generation. The paper included a review of the historical development of existing WHR methods, their operation, and their advantages/limitations. It also described a program to develop and test advanced concepts for scrap preheating, steam production, and electricity generation via recovery of chemical and sensible heat in EAF off-gases with a minimum amount of dilution or cooling air upstream of a pollution control system such as a bag-house. This paper describes EAF off-gas enthalpy models in detail and presents a real-life case study. Any steel plant could use the enthalpy models to calculate overall heat availability (sensible and chemical enthalpy) and recoverable heat values (steam or power generation potential) for an existing EAF and/or to test ORNL's WHR concepts for its particular EAF.

CURRENT PRACTICES TO MANAGE EAF OFF-GASES

The EAF is used to produce molten steel using scrap steel or other types of charge. More than 60% of US steel is produced by EAFs, and the proportion is likely to increase. An EAF melts steel using a batch process in which the charge material is loaded into a water-cooled furnace and energy is supplied to melt the material within 50 to 70 minutes. An EAF uses electricity and various fuels such as natural gas and carbon to supply energy to heat and melt the charge material. Various other materials such as fluxes, lime, carbon, and oxygen are also injected into the EAF during the melting cycle. A large volume of exhaust gases is discharged from the furnace at >3000°F during the melting operation. These gases contain products of incomplete combustion, including carbon dioxide (CO_2), water vapor (H_2O), carbon monoxide (CO), hydrogen (H_2), and other hydrocarbons. They also include small amounts of metallic and nonmetallic solid particles in various sizes.

In the vast majority (>90%) [2] of EAF installations, the common practice is to collect EAF exhaust gases, mix them with ambient air to combust the combustible materials, and then drop their temperature to less than 400°F (see Figure 2). These relatively lower-temperature gases are then passed through a bag-house before being discharged to the atmosphere. The capacity of these direct evacuation systems is typically 1,000 Nm^3/hour per ton of furnace capacity. The exhaust gas system may include a "drop-out" box to drop out large particles, a quench, and an exhaust fan that uses hundreds of horsepower of electrical energy. The entire exhaust gas direct evacuation system requires frequent cleaning and other maintenance. Moreover, fourth-hole direct evacuation systems do not always operate as designed. For example, changes in furnace pressure cause fumes to escape through doors, ports, roof-sidewall joints and electrode openings, bypassing the direct evacuation system. Hence many EAF systems also use a deep rectangular canopy hood over the furnace to capture fumes generated during charging, tapping, melting, and refining. These types of system typically have capacities of 340,000 to 850,000 Nm^3/hour per furnace and consume large amounts of electrical energy.

In some cases, the exhaust gases from the furnace are passed through a scrap preheating system, where the gases supply heat to the charge material to raise its temperature before charging it into the EAF vessel. Several charge preheating system designs are used. Charge preheating offers several benefits, including lower energy use in the EAF, reduced melt time, and increased productivity. The systems proposed and used at some plants include heating of scrap in buckets or shafts or on a conveyor specially designed to withstand high temperatures. In all cases, only part of the exhaust gas heat is transferred to the charge material, and a relatively large amount of heat remains in the exhaust gases leaving the charge preheater. Users have identified several other issues associated with currently available scrap heating systems. Commonly used scrap preheating systems require frequent maintenance and may heat scrap unevenly, with localized melting of steel on the conveyor itself resulting in operational problems. In many systems, operators prefer little or no preheating of scrap material to avoid heat deformation of the charging bucket and resulting maintenance issues, or white smoke or a bad smell produced by preheating. Some scrap preheating systems increase the combustion gas pressure under the furnace roof. In those cases, a highly sensitive furnace pressure control is required to avoid unacceptable pressure in the furnace, which would lead to CO escaping through any gaps in the furnace and associated plant equipment. Many of these problems are due to uncontrolled gas temperatures and the presence of combustibles, together with unpredictable air flow patterns that result in uncontrolled combustion of combustible gases. Hence, there is a need to develop systems that overcome the issues and problems associated with currently available designs and recover the maximum possible waste heat.

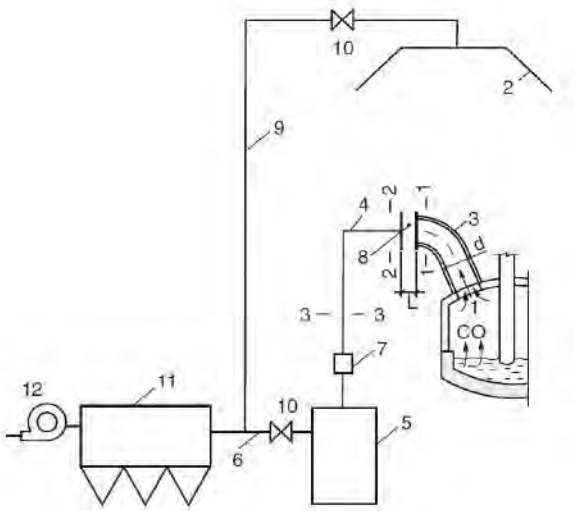

Figure 2 - Schematic diagram of evacuation and purification of gases from EAF [3].

1 – Opening in the furnace roof, 2 – the canopy hood, 3 – the roof elbow, 4 – the stationary gas duct, 5 – the drop out box, 6 – the gas duct, 7 – water quenching device, 8 – the air gap, 9 – the gas duct, 10 – off-gas flow rate control valves, 11 – the baghouse, and 12 – exhauster

ORNL is developing an innovative WHR concept that can recover >70% of off-gas heat to preheat scrap; generate steam; and, if economical, produce electrical power. The proposed WHR system aims to eliminate many of the problems associated with currently used practices and provide an opportunity to recover sensible and chemical heat through controlled burning of combustibles in the gases via integral heat recovery. The proposed WHR system also includes the removal of a large percentage of particulates, resulting in hot and relatively "clean" gases that can be used to preheat charge material and to produce steam and electrical power for use in the plant. The ORNL team expects to test one or more systems in collaboration with industrial partners and end users.

ORNL'S REGENERATIVE DROP-OUT BOX CONCEPT

The proposed WHR system includes several new features and differs from conventional systems in the following ways:

- It preconditions exhaust gases to process (or oxidize) combustible gases at a controlled temperature and removes a large percentage of particulates, resulting in clean or combustibles-free exhaust gases.
- It extracts off-gases from the furnace by keeping off-gas pressure under the furnace roof nearly constant.
- It controls temperature and gas composition while transferring heat.
- It uses heat recovery to reduce the exhaust gas temperature, as opposed to using a large volume of cooling air to do so.
- It uses a heat transfer system that provides heat accumulator capability to reduce the effect of variations in the sensible and chemical heat content of EAF exhaust gases during a heat or during the cycle.
- It preheats scrap using hot gases that contain no combustible materials and are at a controlled temperature, enabling convective heating of the entire mass of scrap before it is charged into the EAF.
- It uses clean exhaust gases in a steam generator that includes auxiliary fuel firing to deliver a fairly constant amount of steam for use in the plant.

- It uses steam to generate electrical power to offset some facility power costs, if economically justified.

DETAILED TECHNICAL DESCRIPTION OF THE PROPOSED SYSTEM

The proposed system for recovering sensible and chemical heat from EAF exhaust gases is shown in Figure 3 and described below.

1. A drop-out box regenerator (DB Regen 1) is used to condition EAF off-gases. It is designed to complete the combustion of gases containing chemical heat under controlled temperature using a minimum amount of combustion and cooling air. It consists of a heat source module that transfers heat from the off-gases to a regenerator with ceramic bricks that can withstand high temperatures and can store heat.
2. A heat transfer module (heat sink) transfers heat stored in the regenerator (Regen 2) to air or another fluid. In doing so, it also cools the regenerator in the heat source module so it can absorb more heat.
3. The system includes a particulate removal or dropping arrangement in or outside the heat transfer modules. It uses a proper geometrical configuration and/or a cleaning medium—such as compressed air, mechanical scrubbing, or other methods—to remove particulates attached to the regenerators.
4. A mixture of hot air from the heat sink module and hot and relatively clean gases—free of combustibles, vapors, and particulates—is used at a controlled temperature in the secondary WHR subsystem.
5. The secondary WHR system includes a scrap or charge preheater and/or a steam generator.
6. Gases are distributed to the scrap preheater and/or to a steam generator based on heat demand in the scrap preheater; excess gases go to the steam generator. The exact use, distribution, and control of the heat depend on specific plant requirements.
7. The system may recirculate scrap preheater exhaust gases to DB Regen 1, where the temperature is well above 982°C (1,800°F), to combust any combustible gases or volatile organic compounds mixed with heating gases in the scrap or charge preheater.
8. The steam generator uses the clean hot gases and air from Regen 2 to produce steam. It may use an auxiliary fuel, such as natural gas, to maintain constant steam production when the heat content of the hot gas and air is not adequate to deliver the desired steam production.
9. The steam can be used in the plant as process steam or for other applications as needed (e.g., vacuum degassing system, vacuum pumps) or for power generation using a conventional steam turbine generator system.
10. Clean, lower-temperature exhaust gases from the steam generator are directed to the bag-house or other pollution control system at a controlled temperature by using dilution air if necessary.
11. If necessary, a gas treatment method such as injection of activated carbon can be used to reduce the concentration of pollutants such as dioxin and furan to meet environmental control regulations.

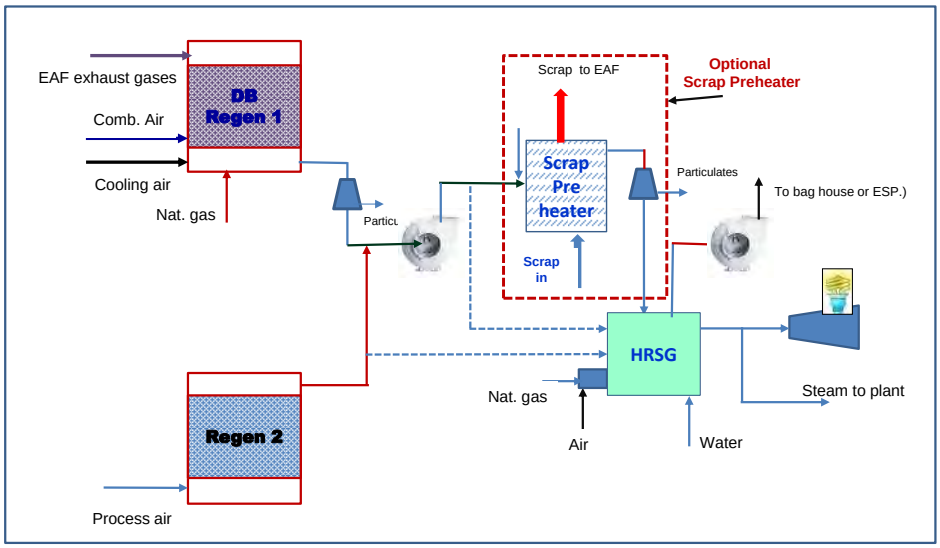

Figure 3 – Regenerative drop-out box heat recovery system for recovering sensible and chemical heat from EAF exhaust gases with integrated scrap preheating.

EAF OFF-GAS WASTE HEAT RECOVERY MODEL

EAF off-gases contain significant amounts of chemical and sensible heat that is not recovered or used for any productive purpose in the facility. Because of the batch or periodic nature of the process, mass and energy flow rates in the EAF are not steady-state but are time-dependent during a particular heat cycle. Mass and energy flow rates depend on variables such as electric power input, injection of oxygen and coal, firing rate of natural gas burners, and post-combustion injectors. These parameters affect the off-gas composition, percentage of combustibles, and mass flow rate and temperature, resulting in wide fluctuations in off-gas enthalpy or waste heat content. The issues of off-gas quantity and composition are highly complicated, because the waste heat quantity is very dependent on the design and operation of the EAF, as well as the type of charge material used.

In many cases, the off-gases react with air that enters the ductwork through openings between the furnace off-gas outlet (often referred to as the "fourth hole") and the ducts leading to the off-gas or fume collection system. It is possible, although difficult, to measure the exact gas composition and temperature at this location. The current trend is to install a gas sampling probe in an off-gas duct close to the furnace where the gases do not have enough time to react with air entering the duct and hence are not completely combusted. However, because of the very high temperatures and the unpredictability of the combustion reaction at the point where a sampling probe would be located, it is difficult to install a long-lasting thermocouple and collect exact temperature data for the gases. The gas composition measured by a sampling probe is reported in percentages of CO, H_2, O_2, and CO_2. Along with the gas composition data, additional data are collected for the off-gas temperature and flow rates. Flow rate data are usually expressed as actual volume flow or cubic feet per minute (acfm) in English units or cubic meter per hour (m^3/hour).

Example off-gas composition, temperature, and flow rate data for a 145 ton batch EAF [4] are shown in Figures 4 and 5. As these figures show, there is wide variation in all parameters of interest for each heat cycle, and the values may change significantly from one cycle to another. Hence, it is necessary to account for these variations in considering potential WHR. The proposed ORNL model was developed to account for these variations.

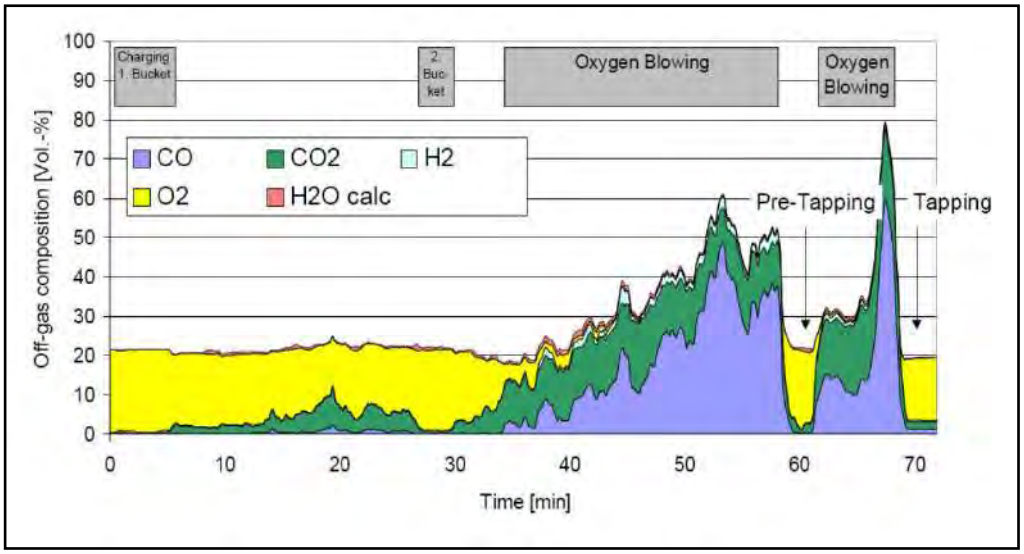

Figure 4 – Measured amounts of off-gas components from a 145 ton/batch EAF [4].

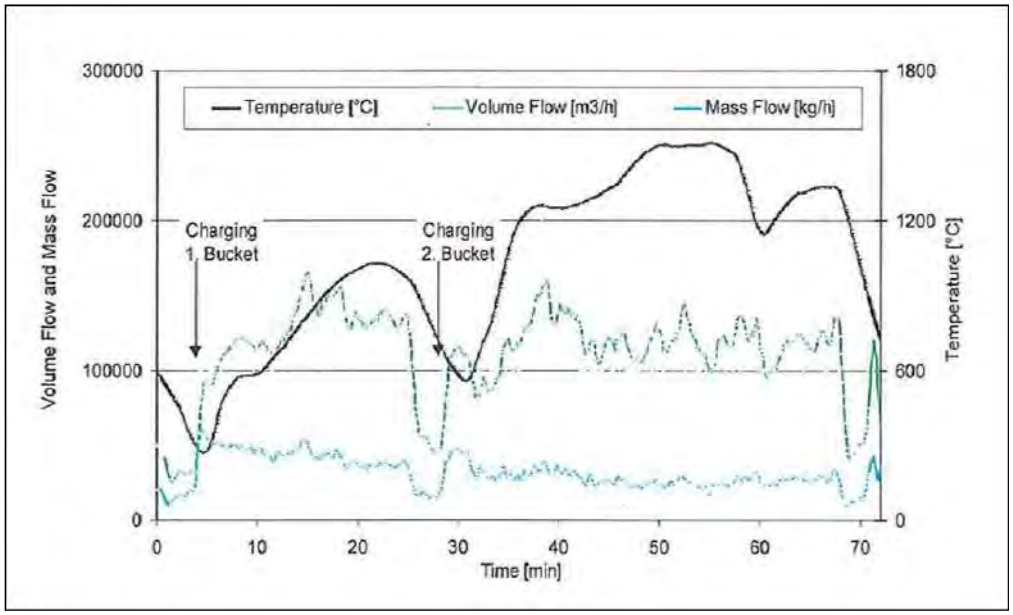

Figure 5 – Measured off-gas volume, mass flows, and temperature in a 145 ton/batch EAF [4].

DESCRIPTION OF THE ENTHALPY MODEL

The research team has developed an Excel-based enthalpy model for calculating overall heat availability (sensible and chemical) and recoverable heat values (steam or power generation potential) for the proposed WHR system. As input parameters, the model uses off-gas data collected using a commercially available off-gas monitoring system. It is designed to estimate steam generation and associated electricity production at several segments at predefined time intervals for a typical heat cycle, as well as for the total duration of the heat cycle, using two different modeling approaches.

The Overall Waste Heat Recovery Model uses the data to calculate steam generation and power generation based on the sensible and chemical heat of the off-gases when they are used directly in a steam generator. Obviously, this is a simple approach. However, it can be used to assess overall WHR potential and decide whether it is worthwhile to conduct a detailed analysis and investigate available WHR methods. The analysis requires no information regarding a heat recovery method. Figure 6 lists the data required to run the high-level Overall Waste Heat Recovery Model.

Because the direct use of off-gases containing variable amounts of particulates and combustibles at high temperatures is difficult, it is necessary to develop an alternate system that allows heat recovery from such gases. The second approach, the Regenerative Drop-out Box System Model, makes calculations for a regenerative drop-out box WHR system of the type described earlier. Using this system, it is possible to dampen or even eliminate wide fluctuations in the flow rates and composition of off-gases. The model also allows the use of auxiliary heat to produce a nearly constant amount of steam and electrical power, which is more practical for use in a plant. This analysis requires considerably more data related to the design and operating parameters for a regenerative drop-out box WHR system like the one described earlier. This model offers the option of using a scrap preheater as part of the WHR system. A list of the data required is provided in Figure 7.

Each of the two modeling approaches divides a typical heat, or cycle, into several time segments. Typically, 5 minute intervals are used for calculations. For each time segment, the following data are used for detailed heat recovery calculations:

- Average off-gas analysis in terms of CO, CO_2, O_2, H_2, and H_2O (if available)
- Average temperature of off-gases
- Average off-gas flow rate

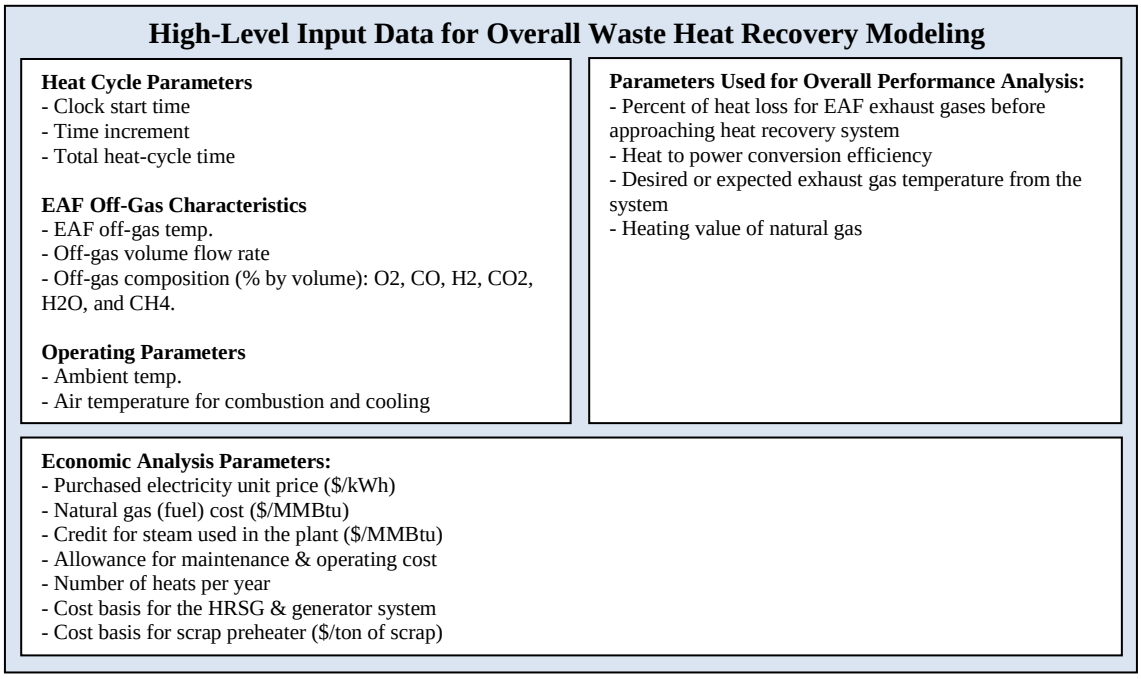

Figure 6 – High-level input data for overall waste heat recovery modeling.

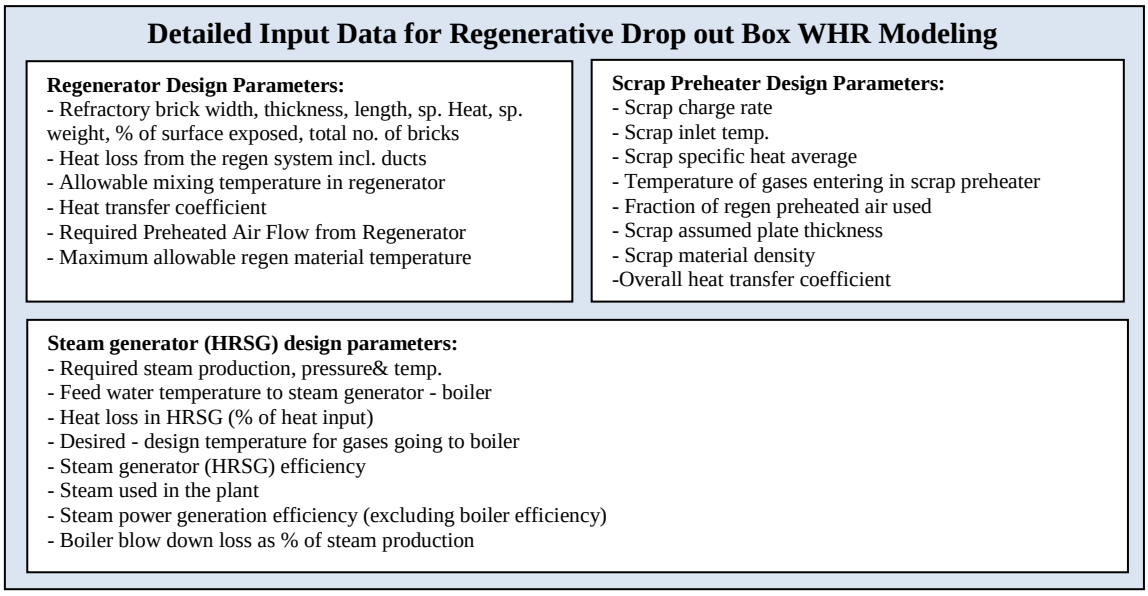

Figure 7 – Detailed input data for regenerative drop out box WHR modeling..

Most data collection systems collect data at very short time increments, as frequently as one data point per second. The result is a very large amount of data that can be difficult to handle using a simple model. Therefore, this Excel-based model uses average values for the required parameters. The average values for each segment can be obtained as an arithmetic average or by any other justifiable method of deriving average values. It is necessary to get the data at a single sampling point location and at a point where the gases have not had time to cool down. This requires the use of an advanced sampling and data collection system; equipment suppliers are capable of delivering this information.

A typical data input process uses the format shown in Table 1. Based on observations at several plants using two different methods of data collection, it is apparent that it is not always possible to collect all of these data at one

sampling point. However, advanced in-situ laser-based systems (e.g. More's LINDARC system [5]) or off-gas extractive systems (e.g. Tenova Goodfellow's EFSOP system [6, 7] or Siemens' Lomas system [8]) can provide the required data with good accuracy. These data are used in the model to calculate potential electrical power generation and steam generation at 5 minute intervals. Note that the time interval can be selected by the user.

Table 1 – EAF off-gas enthalpy modeling - A typical data input format.

DATA INPUT					
EAF Off-Gas Characteristics	Data supplied by Company A - summarized by ORNL, March22, 2015				
Clock Time Start	1/22/2015 10:05	Time increment:	5	minutes	16
Total heat - cycle time	60	minutes per heat	Number of heats:		1
Heat No. 1					
Segment no.	1	2	3	4	5
Clock time	10:05 AM	10:10 AM	10:15 AM	10:20 AM	10:25 AM
Elapsed time: minutes	0:00:00	0:05:00	0:10:00	0:15:00	0:20:00
Elapsed time - hours	-	0.083	0.167	0.250	0.333
EAF off-gas temp Deg. F.	1440	1537	1333	1535	1594
EAF off-Gas volume flow rate acfh	7,491,295	9,946,110	9,378,111	9,481,778	9,357,497
Ex. Gas volume flow rate scfm	34,171	43,165	45,330	41,191	39,483
O2 % by volume (wet analysis)	1.21%	0.01%	10.88%	0.01%	0.03%
CO % by volume (wet analysis)	0.20%	3.30%	0.14%	12.12%	4.89%
H2 % by volume (wet analysis)	1.61%	1.86%	0.23%	7.46%	0.76%
CO2 % by volume (wet analysis)	0.32%	11.70%	0.61%	11.15%	13.37%
H2O % by volume	0.00%	0.00%	0.00%	0.00%	0.00%
CH4 and other combustibles % by volume	0.10%	0.11%	0.05%	0.38%	0.11%

Complete heat cycle 5-minute interval

The model calculates sensible and chemical heat contained in the off-gases, values of steam generation for a given pressure and superheat temperature, and electrical power generation at every time interval. Owing to large variations in gas flow and heat content, power generation varies considerably from one time segment to another. To calculate overall power production potential, an auxiliary fuel such as natural gas is used to maintain constant power production. In this case, the auxiliary fuel is used to deliver the peak power production rate. This requires a large amount of auxiliary heat that is calculated and reported in the results. For all practical purposes, this type of arrangement may not be possible and economically justifiable unless the auxiliary fuel is easily available in the required amount and relatively low in cost. These results are to be used only as a first step in evaluating the potential for power production using off-gas heat. The next step in the performance model uses a more realistic approach that allows the user to select the amount of steam and electrical power production.

Table 2 - Parameters used for economic calculations

Operating parameters		
Total heat or cycle time	60.00	Minutes
EAF batch or heat weight	100.00	tons/heat
Scrap charge - heating rate	100.00	tons/hour
Reference temperature	Deg. F.	60
Air temp for comb and gas cooling air	Deg. F.	80

Parameters used for overall performance analysis		
Air temp ambient and cooling air	Deg. F.	80
Percent of heat loss for EAF exhaust gases before approaching heat recovery system.	%	10%
Heat to power conversion efficiency (overall)	%	25%
Desired or expected exhaust gas temperature from the system	Deg. F.	350
Heating value of natural gas	Btu/scf	1020

Economic analysis parameters		
Purchased electricity cost incl. all charges	$/kwh	$0.08
Natural gas (fuel) cost	$/MM Btu	$4.84
Credit for steam used in the plant	$/1000 lb. steam	$8.00
Allowance for maintenance and operating cost (added cost associated with WHR system operations)	% of cost savings	20%
Number of heats per year	No.	8,000
Cost basis for the system	$/kW produced	$ 2,000.00
Cost basis for scrap preheater - Baseline for 100 tons/hour charge rate ($cap cost)	$/100 tons of scrap charged	$ 10,000,000

The detailed Regenerative Drop-out Box System Model includes a heat storage and recovery system that dampens the fluctuations in the heat capacity of the off-gas heat and thus reduces the use of auxiliary fuel to produce stream and electrical power. The system offers two options:

1. In option one, off-gases are processed to use the chemical heat of the gases under controlled combustion and then used in a steam generator to produce steam. The steam can be used as process steam in the plant and/or used to generate electrical power using a steam turbine generator system.
2. Option two includes a scrap preheater in which the heat of off-gases at a controlled temperature is used to preheat scrap charged in the EAF. Gases from the scrap preheater are used in a steam generator to produce steam for use in the plant and/or to generate electrical power.

In both cases the regenerative drop-out box is used to completely oxidize the combustible components (CO and H_2) of the EAF off-gases and produce hot gases at a constant temperature.

Figure 7 provides a general list of the data required for the detailed model. Tables 2–4 gives examples of specific data used for the calculations discussed in this paper. Table 2 shows parameters used for economic calculations for the system. Table 3 lists design parameters used to design the steam generator and scrap preheater. Table 4 shows the regenerator design parameters.

Table 3 – Steam generator and scrap preheater design parameters

Heat recovery system design parameters - Regenerator System		
Steam generator (HRSG) design parameters		
Required (desired) steam production	lbs./hr	100,000
Required steam pressure	Psig	800
Required steam temperature	Deg. F.	700
Feedwater temperature to steam generator - boiler	Deg. F.	200
Heat loss in HRSG (% of heat input)	%	10%
Desired - design temp. for gases going to boiler	Deg. F.	1,600
Steam generator (HRSG) efficiency	%	75%
Steam used in the plant	lbs./hr	0
Steam power generation efficiency (excluding boiler efficiency)	%	33%
Boiler blow down loss as % of steam production	%	7%
Scrap preheater design parameters		
Scrap charge rate	tons/hr.	100
Scrap Inlet Temperature	Deg. F.	80
Scrap specific heat - average	Btu/(lb. - F)	0.135
Preheater Control Temperature	Deg. F.	1,700
Efficiency of EAF in transfer of electricity	%	50%
Fraction of regen preheated air used	%	100%
Scrap - assumed plate thickness	inch	0.75
Scrap material density	lbs./ft^3	480
Overall heat transfer coefficient	Btu/(hr. ft^2.	3.0

Table 4 – Regenerator design parameters

Regenerator (for each of the two sides) design parameters		
Sp. Heat of brick material	Btu/(lb. F)	0.225
Brick width	inch	4.50
Brick Thickness	inch	2.50
Brick Length	inch	9.00
Volume of the brick	ft^3	0.0586
Sp. Weight of the material	#s/ft^3	125.00
Weight per brick/piece	Lbs.	7.32
Surface area per brick	ft^2/brick	1.03
Exposure	%	90%
Ratio of surface area/volume for regen	ft^2/ft^3	6.00
Height/width ratio		4.00
width/length ratio		2.50
Total weight of the bricks	#s	200,000
Heat loss from the regen system incl. ducts	% of total	3.0%
Allowable mix temp in regen	Deg. F.	3,000
Heat transfer coeff	Btu/(hr-F-ft^2)	5
Required Preheated Air Flow From Regenerator	scfm	10,000
Maximum allowable regen material temperature	Deg. F.	2,500
Start temp for regen material (approximate to start calculations)	Deg. F.	1,435
ID Fan Control Temp	Deg. F.	1,700
Cycle time	Minutes	5

The analysis methodology includes the following steps.

1. Controlled combustion using appropriate amounts of combustion air and cooling air to control off-gas temperature at a predetermined value in a drop-out box. The analysis includes calculation of the required combustion air for combustible gases such as CO, H_2, and hydrocarbons and cooling air to bring the off-gas mixture to a desired temperature. Use of advanced ceramic and refractory materials would allow this temperature to be at a predetermined high value, typically a maximum of 2500°F.
2. Analysis of heat transfer in a regenerative heat exchanger system. The system includes two regenerative beds in which heat is transferred to and from the regenerator bed during heating and cooling cycles. Using design data for a regenerator bed, calculations are made of the heat transferred to a bed and the drop in off-gas temperature during a heating cycle. The regenerator bed provides a flywheel effect to reduce variations in the heat content of off-gases, since a percentage of the heat is transferred to and stored in the regenerator bed. Timing of the heating cycle depends on the regenerator size, type of material used, and other design parameters of the bed. In the calculations used in this paper, a heating cycle time of 5 minutes was assumed. During the cooling cycle, ambient air is used to cool the regenerator bed. The primary goal of the cooling cycle is to absorb as much heat as possible and cool the bed so that heat can be stored in the bed again during the heating cycle. The cooling air volume is controlled to achieve a desired exit air temperature. Heated air can be mixed with the off-gases discharged from the bed that is being heated or can be used in a steam generator. This air is used for combustion of auxiliary fuel and as a heat source for the steam generator.
3. The scrap preheater performance, when it is used, includes calculation of the average temperature of the scrap and of the exhaust gases from the scrap preheater. Hot gases from the regenerator bed and all or some portion of the regenerator cooling air are directed to the scrap preheater. The gas temperature entering the scrap preheater is controlled to a desired value between 1400 and 1600°F. Control of the temperature of the heating gases makes it possible to use convection heating and pass hot gases through the scrap bed. This is somewhat different from the commonly used heating system in which radiation is the main heat transfer mechanism. Convection heating allows more uniform heating and thus a substantial increase in the heat content of the preheated scrap. A forced-draft or an induced-draft fan can be used to provide sufficient gas velocity and overcome the pressure drop throughout the bed. The calculations are carried out by treating the

scrap preheater as a counter flow heat exchanger. It is also possible to account for any additional heat generated within the scrap preheater due to the presence of combustible materials, such as oil, in the scrap. Exhaust gases from the scrap preheater are taken to a steam generator to recover the remaining heat.

4. A heat recovery steam generator (HRSG) is included in the system to recover heat from hot gases from the regenerator and/or the scrap preheater and from heated cooling air from the regenerator bed. Calculations for steam generation are based on the practical value of the HRSG efficiency and specifications of steam pressure and temperature. The model does not include detailed calculations for HRSG design. Since the heat content of gases (temperature and mass flow rate) changes during a heat in an EAF, it is necessary to use an auxiliary heating source, such as natural gas, to maintain the required level of steam production. The model calculates the auxiliary heat required. In most cases, use of a duct burner may be adequate to provide the necessary heat, since the gases entering the HRSG contain enough air for combustion of an auxiliary fuel such as natural gas. However, the calculations include a check on the availability of enough oxygen for combustion of fuel and other combustibles in the hot gases. For the calculations presented in this paper, it is assumed that steam is delivered at 800 psig and 700°F; HRSG efficiency is assumed to be 75%. Steam can be used in the plant as process steam or to produce electricity generation using a steam turbine generator system. It is possible to specify and limit steam generation to a certain value, which is less than the steam generation at peak conditions when the amount of heat entering the HRSG is highest.
5. Potential electricity production using a steam turbine generator system is calculated by using the heat content of the steam used for the turbines. The calculations use a value of overall efficiency of electricity generation using a conventional turbine generator system. For the calculations in this paper, the conversion efficiency is 33% and does not include HRSG efficiency. The overall efficiency of the steam generator and electricity production is 24.75%, which is practically same as the value used for overall performance calculations discussed earlier.
6. Preliminary economic calculations use the energy cost and operating practices for the EAF. The calculations include credit for production of steam used in the plant, electricity produced, and reduction in energy use (mostly electricity) and related cost savings due to scrap preheating. No credit is taken for possible reduction in EAF heat time and increased production, since it depends on business conditions. Allowance is made for operating and maintenance cost as a percentage of the total savings. No attempt is made to calculate the project cost and hence the payback period. However, provision is made to enter user-defined capital costs and the resultant payback period.

The modeling results are reported on a separate page that includes user-defined values of economic and technical performance parameters. Table 5 shows typical results for a regenerative drop-out box system without a scrap preheater.

During the testing phase of the model, an attempt was made to calculate the payback period using very preliminary capital costs. The capital cost values could be debated since they are based on costs available in the literature for electrical power production and scrap preheating systems. The cost of the drop-box regenerator system was estimated based on the past experience of the team members. Using a capital cost of $2,500/kW installed capacity, an attempt was made to estimate total project cost and potential payback. However the numbers are very preliminary and should not be considered representative.

Table 5 – Typical performance results for regenerative drop-out box WHR system without scrap preheater

RESULTS - Regenerator System		
Performance Results	**Without Use of a Scrap Preheater**	
See attached diagram for values of critical parameters for the system		
Average scrap temperature to the EAF	Deg. F.	N/A
Steam generated (average value)	Lbs./hr.	100,000
Steam used (exported) in the plant	Lbs./hr.	0
Electrical power generated (average value)	MW for the heat	11.301
Total electricity produced per heat	kwh per heat	11,301
Electricity savings due to scrap preheating	kwh per heat	0
Total electricity credit per heat	kwh per heat	11,301
Exhaust gas temperature at HRSG exit	Deg. F.	465
Preliminary cost parameters		
Credit for plant process steam	$/1000 lbs.	$8.00
Cost of natural gas	$/MM Btu	$4.84
Credit for incremental electricity	$/kwh	$0.08
No. of heats per year	No.	8,000
Natural gas consumption (average value)	MM Btu/heat.	17.42
Results - Savings and energy Use		
Maximum N. gas demand during a heat	MM Btu/hr.	62.10
Value of electricity produced	$/year	$7,232,842
Electricity cost savings related to scrap preheating	$/year	$0
Value of (credit for) steam used in the plant	$/year	$0
Cost of natural gas (fuel) used for the HR system	$/year	$838,780
Net savings	$/year	$6,394,062
Allowance for O&M cost	% of net savings	20%
O&M cost per year for the HR system	$/year	$1,278,812
Net cost savings per year	$/year	$5,115,250

Table 6 shows the system performance when a scrap preheater is used as an integral part of the heat recovery system.

In addition to the overall performance, the model also gives the flow rates and temperatures of various streams within the system at selected times. Figure 8 shows the locations of various streams numbered from 1 to 19. The model calculates these values at each time increment and allows the user to see their values at the user-selected time in the cycle.
An example in Table 7 shows the flow rate and temperature of the most important flow streams at midpoint in the cycle (10:25:00 a.m.).

The results of the analysis of two cases, one with and one without a scrap preheater, clearly show that using a scrap preheating system as an integral part of the overall WHR system offers relatively large savings. The savings do not include the potential benefits of a shorter heating time and an increased production rate.

Table 6 – Typical performance results for regenerative drop-out box WHR system – with scrap preheater

RESULTS - Regenerator System

Performance Results		With Use of a Scrap Preheater
See attached diagram for values of critical parameters for the system		
Average scrap temperature to the EAF	Deg. F.	1,248
Steam generated (average value)	Lbs./hr.	100,000
Steam used (exported) in the plant	Lbs./hr.	0
Electrical power generated (average value)	MW for the heat	11.301
Total electricity produced per heat	kwh per heat	11,301
Electricity savings due to scrap preheating	kwh per heat	22,664
Total electricity credit per heat	kwh per heat	33,965
Exhaust gas temperature at HRSG exit	Deg. F.	459
Preliminary cost parameters		
Credit for plant process steam	$/1000 lbs.	$8.00
Cost of natural gas	$/MM Btu	$4.84
Credit for incremental electricity	$/kwh	$0.08
No. of heats per year	No.	8,000
Natural gas consumption (average value)	MM Btu/heat.	21.22
Results - Savings and energy Use		
Maximum N. gas demand during a heat	MM Btu/hr.	75.55
Value of electricity produced	$/year	$7,232,842
Electricity cost savings related to scrap preheating	$/year	$14,504,963
Value of (credit for) steam used in the plant	$/year	$0
Cost of natural gas (fuel) used for the HR system	$/year	$985,824
Net savings	$/year	$20,751,982
Allowance for O&M cost	% of net savings	20%
O&M cost per year for the HR system	$/year	$4,150,396
Net cost savings per year	$/year	$16,601,585

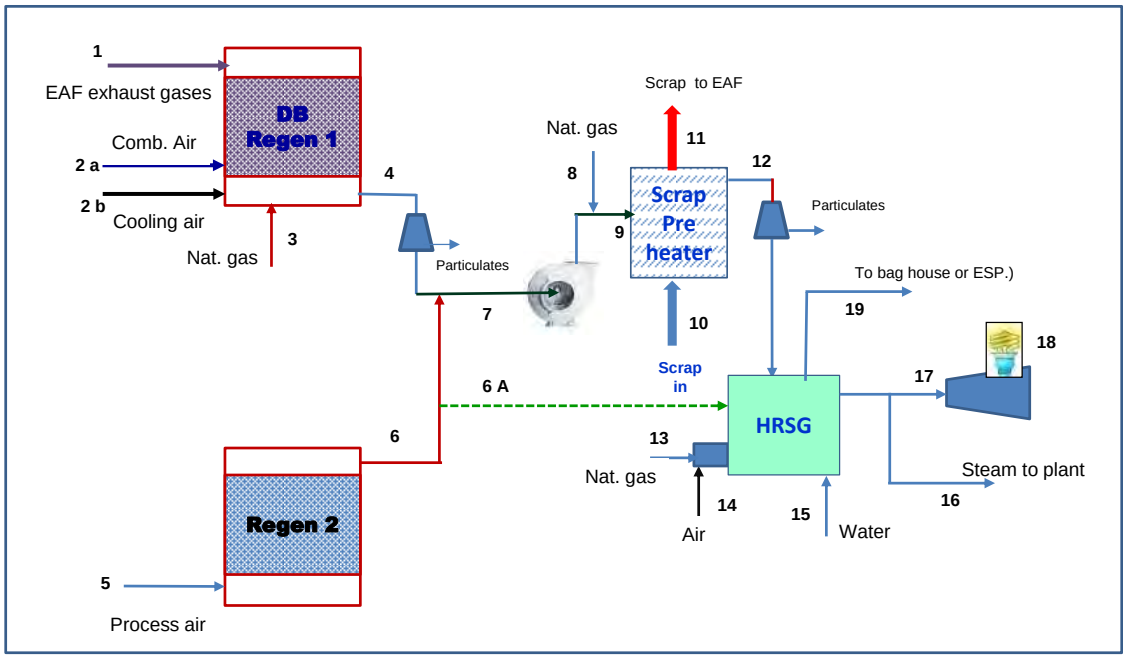

Figure 8 – Regenerative drop-out box heat recovery system—locations of various streams.

Table 7 – Flow and temperature of the most important flow streams at midpoint in the cycle (at 10: 25:00 AM)

Performance Parameters Table - Regenerator WHR System			
Time	Hours	10:25:00 AM	
Process parameter	No.	Flow rate	Temperature
		scfm or Lbs./hr.	Deg. F.
EAF exhaust gas	1	77,522	1,120
Combustion air to the regen unit	2 a	1,270	80
Cooling air to the regen unit	2 b	0	80
Natural gas to the regen unit	3	0	
Exhaust gases to scrap preheater	4	78,791	1,488
Cold air to the regenerator	5	10,000	100
Hot air from regen to scrap preheater	6	10,000	1,752
Hot air from regen to steam generator	6A	10,000	1,752
Total exhaust gases to scrap preheater	7	88,791	1,518
Natural gas added to scrap preheater	8	324	
Heating gases entering to scrap preheater	9	89,109	1,700
Scrap entering to preheater	10	200,000	80
Preheated scrap leaving scrap preheater	11	200,000	1,238
Exhaust Gases leaving scrap preheater	12	88,791	1,408
Natural gas to HRSG (boiler)	13	81	80
Combustion air to HRSG (boiler)	14	0	80
Feed water entering HRSG (boiler)	15	107,000	80
Mass flow of Steam Produced		64,015	
Steam to the plant	16	0	
Steam to the steam turbine	17	64,015	
Electric power	18	11.30	
Exhaust gases from HRSG (boiler)	19	57,176	392

The model is not designed to perform payback analysis, since it is difficult to obtain information on capital and installation costs for the system at any location. However, an attempt was made to obtain a very preliminary possible payback period for the location where the data were collected that were used in the calculations in this paper. Based on preliminary numbers, as shown in Table 8, the payback period can be as low as 1.5 years when the system includes a scrap preheater as part of the WHR system. These values are preliminary and should not be used to make firm conclusions about the justification for such a system.

Table 8 – Preliminary payback analysis

Simple payback - Based on prelimnary cost figures		
Estimated cost of the system	$	$32,602,631
Net credit or revenue	$/year	$16,601,585
Simple payback period	Years	1.96

USE OF THE MODEL

The primary objective of the development of the EAF enthalpy model is to enable EAF users to analyze the potential for steam and electrical power generation based on information obtained regarding off-gas composition and temperature. Since EAF steelmaking is a batch process in which off-gas composition and temperature vary continuously during a heating cycle, it is difficult to estimate the average and total values of recoverable heat wasted by the EAF. Use of this model allows users to estimate the peak values of waste heat, as well as potential for steam and/or electrical power generation. It also allows them to estimate the auxiliary heat required to maintain peak power production and the desired level of steam and electrical power production. Used for a case in which scrap is preheated using waste heat, the model enables the user to calculate the scrap preheat temperature and possible savings in electricity for charging hot scrap in the EAF. It is possible to define the temperatures of hot gases entering the scrap preheater to estimate the maximum temperature of scrap charged in the EAF.

In discussions of the results of the model with managers of the plant where the EAF was located, it became clear that many plant personnel do not realize the potential for generating steam and producing electrical power using EAF off-gas waste heat. With a proper WHR system and auxiliary heat from natural gas or other sources in a steam generator, it is possible to generate a large percentage of the total electrical power used in an EAF plant.

The most important requirement for using the model is to supply accurate data for off-gas analysis, primarily the levels of CO, H_2, and other combustibles along with the off-gas temperature and flow rate. Currently available off-gas monitoring systems promoted for the control of EAF operation can be used to provide inputs for this model.

FUTURE WORK

The enthalpy model is based on currently available information for the performance of regenerators and scrap preheaters. At this time, the project team continues to work with equipment suppliers and the steel industry to modify the model as more information is made available. In its current form, the model has been very useful in making industry personnel aware of the potential for WHR from EAF off-gases and the potential returns from a WHR system. The model will be modified to allow for industry requirements and additional information on materials and design.

CONCLUSION

A simple Excel-based model was developed to evaluate the recovery of chemical and sensible heat from EAF off-gases. The model can be populated with EAF off-gas data collected by commercially available off-gas monitoring systems. Such systems provide an off-gas analysis in terms of combustible gases such as CO, H_2, CH_4, and noncombustible gases such as O_2 and H_2O, along with off-gas flow rate and temperature data at or very near the EAF off-gas outlet. The model can be used to estimate scrap preheat temperature, steam generation, and electrical power generation using data taken at small time increments to allow for large variations in all the parameters. The calculations can be made at a high level when the WHR system performance is calculated at a high level, independent of the type of WHR system used. It can also be used to model a regenerative drop-out box WHR system being developed at ORNL. The model results give energy savings, scrap temperature at the outlet of a scrap preheater, possible steam generation, and electrical power production. It also estimates the economic benefits in terms of annual dollar savings for a given set of operating conditions. The research team has run this model using data obtained from a number of steel companies and is continuing to modify it as more data and component performance information become available.

ACKNOWLEDGMENTS

This work was supported by the US Department of Energy's Advanced Manufacturing office (AMO) under contract number FWP No. CEED 210, Project 19864, Agreement 19128. We acknowledge the technical support and guidance provided by Toledo Engineering Company, Steel Dynamics, Inc., Gerdau Knoxville Steel Mill, and ArcelorMittal Steel Company.

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Annexure IV- Conversion Factors and Emission factors

A Conversion Factors used;

1. MMBTU per short Ton = 278x10 (-)^{6}Kcal/Kg
2. One BTU= 252 Calorie
3. One Calorie= 4.184 Joules

B. GHG emissions during Transportation by

a) Employees Travel by two wheelers;
   i. CO_2 - 0.11 gms/km
   ii. CH_4 - 0.005 gms/km
   iii. N2O- 0.0005 gms/km
b) Material Transport by Trucks of 20 T capacity
   i. CO_2- 0.90 gms/km
   ii. CH_4 -0.009 gms/km
   iii. N2O- 0.006 gms/km

C. Emission Factors tCO_2/t of material

1. Anthracite-2.86
2. Indian Coal- 1.84
3. Imported Coal-2.20
4. Coke- 3.10
5. Lime Stone - 0.44
6. Dolomite-0.47
7. Electrode Paste- 2.07
8. Slag- 0.56

D. GHG Credits from use of: tCO_2/t

a) Iron ore tailings in Cement making- 0.56
b) Fly ash in Cement making- 0.56
c) EAF slag in Cement making-0.56
d) WHR from EAF flue gases- 113 kwh /t steel

E. Emission factors for Different Fuels

S.No	Parameter	Value	Unit	Remarks/Source
1	CO_2 emission factor of diesel	74.1	tCO_2/TJ	IPCC 2006 Guidelines for National Greenhouse Gas Inventories, 2006 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html), Table 1.4 - Default CO_2 emission factors for combustion
2	CH_4 Default emissions for diesel	3	$kgCO_2/TJ$	IPCC 2006 Guidelines for National Greenhouse Gas Inventories, 2006 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html) Table 2.2 - Default emission factors for stationarycombustion in the energy industry
3	N_2O Default emissions for diesel	0.6	$kgCO_2/TJ$	IPCC 2006 Guidelines for National Greenhouse Gas Inventories, 2006 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html) Table 2.2 - Default emission factors for stationarycombustion in the energy industry
4	Effective CO_2 emission factors in coal	95.8	tCO_2/TJ	CEA Baseline CO_2 database for Indian Power Sector (http://cea.nic.in/reports/others/thermal/tpece/cdm_co2/user_guide_ver10.pdf)
5	CH_4 Default emissions for coal	1	$kgCO_2/TJ$	IPCC 2006 Guidelines for National Greenhouse Gas Inventories, 2006 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html) Table 2.2 - Default emission factors for stationarycombustion in the energy industry

6	N_2O emission factor for coal	1.5	$kgCO_2/TJ$	IPCC 2006 Guidelines for National Greenhouse Gas Inventories, 2006 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html) Table 2.2 - Default emission factors for stationary combustion in the energy industry
7	CO_2 emission factor in Natural Gas	56.1	tCO_2/TJ	IPCC 2006 Guidelines for National Greenhouse GasInventories, 2006 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html) Table 1.4 - Default CO_2 emission factors for combustion
8	CH_4 Default Emission for NaturalGas	1	$kgCO_2/TJ$	IPCC 2006 Guidelines for National Greenhouse Gas Inventories, 2006 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html) Table 2.2 - Default emission factors for stationarycombustion in the energy industry
9	N_2O emission factors for Natural Gas	0.1	$kgCO_2/TJ$	IPCC 2006 Guidelines for National Greenhouse Gas Inventories, 2006 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html) Table 2.2 - Default emission factors for stationarycombustion in the energy industry

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GREEN BELT DEVELOPMENT

The greenbelt shall be developed simultaneously with the plant construction. This will further mitigate the pollution impacts. **It has been proposed to develop minimum of 10 meters wide green belt along the periphery inside the factory premises.**

Greenbelt plantation

Greenbelt will be developed in a set of rows of trees planted in such a way that they form an effective barrier between the plant and the surroundings. The main purpose of greenbelt development is to contribute to the following factors.

- To maintain the ecological homeostatus.
- To attenuate the air emissions from the kiln and the fugitive dust emissions.
- To prevent the soil erosion.
- To attenuate the noise levels.

Plantation of grass, flowers, bushes and trees will be taken up to reduce the generation of dust from the bare earth and to enhance the aesthetic value.

Plantation species

Plantation species will be considered based on the following.

- Suitable to the Geo-climatic conditions of the area.
- Mix of round, spreading, oblong and conical canopies.
- Ever green trees.
- Different heights ranging from 4m to 20m.

Plantation for arresting dust

Trees particularly having compact branching closely arranged leaves of simple elliptical and hairy structure, shiny or waxy leaves and hairy twigs are efficient filters of dust. The following species are suggested to arrest the dust:-

- *AlstoniaScholaris*
- *Bauhinia purpurea*
- *Cassiasiamea*
- *Peltoferrumferrugineum*
- *Butea monosperma*
- *Tamarindus indica*
- *Azadirachta indica*

Plantation to absorb SO_2 emissions

The following plants are suggested for plantation to absorb SO_2 in the air.

- *Azadirachta indica*
- *Albizia lebbeck*
- *Alstoniascholaris*
- *Lagerstroemia flosregineae*
- *Melia azedarach*
- *Minusopselangi*
- Poloyalthialongifloia

Plantation to reduce noise pollution

Trees having thick and flushy leaves with petioles are suitable. Heavier branches and trunks of trees also deflect the sound waves. The following plant species are suggested to reduce noise pollution.

- *Alstoniascholaris*
- *Azadirachta indica*
- *Melia monosperma*
- *Grevilleaperidifolia*
- *Tamarindus indica*

Plantation along the roads (Avenue plantation)

- *Alstoniascholaris*
- *Cassia fistula*
- *Bauhinia purpurea*
- *Mimusopselangi*
- *Pongamiapinnata*
- *Polyalthialongifolia*
- *Poluferrumferrugineum*
- *Lagerstroemia flosreginea*
- *Cassia siamea*

GREENBELT DEVELOPMENT PLAN

- **80.94 Ha. (200 Acres)** of Greenbelt will be developed within the project site.
- It is proposed to cut 470 nos. of trees as part of proposed project. Tree Cutting Permission has been obtained from Forest Department, Raghunathpur Range, Kangsabati North Division.
- Compensatory afforestation will be taken up @ 5 trees/plant is 2,350 nos. within the project site premises, which accounts to 1.0 Ha. additional Greenbelt.
- Hence the Total Greenbelt will be 81.94 Ha. (202.5 Acres).
- SSWPL will take-up extensive green belt development by planting about 2500 trees per Ha. as per CPCB norms.
- **10 m wide plantation will be taken up on either side of the water stream that is passing through the site.**
- **30 m green belt will be developed inside the project area towards the villages namely Maharajnagar (0.02 Kms), Lachhmanpur (0. 03 kms), Shikratyar (0.06 Kms) and Digardhi (0.05 kms).**
- **Unnamed stream is passing along the South West Boundary toward north direction approaching Panchet Reservoir. The existing hydrological pattern of the stream will not be disturbed. Where ever crossing of stream is required culverts will be constructed.** ***Landscaping will be done on both sides of Stream along with measures for soil stabilization including development of lawns with shrubs with 10 m width. Moreover, no process activity is proposed on the side of the stream and same will be utilised for greenbelt & other non-process activity.***
- The tree species to be selected for the plantation are pollutant tolerant, fast growing, wind firm, deep rooted. A three-tier plantation is proposed comprising of an outer most belt of taller trees which will act as barrier, middle core acting as air cleaner and the innermost core which may be termed as absorptive layer consisting of trees which are known to be particularly tolerant to pollutants.
- Local DFO will be consulted in developing the green belt.

Scheme for Landscaping on both sides of Seasonal Stream flowing across the project site

Making use of the soil extracted from the construction site, 10 m wide bund shall be laid along the sides of the nala. The soil shall be consolidated with a retaining Rockwall on the nala side. On the 5 m side, a 2 m wide walking, jogging track shall be made in the center. Along the shoulders and along the sides of the track, soil binding perennial grasses such as the Buffalo grass (*Stenotaphrumsecundatum*) and or broadleaf Carpet grass (*Axonopuscompressus*) shall be grown. One row of dwarf date palms (*Phoenix acaulis*) shall be planted at a distance of 3 m along the slope of the bund. Dwarf date palms are chosen because they are common in the local forest areas; drought and disease resistant; slow growing and non-shedding soil binders. They also improve the aesthetics. Towards the nala side, one row of Bamboo Palms (*Chamaedoreaseifrizii*) shall be grown. On the opposite side, Buffalo grass (*Stenotaphrumsecundatum*) and or broadleaf Carpet grass (*Axonopuscompressus*) shall be grown. False Sago Palm (*Cycas revoluta*) and other ornamental shrubs shall also be planted within the lawn.

Table No. 10.3.16:

List of Plants suggested for Greenbelt, avenue plantation & landscaping of Stream banks

Scientific name	Common name	Purpose
Albizia lebbeck	Siris	Multipurpose
Anthocephaluscadamba	Cadamb	Multipurpose
Conocarpuslancifolius	Gulf tree	Highly suitable
Dendrocalmusstrictus	Bamboo	Bamboo
Ficus benjamina	Weeping fig	Boundary plantation
Leucaena leucocephala	Subabul	Fodder legume - Greenbelt
Madhuca longifolia	Mahua	Multipurpose
Mangifera indica	Mango / Aam	Fruit tree
Melia azadirachta	Neem	Multipurpose
Melia dubia	Malabar neem	Timber tree -Greenbelt
Phoenix sylvestris	Wild date palm	Multipurpose
Samanea saman	Rain tree	Multipurpose
Swietenia macrophylla	Broad-leaf Mahogany	Timber tree -Greenbelt
Syzygiumcumini	Jamun	Fruit tree
Terminalia catappa	Almond / Badam	Multipurpose
Stylosantheshamta	Hamata grass for ground cover	Nitrogen fixing fodder legume
Stenotaphrumsecundatum	Buffalo grass	Soil binder for control of soil erosion
Axonopuscompressus	Broad-leaf carpet grass	Carpet grass
Cycas revoluta	False Sago Palm	Soil binding ornamental
Phoenix acaulis	Dwarf Date Palm	Soil binding ornamental

Chamaedoreaseifrizii	Bamboo Palm	Soil binding ornamental

भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन नदी विकास एवं गंगा संरक्षण विभाग
केंद्रीय जल आयोग
दामोदर घाटी जलाशय नियंत्रण यूनिट
मैथन, धनबाद (झारखण्ड)

सत्यमेव जयते

Government of India
Ministry of Jal Shakti
Dept. of Water Resources, RD&GR
Central Water Commission
Damodar Valley Reservoir Regulation Unit
Maithon, Dhanbad (Jharkhand)

No. MD/DVRR/W-6(145)/2022/ 744-48

Date: 20.12.2022

To,

The General Manager (Commercial),
Shyam Steel Works Pvt. Ltd.,
Shyam tower, EN-32, Sector – V,
Salt lake, Kolkata - 700091 (WB)

Sub :- Concurrence for drawl of 6 MGD (27300 m^3 per day) - Phase wise of raw water from Panchet Reservoir for proposed Integrated Steel Plant at Parcel - II of Jungal Sundari Karmanagari (JSK) Project, Raghunathpur- 1, Dist.- Purulia (WB) of Shyam Steel works PVT. Ltd.:- reg.

Ref : (1) Your application No. SSWPL/2022-23/GM/18 dt. 25.05.2022.
(2) GoWB letter No.- WBIDC/DVRRC/08-09/814 dt. 14.07.2022.
(3) DVRRC letter No.- MD/DVRR/W-6/145/2022/718-37 dt. 16.12.2022.

Sir,

Please refer the letter under reference (i) vide which request was made for allocation of 6 MGD –Phase-wise (Initial- 2 MGD, Intermediate at the end of 2026 – 4 MGD and Final at the end of 2029 – 6 MGD) of raw water from Panchet reservoir for Integrated steel Plant at Parcel - II of Jungal Sundari Karmanagari (JSK) Project, Raghunathpur- 1, Dist.- Purulia (WB) of Shyam Steel works Pvt. Ltd. NOC was also obtained from the Executive Director, WBDIC vide letter under reference (ii). On the recommendation of the 29th Sub-Committee of DVRRC, the case was submitted for consideration in 145th meeting of DVRR Committee held on 24.11.2022 at Ranchi and was accepted. The minutes of the 145th DVRRC meeting has already been circulated to the concerned officials vide letter under reference (iii). The concurrence of DVRRC for allocation of 6 MGD (Phase-wise as above) of raw water is hereby conveyed for drawl from Panchet Reservoir (Damodar River) is subject to the following conditions:

(A) Exact location for drawl of water may be decided in consultation with DVC. The water shall be drawn from the reservoir as and when available and intake structure/conveyance system should be designed accordingly. As sufficient water in the reservoir may not be available during certain days in the year particularly during summer months, you may have to make arrangement for captive storage to meet water requirement in such situations.

(B) Adequate care should be taken in design and construction of the intake structure to ensure availability of water even during summer months. The intake structure should also be able to withstand the high levels in the river.

(C) The sourcing point and concurrence of water drawl (6 MGD) is project specific. The water drawn shall, in no way be utilized by the firm for any other purposes.

(D) You shall have to execute an agreement with DVC and pay charges to DVC for the water drawn by you as per the terms and conditions in force. The allocation will come into effect from the day of execution of the agreement with DVC. The allocation of water will be treated as cancelled, if your office does not apply to DVC for executing an agreement for drawl of water within a period of 3 (three) months from the date of issue of this letter.

(E) Drawl of water should start within 24 months from the date of issue of this letter. In case of non drawl after lapse of 24 months from the date of issue of this letter, the allocation shall deemed to be cancelled and the firm will have to apply a fresh for revalidation of allocation.

The present allocation is temporarily allocated subject to fulfilment of all the primary formalities within the stipulated time period.

Yours faithfully

(Shashi Rakesh)
Member Secretary, DVRRC

Copy to the:

1. Chief Engineer (West), I & WD, Govt. of W.B., Kanainatsal, Sripally, Paschim Bardhaman, W.B. 713103.
2. Executive Director,West Bengal Industrial Development Corporation, Protiti, 23 Abnindranath Tagore Sarani, Kolkata 700016.
3. Excutive Director (Civil) & H.O.P, Damodar Valley Corporation, Maithon.
4. Manager, Reservoir Operation, DVC, Maithon.

एरिया नंबर 2
मैथन डैम - ८२८२०७
दूरभाष: ०६५४०-२७४२१४ ,
ई मेल: sehocmaithon-cwc@gov.in
♦जल संरक्षण-सुरक्षित भविष्य♦

Area No 2,
Maithon Dam-828207
Tel: 06540-274214
E-mail: sehocmaithon-cwc@gov.in
♦Conserve Water- Save Life♦

Annexure-4

Damodar Valley Corporation
Office of the Manager Reservoir Operations
Maithan Dam, Dhanbad
Jharkhand-828 207
Phone : 06540 279445

No.: MRO/Tariff Cell/ SSWPL / 318 Dated- 18-04-2023

To
The Authorized Signatory,
BIPUL PANIGRAHI
SHYAM STEEL WORKS PVT. LTD.
PREMISES NO.-03-319, DH6/11, RAJARHAT, STREET NO-319, ACTION AREA -1D, NEW TOWN, DISTRICT- NORTH 24 PARGANAS, KOLKATA-700 156, WEST BENGAL

Sub.: Execution of Agreement for Water withdrawal of 6.0 (Six Point Zero) MGD (Initial- 2 MGD, Intermediate at end of 2026- 4MGD and Final at the end of 2029 - 6 MGD) of Raw Water for M/S SHYAM STEEL WORKS PVT. LTD., Premises No.-03-319, Dh6/11, Rajarhat, Street No-319, Action Area -1D, New Town, District- North 24 Parganas, Kolkata-700 156, West Bengal

Dear Sir,

Enclosed, please find here with a copy of the Agreement for drawal of 6.0 (Six Point Zero) MGD (Initial- 2 MGD, Intermediate at end of 2026- 4MGD and Final at the end of 2029 - 6 MGD) of Raw Water for SHYAM STEEL WORKS PVT. LTD., on 18-April-2023 for your record.

Yours faithfully,
Rakesh Ranjan 18/04/23
(Rakesh Ranjan)
Sr. Divisional Engineer (Civil),
Tariff Cell, MRO'S Office, DVC, Maithon

Dated. 18-04-2023

NRIEMT- 12/2022-2023

A REPORT ON "THE STUDY OF RAIN WATER HARVESTING SCHEME FROM STORM WATER DRAINAGE / RUN OFF WATER" OF THE PROPOSED PROJECT WITHIN THE CAMPUS OF SHYAM STEEL WORKS PRIVATE LTD. AT JANGAL SUNDARI KARMANAGARI PARCEL II, RAGHUNATHPUR, PURULIA DISTRICT, WEST BENGAL"

Care for Environment

Prepared by:

NATURAL RESOURCES INVESTIGATION, EVALUATION & MANAGEMENT TECHNOLOGIES (NRIEMT), KOLKATA, INDIA, NOVEMBER, 2022

NRIEMT- 12/2022-2023

A REPORT ON "THE STUDY OF RAIN WATER HARVESTING SCHEME FROM STORM WATER DRAINAGE / RUN OFF WATER" OF THE PROPOSED PROJECT WITHIN THE CAMPUS OF SHYAM STEEL WORKS PRIVATE LTD. AT JANGAL SUNDARI KARMANAGARI PARCEL II, RAGHUNATHPUR, PURULIA DISTRICT, WEST BENGAL"

Technical and other experts involved:

1. Mr. R. Saha, Chief Technical Director, NRIEMT
2. Mr. Sandip Hazra, M. Tech, Consultant Engineer, NRIEMT.
3. Mr. T. Das, Executive Director (Hydrogeology), NRIEMT
4. Mr. A. Chaudhuri, Executive Director (Hydrogeology), NRIEMT
5. Mr. S. Bhowmik, Executive Director (Hydrogeology), NRIEMT
6. Dr. P. Dasgupta, Executive Director (Hydrogeology), NRIEMT.
7. Dr. R.N. Saha, Executive Director (Hydrogeology), NRIEMT
8. Ms. Sneha Ghosh, Project Scientist, NRIEMT.

Prepared by:

NATURAL RESOURCES INVESTIGATION, EVALUATION & MANAGEMENT TECHNOLOGIES (NRIEMT),KOLKATA, INDIA, NOVEMBER, 2022

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A REPORT ON "THE STUDY OF RAIN WATER HARVESTING SCHEME FROM STORM WATER DRAINAGE / RUN OFF WATER" OF THE PROPOSED PROJECT WITHIN THE CAMPUS OF SHYAM STEEL WORKS PRIVATE LTD. AT JANGAL SUNDARI KARMANAGARI PARCEL II, RAGHUNATHPUR, PURULIA DISTRICT, WEST BENGAL"

INTRODUCTION:

It is a great opportunity that **NATURAL RESOURCES INVESTIGATION, EVALUATION AND MANAGEMENT TECHNOLOGIES (NRIEMT)**, Kolkata, having its office at 190, Mahatma Gandhi Road, P.O. Haridevpur, Kolkata – 700082. West Bengal, India, has been offered by ***SHYAM STEEL WORKS PRIVATE LTD***, having its Corporate office at Shyam Tower, En-32, Salt Lake City, Sector-V, Kolkata-700091, and proposed plant site *at Jangal Sundari Karmanagari Parcel II, Raghunathpur, Purulia District, West Bengal***,** Vide Purchase Order No: 3303000221 P.O. Date: 31. 10. 2022 for carrying out ***"THE STUDY OF RAIN WATER HARVESTING SCHEME FROM STORM WATER DRAINAGE / RUN OFF WATER" OF THE PROPOSED PROJECT WITHIN THE CAMPUS OF SHYAM STEEL WORKS PRIVATE LTD. AT JANGAL SUNDARI KARMANAGARI PARCEL II, RAGHUNATHPUR, PURULIA DISTRICT, WEST BENGAL"*** to know the details of Rainwater Harvesting System covering Storm water drainage system plotted in plant layout, drainage disposal calculation, detail calculations of quantum of water that can be harvested from the storm water etc. etc.

Shyam Steel Works Private ltd. proposes to set up an integrated steel plant (mainly TMT Bar) and a Captive Power Plant at Raghunathpur. As per estimates of M/S. Shyam Steel Works Private Limited, the total requirement of water would be in the tune of ***30743KL/day.*** As such, a dedicated team of well experienced Hydrogeologists and Engineer having more than 43 years of experiences in National and International level projects, with the overall supervision of Mr. R. Saha, Chief Technical Director and Consultant Hydrogeologist, NRIEMT, Kolkata visited several times and carried out the field work and completed the investigational programme and submitted this ***Final Report***.

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SCOPE OF THE WORKS:

1. **Study of different parts of the rain water harvesting system.**
2. **Study of Storm water drainage system to be plotted in Plant Layout.**
3. **Preparation and submission of detailed lay out plan (without Architectural & Structural design) drawing for new storm water drainage system as per project requirement and suitable for construction.**
4. **Calculation of quantum of water that can be harvested from storm water and can be thrown within nearby pond after necessary filtration to avoid any contamination.**

METHODOLOGY:

1. Analyze topography
2. Analyze other site conditions
3. Analyze areas for probable location of drainage structures and facilities.
4. Identify the type and size and integrate with the overall storm water management system and plan.
5. Storm drain systems should have adequate capacity so that they can accommodate runoff that enters the system for the design frequency.
6. Storm drain systems should be designed with future development in mind if it is appropriate.
7. Attention shall be given to the storm drain outfall design to insure that the potential for erosion is minimized.
8. Storm drain placement and capacity should be consistent with local storm water management plans

LOCATION & ACCESSIBILITY::

Purulia district is located on the Eastern slope of the Chhotonagpur plateau forming the south eastern part of the state of West Bengal. Purulia district covers 6259 sq. km. areas with population density 255 per sq. km. approx. The district is sub divided into 20 administrative blocks distributed in 3 sub-divisions. .Asansol – Purulia – Chakradharpur section of the South - Eastern Railway bisect the district NE / SW direction. Purulia town, the district headquarter is connected by State Highway to Dhanbad to the north, Jamshedpur to the south and Ranchi

to the west. The district headquarter is also connected to Kolkata through Asansol and through Bankura and Kharagpur by rail and metal road.

The proposed site area is situated in the North-Eastern part of the district Purulia and it is approximately 10 Km away and NE of Sub-division H.Q. Raghunathpur and 52 Km NE of district H.Q. Purulia and falls within the Survey of India ***Topo Sheet no I / 10***. The Location map of the proposed project area have been shown in **Plate – I.**

PLATE I: MAP SHOWING LOCATION OF THE PROPOSED PROJECT AREA OF M/S. SHYAM STEEL WORKS (P) LTD. AT LACHHMANPUR, P.S. RAGHUNATHPUR, DIST. PURULIA, W.B.

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MOUZA MAP OF THE PROJECT AREA SHYAM STEEL WORKS PRIVATE LTD

PLATE- IA

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The proposed area consists of 6 (six) mouzas namely: Lachhmanpur (145), Senera (185), Sikratanar (151), Siulibari (149), Digardi (150) and Talsankra (163). Total land area is around 600 Acres with 4 numbers of major ponds. The area of the major ponds are ***Lachhmanpur plot no 281 (4.46Acre), Digardi plot no 117(23Acre) & plot no. 667 (4.16 Acre) and Siulibari Plot no 578 (11.36 Acre). The Mouza map of the project area has shown in Plate IA.***

LAND USE

In most of the cultivable land cropping is done once in a year and is totally dependent on monsoonal rain. Double cropping is practiced on a very local scale in some locality where check dam / percolation tank has been constructed and in areas where agricultural wells are located.

reveals that cultivable land and cultivable waste land constitute ostly alluvial flat areas and a part of pedeplain with slope varying

These areas are mostly dissected pediments and undulatory rocky upland. Most of the areas under these two categories covered wth shrubs and bushes. Barren and uncultivable waste land covering about 8.00% of the total area is located in the areas where the slope is greater than 6.

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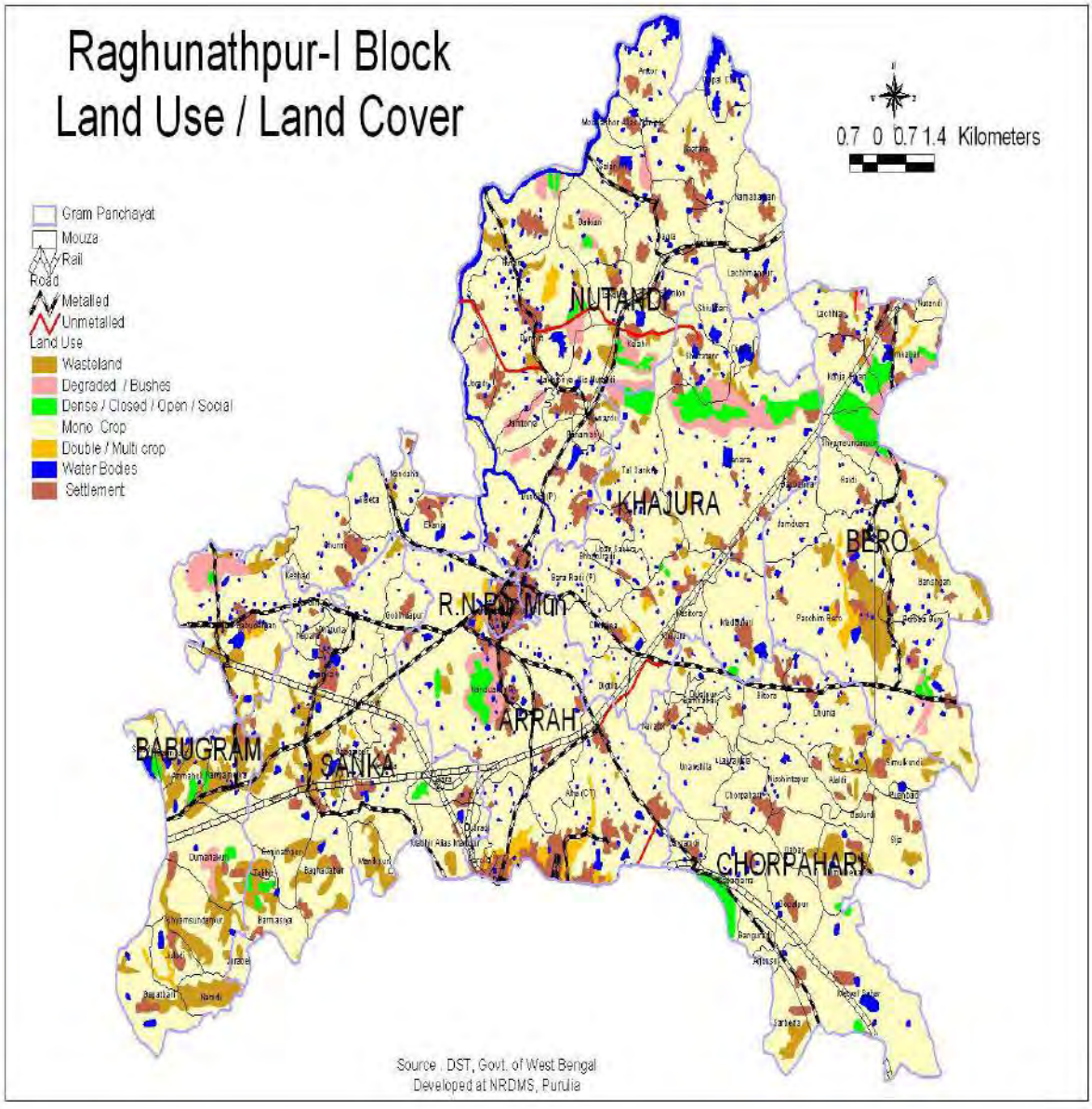
LAND USE AND LAND COVER MAP OF RAGHUNATHPUR-I BLOCK

PLATE-II



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GEOMHORPHOLOGY:

The major part of the area is represented by pediplain with widely scattered residue hills produced by residue hills produced by denudational processes.

The pediplain shows a rolling topography with gentle eastward slope covered by residual granitic soil. The soil cover is very thin and composed of loose gritty and sandy reddish material. The soil cover is very thin and composed of loose gritty and sandy The geomorphology of the area is slightly undulatory in nature, of which the low contoured cultivated lands are mostly covered by alluvium soil and lateritic soil.

Geomorphological Features

The overall geomorphological features of the district which includes Raghunathpur area also has been shown in Plate - 4 From the map it can be inferred that mainly there are three types of features;

1. Shallow to moderately buried pediment and vally.
2. Pediment with rocky outcrop and denudational terrace.

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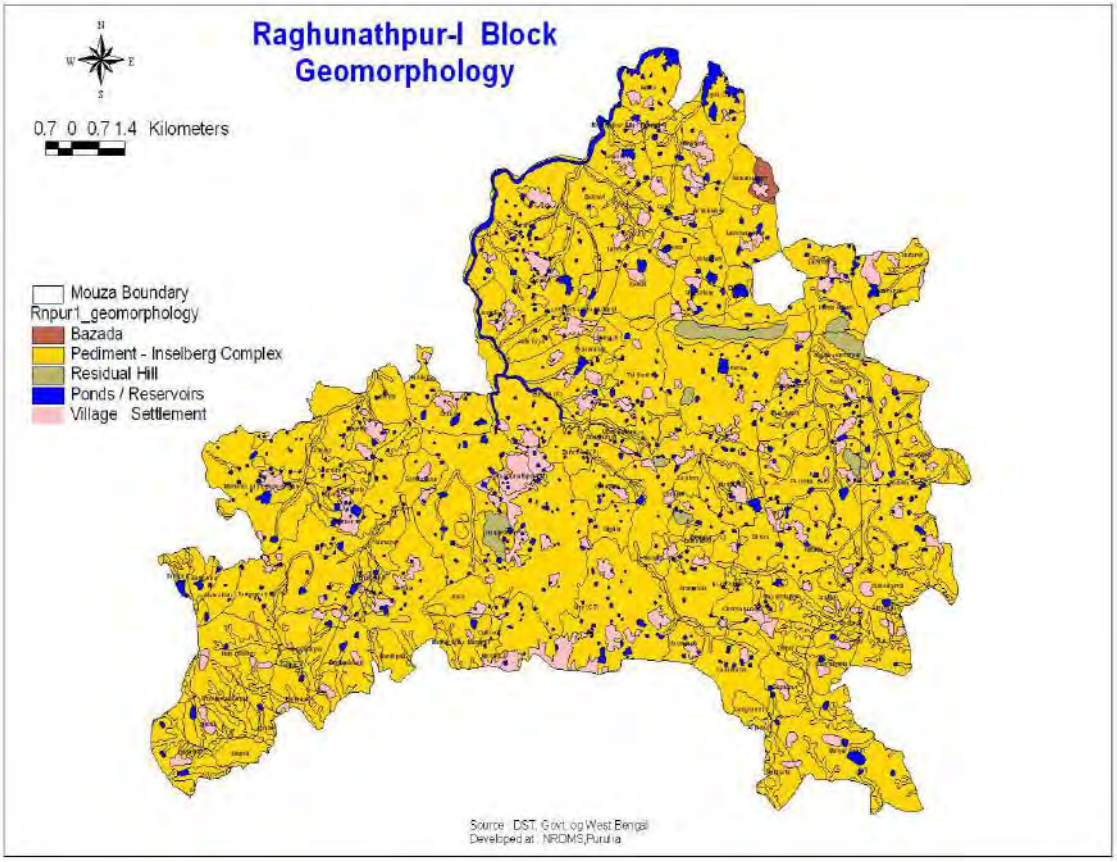
GEOMORPHOLOGICAL MAP OF RAGHUNATHPUR-I BLOCK

PLATE-III



DRAINAGE

Purulia district lies in the interfluve between Damodar river in the north and the Subarnarekha river in the south and is drained by numerous tributaries viz. *Kasai, Kumari, Darakeswar and Tofko etc.* and Raghunathpur area is within the river basin of *Damodar river* and Panchet dam is situated in the northern part of the area.

The principle river draining in the area are *Kangshabati, Kumari, Subarnarekha, Darakeswar and Dammodar* of which *Kumari and Kangshabati* originates from the district covers a large area, are the dominant river of the district which have a commendable control over the water availability of the district.The entire district can be divided into several sub-river basins like Damodar, Darakeswar, Kasai, Kumari and Subarnarekha.

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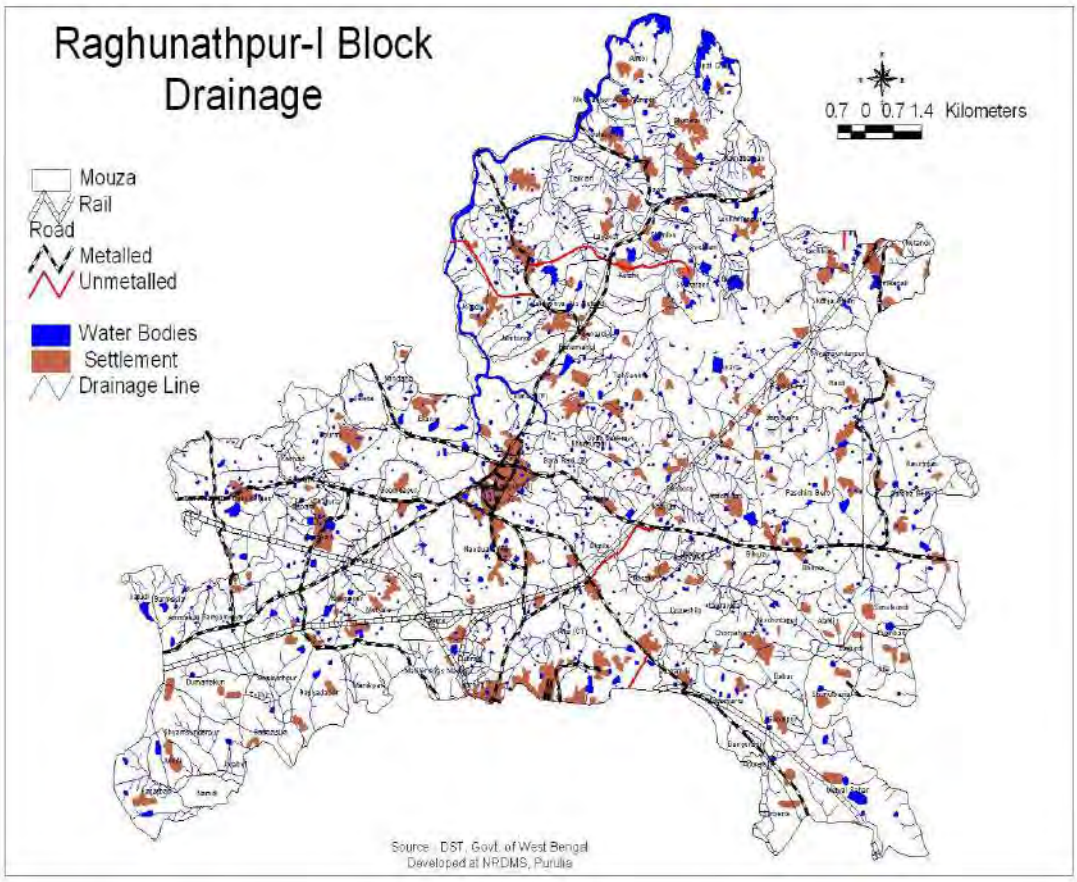
DRAINAGE MAP FOR RAGHUNATHPUR – I BLOCK

PLATE-IV



Soil

The cultivable soils have been classified in four classes namely Tar, Baid, Kanali and Bohal (all local name). The upland is Tar and extreme low lands are the Bohals. The Kanali and Bohal are recognized as fertile land. The area is characterized by undulatory topography with broad valleys and rising uplands. The valley consists of typical rolling landscape with rock exposure here and there. The predominant variety of soil is red loamy. The climate of this region is one of a humid sub tropical type. The region is characterized by high evaporation and low precipitation.

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RAINFALL AND CLIMATE

The district experiences very hot summer and moderately cold winter. Temperature varies from 48^{o} C and 4.9^{o} C. Average annual rainfall is 1368mm. (80 years average). Evapo-transpiration rate of the district is high due to bright sunshine and flow of heat waves.

GEOLOGICAL SET UP:

The present area embraces a small part of the well known Singhbhum Shear Zone described by Dunn and others. The geology of the Singhbhum and adjoining districts have evoked considerable interest not only because of economic importance from the discovery metallic, atomic, and other mineral reserves contained in this area but also due to the yet unsolved problems of the geological evolution of the region. Along with the development of the economic resources Singhbhum geology has now assumed many academic challenges regarding its structural, stratigraphical and petrological problems.

The Gondwanas occurring in the north-eastern part of the district are represented by the Ironstone shales and ferruginous sandstones of the Barren Measures formations, sandstone shales and coal seams of the Ranigunj formation, sandstone and shales of the Panchet formation and sandstone of the Upper Gondwana (Supra Panchet). The Panchet hill is the type section of the Panchet series.

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PROPOSED RAINWATER HARVESTING SCHEME FOR SHYAM STEEL WORK (P) LTD, BLOCK – RAGHUNATHPUR - I, DISTRICT - PURULIA, WEST BENGAL

RAINWATER HARVESTING

Rapid urbanization and industrialization has led to incessant withdrawal of ground water in recent times, without paying much heed to the hydrogeological characteristics of thr area, thereby depleting the groundwater level at a first rate. West Bengal receives a fair amount of rainfall in almost all parts during monsoon. However, in absence of any structural strategy for harvesting the rain water excepting some piecemeal approaches, most part of the rain water finds its way to drains / nullahs as runoff.

Advantages of Rain water harvesting:

- Helps in meeting the ever increasing demand for water.
- Helps in conserving ground water and supplement surface water resources.
- Rain water is bacteriologically pure, free from organic matter and soft.
- Helps in utilization of runoff going in to drains and
- Reduces soil erosion, flood hazard etc.

Rain Water Harvesting is not a new concept, for centuries mankind relied on rain water harvesting for domestic, agriculture, industry and also for landscaping. With rapid urbanization, industrialization and population explosion, withdrawal of groundwater over the years has increased significantly. The gap between demands and supply is also widening day by day. Days are not far off when availability of water from groundwater resources will be one of the most serious problems. The situation, thus, has compelled one and all of us to explore and implement rain water harvesting as far as practicable.

Rainwater harvesting is the process to capture and store rainwater where we get it to prevent its runoff, evaporation and seepage for its conservation and also for artificial recharge to groundwater. Rainwater harvesting is an effective tool to utilize a large quantity of god quality water which otherwise goes waste creating several problems on its way.

Rainwater harvesting and conservation is the activity of direct collection of rainwater. The conservation of rainwater so called can be stored for direct use or can be recharged in to groundwater. Rainwater harvesting and conservation means to understand the value of rain and to make optimum use of rainwater at the place where it falls.

Roof top rainwater harvesting is a type of rainwater harvesting where the roof of a building or hut etc. is considered as the catchments area and rainwater from the roof is collected and stored in storage tank on or below ground surface or recharge to groundwater for future use.

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The objectives of rain water harvesting are as follows:-

- To conserve and augment the storage of groundwater.
- To reduce water level depletion.
- To improve the quality of existing groundwater through dilution.
- To arrest seawater intrusion in coastal areas.
- To avoid flood and water logging in urban areas.

Rainwater can be harvested in three ways:-

- Collected and stored for ready use in containers.
- Collected and stored in surface water sources like lakes and ponds to be supplied to community providing treatment.
- Recharges in to groundwater for withdrawal later.

RAIN WATER HARVESTING FROM PONDS

Within the Proposed Steel Works (P) Ltd. Project area (600acre) at Ragunathpur-I block, there are 4 (four) nos of major ponds as shown below:

Mouza name(J.L.no)	***Plot no***	***Area in acre (approx)***.	***Area in Sqm (approx)***
1. Lachhmanpur (145)	281	4.46	4.46 x 4046 = 18,045
2. Digardhi (150)	117	23.10	23.10 x 4046 = 93,462
3. Digardhi (150)	667	4.16	4.16 x 4046 = 16,831
4. Siulibari (149)	578	11.36	11.36 x 4046 = 45,962

Total surface area of 4 ponds = 1, 74,300 sq metre

How much Rainwater can be harvested within the existing 4 (four) ponds

Rainwater Harvesting Potential = Rainfall (mm) x Collection efficiency.

Annual average rainfall in Raghunathpur area: 1368mm (approx).

= Monsoon rainfall = 80% of total rain

= 1368 x 80% = 1094.40 mm = say 1095mm

Area of pond Catchment = 1,74,300 sq.m

Height of rainfall = 1.095 m

Volume of rainfall = Area x Height of rainfall

= 1, 74, 300 m2 x 1.095 m = 1, 90,858.50 $m^{3.}$

Co-eff. of evaporation, Spillage = 0.8, ***Harvested water potential =1, 90,858.50 m^3 x 0.8 = 1,52,686.8 m^3 / year***

This rain water harvesting is only considering 4 (four) numbers of existing ponds within the proposed plant area. The amount that can be stored in the ponds may be utilized for different uses which reduce the consumption of ground water. The total quantum of rain water that can be stored in four ponds depends on the total volume of the four ponds.

RAIN WATER HARVESTING FROM DIFFERENT CATCHMENT AREAS (ROOF / SHED, INTERNAL ROADS, GREENBELTS AND OPEN AREAS)

Roof top Rainwater Harvesting Components:

All Rain Water harvesting systems whether large or small are composed of the following components:

1. Catchment area / roof surface upon which rain falls.
2. Gutters and down spouts.
3. Leaf screen and Roof washers, the system that remove contaminants and debris.
4. Cistern or storage tanks.
5. Filtration device and water treatment, the system that removes the suspended silt and dust particles and disinfect.
6. Conveying system and storage tanks and collection pit.& Water treatment device..
7. Existing ponds etc within the proposed plant area.

As per official records from ***Shyam Steel Works Private Ltd*** the following are the available land areas.

1. Total land: 600.00 Acres.
2. Total Greenery: 200.00 Acres.

In this project report it has been estimated how much quantity of storm water can a catchment area will produce, and a drain can be sized to remove this water and determine whether a proposed drainage system is realistic.

First the catchment area with its boundaries will have to be identified on the site plan.

A catchment area is the entire surface that will discharge its storm water to one point (the discharge point). As water always flows from high to low, it is possible to identify the catchment area. Once the catchment area is identified, its surface must be estimated.

The whole of the proposed project area has been divided in to 5 areas depending on the slopes etc. in to 5 areas (Area 1 to Area 5). Each area again has been described in 4 (four) different categories for easier calculations of the RWH schemes. The details have been shown separately AS CATCHMENT AREA. For each catchment area details calculations for amount of water that can be harvested and also the size of the drain has been shown

separately.

TABLE: 1

TOTAL AREA OF CATCHMENT

TOTAL AREA OF CATCHMENT			
S.L	**NAME**	**TOTAL AREA**	**UNIT**
1	**Catchment Area-1**	**601827.62**	**SQM**
2	**Catchment Area-2**	**278619.31**	**SQM**
3	**Catchment Area-3**	**195354.58**	**SQM**
4	**Catchment Area-4**	**248907.80**	**SQM**
5	**Catchment Area-5**	**509720.43**	**SQM**

TABLE-2 AREA OF PONDS

TOTAL AREA OF PONDS			
S.L	**NAME**	**TOTAL AREA**	**UNIT**
1	**POND-1**	**38305.94**	**SQM**
2	**POND-2**	**1301.02**	**SQM**
3	**POND-3**	**19230.71**	**SQM**
4	**POND-4**	**44304.34**	**SQM**

TABLE – 3 AREA OF ROOF TOP

TOTAL AREA OF ROOF TOP (Plant facilities & Storage sheds)			
S.L	**NAME**	**TOTAL AREA**	**UNIT**
1	**Total Roof top area**	**669813.88**	**SQM**

TABLE – 4 AREA OF INTERNAL ROADS

TOTAL AREA OF INTERNAL ROADS			
S.L	**NAME**	**TOTAL AREA**	**UNIT**
1	**Total Internal roads area**	**187056.60**	**SQM**

TABLE – 5 AREA OF GREEN BELT

TOTAL AREA OF GREENBELT			
S.L	**NAME**	**TOTAL AREA**	**UNIT**
1	**Total Greenbelt area**	**620727.32**	**SQM**

TABLE - 6 TOTAL AREA OF OPEN LAND

S.L	**NAME**	**TOTAL AREA**	**UNIT**
1	**Total Open Land area**	**356831.93**	**SQM**

Runoff Coefficient

The runoff coefficient is a dimensionless value representing characteristics of the watershed that affect how much of the rain will become runoff. Coefficient selection is based on land use and soil conditions. The weighted C value is to be based on a ratio of the drainage areas associated with each C value. The runoff coefficients for various types of surfaces are provided in Table. 7

TABLE-7 RUNOFF COEFFICIANT

S.L	DESCRIPTION	VALUE
1	Roof top area (plant facilities & Storage sheds)	0.85
2	Internal roads	0.65
3	Greenbelt	0.15
4	Open areas	0.20

Rainfall Intensity

Rainfall intensity (i) is average rainfall intensity for duration equal to the time of concentration and for a select recurrence interval. Rainfall intensity is the intensity of rainfall in inches per hour for duration equal to the time of concentration. Intensity is a rate of rainfall over an interval of time such that intensity multiplied by duration equals total amount of rain. We know annual average rainfall in Raghunathpur area: 1368 mm (approx) and maximum hourly rainfall 6.6mm/hr.

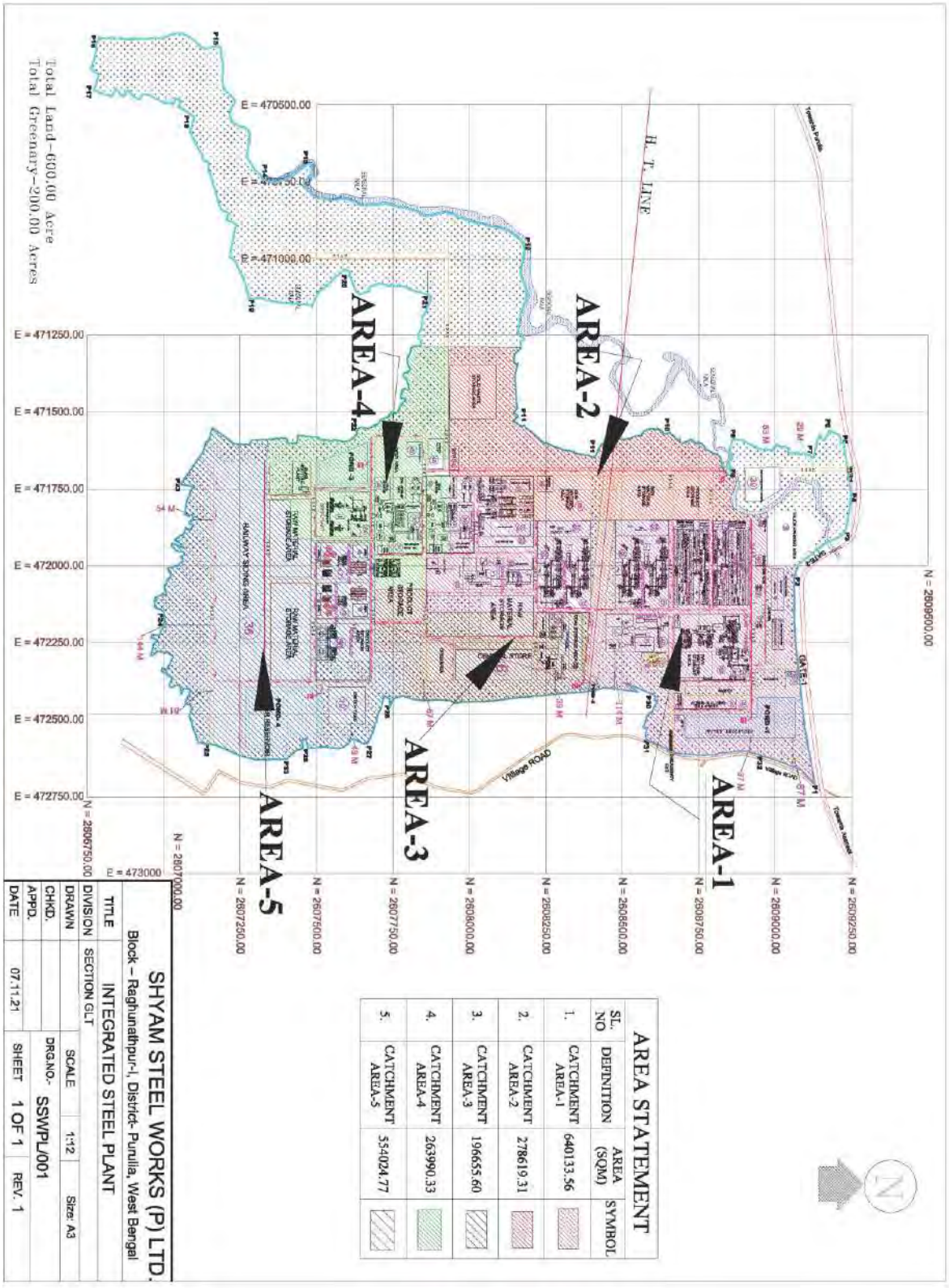

PLATE-V: Map Showing Different Areas.

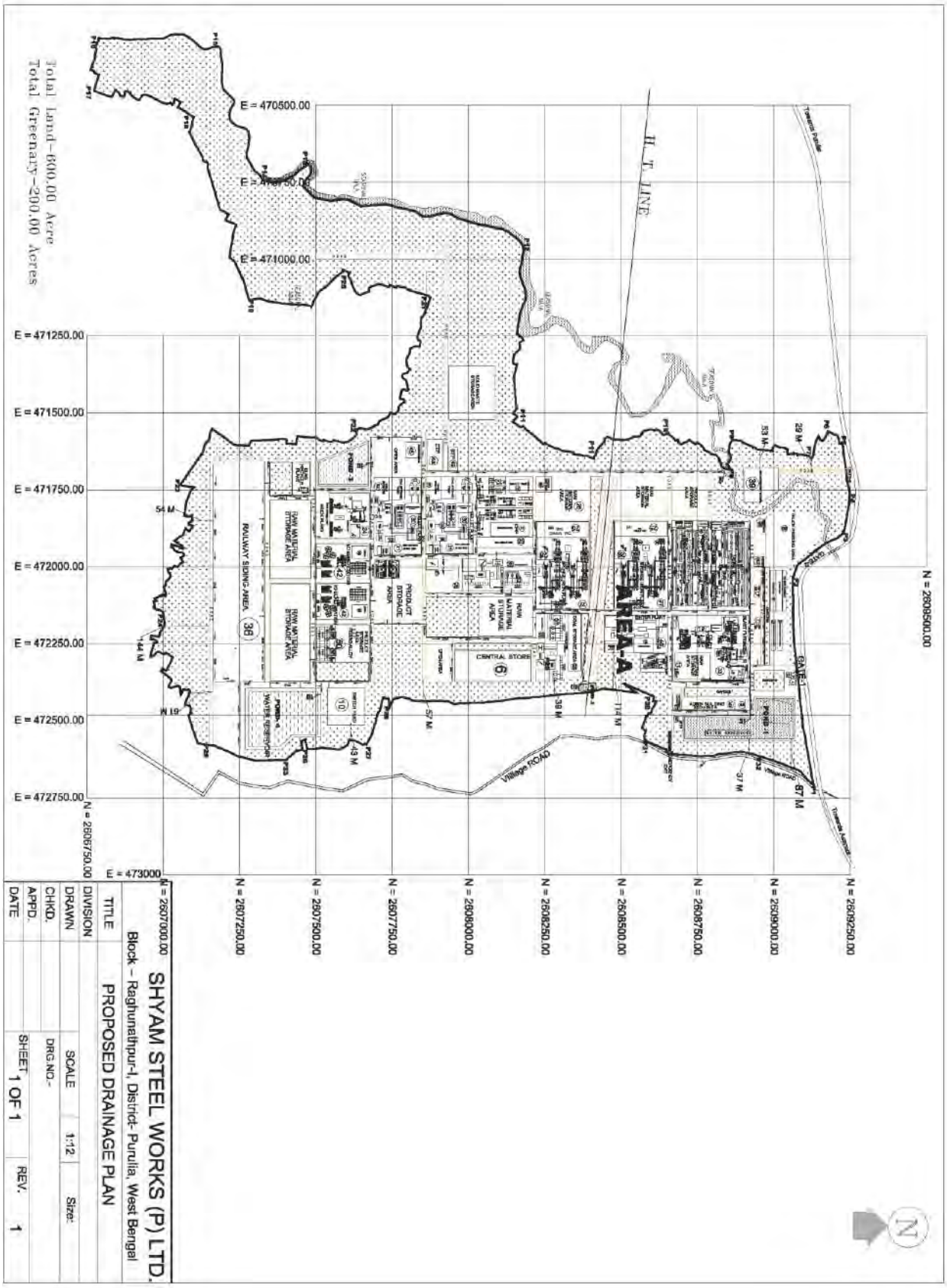

PLATE-VI Map Showing Drainage System.

CONCLUSIONS

***SHYAM STEEL WORKS PRIVATE LTD*. desires to implement a Rain Water Harvesting scheme from Storm Water Drainage / Run off water, Roof top rain water as well as considering the existing 4 numbers ponds of the proposed project within the campus of Shyam Steel Works Private Ltd. at jangal sundari karmanagari parcel ii, raghunathpur, purulia district, west bengal"** to know the details of rainwater harvesting system covering storm water drainage system plotted in plant layout, drainage disposal calculation, detail calculations of quantum of water that can be harvested from the storm water etc.

Accordingly, a dedicated team carried out the whole programme and results are furnished below.

- Within the Proposed Steel Works (P) Ltd. Project area (600acre) at Ragunathpur-I block, there are 4 (four) nos of major ponds
- The total roof/shed area of the project: **669813.88 m2 (approx)**
- **Total quantum of available rain water from roof top areas is 778859.59 *m^3 / year*** (approx)
- **Total surface area of 4 ponds = 1, 74,300 sq m (approx)**
- **Harvested water potential from pond may be in the tune of =*1, 90,858.50 m^3* x 0.8 = *1,52,686.8 m^3 / year*** (approx)
- **Total quantum of available rain water from internal road areas is 166330.73 *m^3 / year*** (approx).Internal road areas is **187056.60 m2** (approx)
- **Total quantum of available rain water from Green belt areas is 127373.25 *m^3 / year (approx). Green belt areas is 620727.32m2(approx)***
- **Total quantum of available rain water from open areas is 73221.91 *m^3 / year (approx).***
- **The whole of the project area has been sub-divided in to 5 separate areas (AREA -1 , AREA-2, AREA-3, AREA-4 and AREA – 5 on the basis of topographical relief.**
- **For each of areas from Area-1 to Area – 5 separate calculations has been made as shown in the attachments.**
- **From the rainfall intensity the possible design of drains have been calculated.**

- **Over all a comprehensive Rain Water Harvesting scheme may be undertaken which will very much helpful for the use within the proposed plant area and with necessary treatment.**

(RANAJIT SAHA)
Chief Technical Director& Consultant Hydrogeologist,
NRIEMT, Kolkata &
Former Superintending Geologist, State Water Investigation Directorate,
Government of West Bengal &
International Water resources Management Consultant

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DETAIL CALCULATIONS OF CATCHMENT AREAS ARE SHOWN IN ATTACHMENTS

DETAIL CALCULATION OF CATCHMENT AREA-1

S.L	DESCRIPTION	AREA (SQM) (A)	Runoff co-efficient (C)	A X C
1	Roof top area (plant facilities & Storage sheds) (A1)	335792.22	0.85	285423.39
2	Internal roads (A2)	62005.00	0.65	40303.25
3	Greenbelt (A3)	113524.90	0.15	17028.74
4	Open areas (A4)	90505.50	0.20	18101.10
	TOTAL=	601827.62		360856.47

Runoff co-efficient

$$Weighted\ C = \frac{A_1C_1 + A_2C_2 + \ldots + A_nC_n}{A_1 + A_2 + \ldots + A_n}$$

TABLE-1		
NAME	**VALUE**	**UNIT**
Runoff co-efficient (C) =	**0.60**	
Rainfall intensity (I)=	**6.60**	**mm/h**
Surface area (A) =	**60.18**	**Ha**

AS PER PURULIA DISTRICT WEBSITE

Calculating the amount of water the catchment area-1 will produce

The amount of storm water the catchment will produce can be determined withthe formula:

$$Q_{des} = 2.8 \times C \times i \times A$$

Qdes :- the design peak runoff rate, or the maximum flow of storm water the system will be designed for (in litres per second)

C :- the runoff coefficient (see table-1)

i :- the rainfall intensity at the time of concentration read from the chosen IDF curve; if no IDF curves are available, a value of 100 mm/h can be taken (in mm/h)

A : the surface area of the catchment area (in ha (10,000 m2))

Q des = 2.8 x 0.6 x 6.6 x 60.18
= 667.27584 Lit/ Sec

The size of the drain can be calculated with the formula

$$Q = 1000 \times \left(\frac{A \times (R)^{0.67} \times (S)^{0.5}}{N} \right)$$

Q : the capacity of discharge of the drain (in l/s)
A : the cross section of the flow (in m2)
R : the hydraulic radius of the drain (see figure F.1, in m)
S : the gradient of the drain
N : Manning's roughness coefficient: for smooth concrete drain 0.015

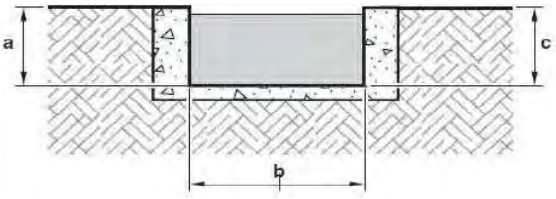

Figure 1. The hydraulic radius

We know Hydraulic radius = (a x b) / (a + b + c)

We consider a smooth concrete drain of 0.6 m by 1 m,

A= 0.6 X 1= 0.6

R= (0.6X1)/ (1+0.6+1) =0.23

S= 0.005 (APPROX)

N= 0.015

Capacity of Drain is Q= 1044.40 Lit/ Sec

Q des < Q	**Hence Ok**

Conclusion:-

Then Catchment Area-1 R.C.C Drain size is = Width 0.6m and Depth 1.00 m

DETAILS CALCULATION OF CATCHMENT AREA-2

S.L	DESCRIPTION	AREA (SQM) (A)	Runoff co-efficient (C)	A X C
1	Roof top area (plant facilities & Storage sheds) (A1)	33193.37	0.85	28214.36
2	Internal roads (A2)	27032.00	0.65	17570.80
3	Greenbelt (A3)	141287.20	0.15	21193.08
4	Open areas (A4)	77106.74	0.20	15421.35
	TOTAL=	278619.31		82399.59

Runoff co-efficient

$$Weighted\ C = \frac{A_1C_1 + A_2C_2 + \ldots + A_nC_n}{A_1 + A_2 + \ldots + A_n}$$

TABLE-2		
NAME	**VALUE**	**UNIT**
Runoff co-efficient (C) =	**0.30**	
Rainfall intensity (I)=	**6.60**	**mm/h**
Surface area (A) =	**27.86**	**Ha**

AS PER PURULIA DISTRICT WEBSITE

Calculating the amount of water the catchment area-2 will produce

The amount of stormwater the catchment will produce can be determined with the formula:

$$Q_{des} = 2.8 \times C \times i \times A$$

Qdes :- the design peak runoff rate, or the maximum flow of stormwater the system will be designed for (in litres per second)

C :- the runoff coefficient (see table-2)

i :- the rainfall intensity at the time of concentration read from the chosen IDF curve; if no IDF curves are available, a value of 100 mm/h can be taken (in mm/h)

A : the surface area of the catchment area (in ha (10,000 m2))

Q des = 2.8 x 0.3 x 6.6 x 27.86
= 154.46 Lit/ Sec

The size of the drain can be calculated with the formula

$$Q = 1000 \times \left(\frac{A \times (R)^{0.67} \times (S)^{0.5}}{N} \right)$$

Q : the capacity of discharge of the drain (in l/s)
A : the cross section of the flow (in m2)
R : the hydraulic radius of the drain (see figure F.2, in m)
S : the gradient of the drain
N : Manning's roughness coefficient: for smooth concrete drain 0.015

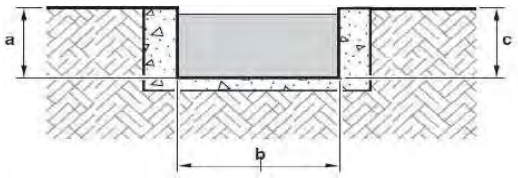

Figure 2. The hydraulic radius

We know Hydraulic radius = (a x b) / (a + b + c)

We consider a smooth concrete drain of 0.5 m by 7 m,

A= 0.5 X 0.7= 0.35

R=(0.5X0.7)/ (0.5+0.7+0.5) = 0.21

S= 0.005 (APPROX)

N= 0.015

Capacity of Drain is Q= 571.66 Lit/ Sec

Q des< Q	**Hence Ok**

Conclusion:-

Then Catchment Area-2 R.C.C Drain size is = Width 0.5m and Depth 0.7 m

DETAILS CALCULATION OF CATCHMENT AREA-3

S.L	DESCRIPTION	AREA (SQM) (A)	Runoff co-efficient (C)	A X C
1	Roof top area (plant facilities & Storage sheds) (A1)	68072.83	0.85	57861.91
2	Internal roads (A2)	16320	0.65	10608.00
3	Greenbelt (A3)	83796.67	0.15	12569.50
4	Open areas (A4)	27165.08	0.20	5433.02
	TOTAL=	195354.58		86472.42

Runoff co-efficient

$$Weighted\ C = \frac{A_1C_1 + A_2C_2 + \ldots + A_nC_n}{A_1 + A_2 + \ldots + A_n}$$

TABLE-3		
NAME	**VALUE**	**UNIT**
Runoff co-efficient (C) =	**0.44**	
Rainfall intensity (I)=	**6.60**	**mm/h**
Surface area (A) =	**19.54**	**Ha**

AS PER PURULIA DISTRICT WEBSITE

Calculating the amount of water the catchment area-3 will produce

The amount of stormwater the catchment will produce can be determined with the formula:

$$Q_{des} = 2.8 \times C \times i \times A$$

Qdes :- the design peak runoff rate, or the maximum flow of stormwater the system will be designed for (in litres per second)

C :- the runoff coefficient (see table-3)

i :- the rainfall intensity at the time of concentration read from the chosen IDF curve; if no IDF curves are available, a value of 100 mm/h can be taken (in mm/h)

A : the surface area of the catchment area (in ha (10,000 m2))

Q des = 2.8 x 0.44 x 6.6 x 19.54
= 158.88 Lit/ Sec

The size of the drain can be calculated with the formula

$$Q = 1000 \times \left(\frac{A \times (R)^{0.67} \times (S)^{0.5}}{N} \right)$$

Q : the capacity of discharge of the drain (in l/s)
A : the cross section of the flow (in m2)
R : the hydraulic radius of the drain (see figure F.3, in m)
S : the gradient of the drain
N : Manning's roughness coefficient: for smooth concrete drain 0.015

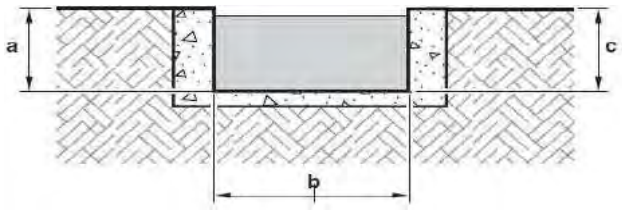

Figure 3. The hydraulic radius

We know Hydraulic radius = (a x b) / (a + b + c)

We consider a smooth concrete drain of 0.5 m by 7 m,

A= 0.5 X 0.7= 0.35

R=(0.5X0.7)/ (0.5+0.7+0.5) = 0.21

S= 0.005 (APPROX)

N= 0.015

Capacity of Drain is Q= 571.66 Lit/ Sec

Q des< Q	**Hence Ok**

Conclusion:-

Then Catchment Area-3 R.C.C Drain size is = Width 0.5m and Depth 0.7 m

DETAILS CALCULATION OF CATCHMENT AREA-4

S.L	DESCRIPTION	AREA (SQM) (A)	Runoff co-efficient (C)	A X C
1	Roof top area (plant facilities & Storage sheds) (A1)	104625.29	0.85	88931.50
2	Internal roads (A2)	25496.3	0.65	16572.60
3	Greenbelt (A3)	65488	0.15	9823.20
4	Open areas (A4)	53298.21	0.20	10659.64
	TOTAL=	248907.80		125986.93

Runoff co-efficient

$$Weighted\ C = \frac{A_1C_1 + A_2C_2 + \ldots + A_nC_n}{A_1 + A_2 + \ldots + A_n}$$

TABLE-4		
NAME	**VALUE**	**UNIT**
Runoff co-efficient (C) =	**0.51**	
Rainfall intensity (I)=	**6.60**	**mm/h**
Surface area (A) =	**24.89**	**Ha**

AS PER PURULIA DISTRICT WEBSITE

Calculating the amount of water the catchment area-4 will produce

The amount of stormwater the catchment will produce can be determined with the formula:

$$Q_{des} = 2.8 \times C \times i \times A$$

Qdes :- the design peak runoff rate, or the maximum flow of stormwater the system will be designed for (in litres per second)

C :- the runoff coefficient (see table-4)

i :- the rainfall intensity at the time of concentration read from the chosen IDF curve; if no IDF curves are available, a value of 100 mm/h can be taken (in mm/h)

A : the surface area of the catchment area (in ha (10,000 m2))

Q des = 2.8 x 0.51 x 6.6 x 24.89
= 234.583272 Lit/ Sec

The size of the drain can be calculated with the formula

$$Q = 1000 \times \left(\frac{A \times (R)^{0.67} \times (S)^{0.5}}{N} \right)$$

Q : the capacity of discharge of the drain (in l/s)
A : the cross section of the flow (in m2)
R : the hydraulic radius of the drain (see figure F.4, in m)
S : the gradient of the drain
N : Manning's roughness coefficient: for smooth concrete drain 0.015

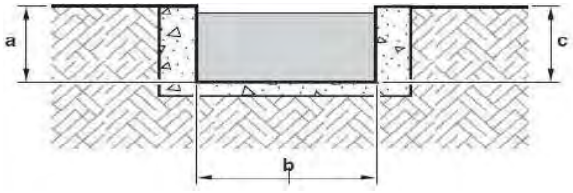

Figure 4. The hydraulic radius

We know Hydraulic radius = (a x b) / (a + b + c)

We consider a smooth concrete drain of 0.5 m by 7 m,

A= 0.5 X 0.7= 0.35

R=(0.5X0.7)/ (0.5+0.7+0.5) = 0.21

S= 0.005 (APPROX)

N= 0.015

Capacity of Drain is Q= 571.66 Lit/ Sec

Q des< Q	**Hence Ok**

Conclusion:-

Then Catchment Area-4 R.C.C Drain size is = Width 0.5m and Depth 0.7 m

DETAILS CALCULATION OF CATCHMENT AREA-5

S.L	DESCRIPTION	AREA (SQM) (A)	Runoff co-efficient (C)	A X C
1	Roof top area (plant facilities & Storage sheds) (A1)	128130.18	0.85	108910.65
2	Internal roads (A2)	56203.3	0.65	36532.15
3	Greenbelt (A3)	216630.55	0.15	32494.58
4	Open areas (A4)	108756.4	0.20	21751.28
	TOTAL=	509720.43		199688.66

Runoff co-efficient

$$Weighted\ C = \frac{A_1C_1 + A_2C_2 + \ldots + A_nC_n}{A_1 + A_2 + \ldots + A_n}$$

TABLE-5		
NAME	**VALUE**	**UNIT**
Runoff co-efficient (C) =	**0.39**	
Rainfall intensity (I)=	**6.60**	**mm/h**
Surface area (A) =	**50.97**	**Ha**

AS PER PURULIA DISTRICT WEBSITE

Calculating the amount of water the catchment area-5 will produce

The amount of stormwater the catchment will produce can be determined with the formula:

$$Q_{des} = 2.8 \times C \times i \times A$$

Qdes :- the design peak runoff rate, or the maximum flow of stormwater the system will be designed for (in litres per second)

C :- the runoff coefficient (see table-5)

i :- the rainfall intensity at the time of concentration read from the chosen IDF curve; if no IDF curves are available, a value of 100 mm/h can be taken (in mm/h)

A : the surface area of the catchment area (in ha (10,000 m2))

Q des = 2.8 x 0.39 x 6.6 x 50.97
= 367.4 Lit/ Sec

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The size of the drain can be calculated with the formula

$$Q = 1000 \times \left(\frac{A \times (R)^{0.67} \times (S)^{0.5}}{N} \right)$$

Q : the capacity of discharge of the drain (in l/s)
A : the cross section of the flow (in m2)
R : the hydraulic radius of the drain (see figure F.5, in m)
S : the gradient of the drain
N : Manning's roughness coefficient: for smooth concrete drain 0.015

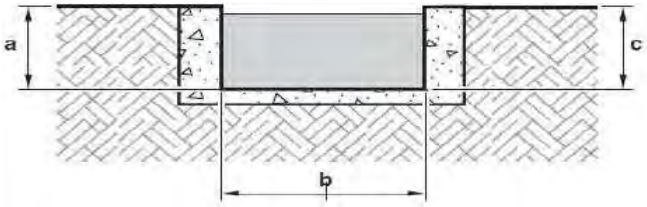

Figure 4. The hydraulic radius

We know Hydraulic radius = (a x b) / (a + b + c)

We consider a smooth concrete drain of 0.5 m by 7 m,

A= 0.5 X 0.7= 0.35

R=(0.5X0.7)/ (0.5+0.7+0.5) = 0.21

S= 0.005 (APPROX)

N= 0.015

Capacity of Drain is Q= 571.66 Lit/ Sec

Q des< Q	**Hence Ok**

Conclusion:-

Then Catchment Area-4 R.C.C Drain size is = Width 0.5m and Depth 0.7 m

DETAILS ANNUAL RAINFALL CALCULATION FOR ROOF TOP AREA

S.L	DESCRIPTION	AREA (SQM) (A)	Runoff co-efficient (C)	Rainfall (in m/y)	Rainwater Collection Potential (m3/y)
1	Roof top area (plant facilities & Storage sheds) of Catchment area-1	335792.22	0.85	1.368	390459.19
2	Roof top area (plant facilities & Storage sheds) of Catchment area-2	33193.37	0.85	1.368	38597.25
3	Roof top area (plant facilities & Storage sheds) of Catchment area-3	68072.83	0.85	1.368	79155.09
4	Roof top area (plant facilities & Storage sheds) of Catchment area-4	104625.29	0.85	1.368	121658.29
5	Roof top area (plant facilities & Storage sheds) of Catchment area-5	128130.18	0.85	1.368	148989.77
	TOTAL=	**669813.89**			**778859.59**

Total Roof top area is= 669813.89 SQM OR 66.98 Ha

Total Quantum ofavailable runoff (cum/y) = 778859.59 CUM/YEAR

DETAILS PEAK HOURLY RAINFALL CALCULATION FOR ROOF TOP AREA

TABLE-1

NAME	VALUE	UNIT
Total Roof top area is=	66.98	Ha
Runoff co-efficient for roof top area (C) =	0.85	
Rainfall intensity (I)=	6.60	mm/h

** AS PER PURULIA DISTRICT WEBSITE

Calculating the amount of water will produce for one hour peak rainfall

The amount of stormwater the catchment will produce can be determined with the formula:

$$Q_{des} = 2.8 \times C \times i \times A$$

Qdes :- the design peak runoff rate, or the maximum flow of stormwater the system will be designed for (in litres per second)

C :- the runoff coefficient (see table-1)

i :- the rainfall intensity at the time of concentration read from the chosen IDF curve.

A : the rooftop area of the catchment area in ha (1 Ha=10,000 m2)

Q des =	2.8 x 0.85 x 6.6 x 66.98
=	1052.12 Lit/ Sec

Note:- It should be remembered that this figure is not a fixed value. .

DETAILS ANNUAL RAINFALL CALCULATION FOR INTERNAL ROAD AREA					
S.L	**DESCRIPTION**	**AREA (SQM) (A)**	**Runoff co-efficient (C)**	**Rainfall (in m/y)**	**Rainwater Collection Potential (m3/y)**
1	Internal roads area of Catchment area-1	62005.00	0.65	1.368	55134.85
2	Internal roads area of Catchment area-2	27032.00	0.65	1.368	24036.85
3	Internal roads area of Catchment area-3	16320.00	0.65	1.368	14511.74
4	Internal roads area of Catchment area-4	25496.30	0.65	1.368	22671.31
5	Internal roads area of Catchment area-5	56203.30	0.65	1.368	49975.97
	TOTAL=	**187056.60**			**166330.73**

Total Internal Road area is= 187056.60 SQM OR 18.70 Ha

Total Quantum of available runoff (cum/y) = 166330.73 CUM/YEAR

DETAILS PEAK HOURLY RAINFALL CALCULATION FOR INTERNAL ROAD AREA

TABLE-2

NAME	VALUE	UNIT	
Total Internal Road area is =	18.7	Ha	
Runoff co-efficient for Internal Road area (C) =	0.65		
Rainfall intensity (I)=	6.60	mm/h	** AS PER PURULIA DISTRICT WEBSITE

Calculating the amount of water will produce for one hour peak rainfall

The amount of stormwater the catchment will produce can be determined with the formula:

$$Q_{des} = 2.8 \times C \times i \times A$$

Qdes :- the design peak runoff rate, or the maximum flow of stormwater the system will be designed for (in litres per second)

C :- the runoff coefficient (see table-2)

i :- the rainfall intensity at the time of concentration read from the chosen IDF curve.

A : the rooftop area of the catchment area in ha (1 Ha=10,000 m2)

Q des =	2.8 x 0.65 x 6.6 x 18.70
=	224.62 Lit/ Sec

Note:- It should be remembered that this figure is not a fixed value. .

DETAILS ANNUAL RAINFALL CALCULATION FOR GREENBELT AREA

S.L	DESCRIPTION	AREA (SQM) (A)	Runoff co-efficient (C)	Rainfall (in m/y)	Rainwater Collection Potential (m3/y)
1	Greenbelt area of Catchment area-1	113524.90	0.15	1.368	23295.31
2	Greenbelt area of Catchment area-2	141287.20	0.15	1.368	28992.13
3	Greenbelt area of Catchment area-3	83796.67	0.15	1.368	17195.08
4	Greenbelt area of Catchment area-4	65488.00	0.15	1.368	13438.14
5	Greenbelt area of Catchment area-5	216630.55	0.15	1.368	44452.59
	TOTAL=	**620727.32**			**127373.25**

Total Greenbel area is= 620727.32 SQM OR 62.07 Ha

Total Quantum of available runoff (cum/y) = 127373.25 CUM/YEAR

DETAILS PEAK HOURLY RAINFALL CALCULATION FOR GREENBELT AREA

TABLE-3

NAME	VALUE	UNIT
Total Greenbelt area is =	62.07	Ha
Runoff co-efficient for Greenbelt area (C) =	0.15	
Rainfall intensity (I)=	6.60	mm/h

** AS PER PURULIA DISTRICT WEBSITE

Calculating the amount of water will produce for one hour peak rainfall

The amount of stormwater the catchment will produce can be determined with the formula:

$$Q_{des} = 2.8 \times C \times i \times A$$

Qdes :- the design peak runoff rate, or the maximum flow of stormwater the system will be designed for (in litres per second)

C :- the runoff coefficient (see table-3)

i :- the rainfall intensity at the time of concentration read from the chosen IDF curve.

A : the rooftop area of the catchment area in ha (1 Ha=10,000 m2)

Q des =	2.8 x 0.15 x 6.6 x 62.07
=	172.06 Lit/ Sec

Note:- It should be remembered that this figure is not a fixed value. .

DETAILS ANNUAL RAINFALL CALCULATION FOR OPEN AREA					
S.L	**DESCRIPTION**	**AREA (SQM) (A)**	**Runoff co-efficient (C)**	**Rainfall (in m/y)**	**Rainwater Collection Potential (m3/y)**
1	Open area of Catchment area-1	90505.50	0.15	1.368	18571.73
2	Open area of Catchment area-2	77106.74	0.15	1.368	15822.30
3	Open area of Catchment area-3	27165.08	0.15	1.368	5574.27
4	Open area of Catchment area-4	53298.21	0.15	1.368	10936.79
5	Open area of Catchment area-5	108756.4	0.15	1.368	22316.81
	TOTAL=	**356831.93**			**73221.91**

Total Greenbel area is= 356831.93 SQM OR 35.68 Ha

Total Quantum of available runoff (cum/y) = 73221.91 CUM/YEAR

DETAILS PEAK HOURLY RAINFALL CALCULATION FOR OPEN AREA

TABLE-4

NAME	VALUE	UNIT
Total Open area is =	35.68	Ha
Runoff co-efficient for Open area (C) =	0.20	
Rainfall intensity (I)=	6.60	mm/h

** AS PER PURULIA DISTRICT WEBSITE

Calculating the amount of water will produce for one hour peak rainfall

The amount of stormwater the catchment will produce can be determined with the formula:

$$Q_{des} = 2.8 \times C \times i \times A$$

Qdes :- the design peak runoff rate, or the maximum flow of stormwater the system will be designed for (in litres per second)

C :- the runoff coefficient (see table-3)

i :- the rainfall intensity at the time of concentration read from the chosen IDF curve.

A : the rooftop area of the catchment area in ha (1 Ha=10,000 m2)

Q des =	2.8 x 0.20 x 6.6 x 35.68
=	131.87 Lit/ Sec

Note:- It should be remembered that this figure is not a fixed value. .

Revised Action plan as per MoEF&CC O.M. dated 30/09/2020 with a budget of 1.5% of Project cost i.e. Rs. 69.09 Cr.

S.NO.	MAJOR ACTIVITY HEADS		YEAR OF IMPLEMENTATION					TOTAL EXPENDITURE
			1st Year	2nd Year	3rd Year	4TH Year	5TH Year	(Rs. in Lakhs)
			(Rs. in Lakhs)	(Rs. in Lakhs)	(Rs. in Lakhs)	(Rs. in Lakhs)	(Rs. in Lakhs)	
A). Based on Need Based & SIA Study								
1	Community & Infrastructure Development							
	i) Impart technical training to the local youth and women for skill development @ 100000 per candidate.	Physical Nos. & village	100 nos of local youth and women will be imparted training for skill development from 2 nos of villages i.e. Lachhmanpur & Siulibari,	90 nos of local youth and women will be imparted training for skill development from 2 nos of villages i.e. Jarukhamar & Maharajnagar.	90 nos of local youth and women will be imparted training for skill development from 2 nos of villages i.e. Senera & Talshankra.	85 nos of local youth and women will be imparted training for skill development from 2 nos of villages i.e. igardhi & Shikratyar.	85 nos of local youth and women will be imparted training for skill development from 2 nos of villages i.e. Jarka & Shimlon.	450
		Budget in Lakhs	100	90	90	85	85	
	ii) Construction of Skill Development Training Center.	Physical Nos. & village	Skill development to unemployed local youths and women through National Skill Development Corporation, Govt. of India Scheme. Construction of a building along with the necessary infrastructures for this purpose will be developed in 5 consecutive years. During 1st , 2nd & 3rd Year building will be constructed and in 3rd year onwards equipment will be installed					160
		Budget in Lakhs	40	40	30	30	20	
	iii) Construction of public toilets in nearby villages (120 nos @ 300000 per toilet)	Physical Nos. & village	20 nos- Lachhmanpur 10 nos- Siulibari	10 nos- Digardhi 10 nos- Shikratyar	30 nos- Senera 10 nos- Talshankra	5 nos- Jarukhamar 10 nos- Maharajnagar	5 nos- Jarka 10 nos- Shimlon	360
		Budget in Lakhs	90	60	120	45	45	
	iv) Laying of drinking water supply pipeline with overhead tanks in nearby villages (12 nos @ 1750000 per Drinking	Physical Nos. & village	2 no- Lachhmanpur 1 no- Siulibari	1 no- Digardhi 1 no- Shikratyar	2 no- Senera 1 no- Talshankra	1 no- Jarukhamar 1 no- Maharajnagar	1 no- Jarka 1 no- Shimlon	210
		Budget in Lakhs	52.5	35	52.5	35	35	

	water supply facility)							
	v) Street Lighting (Solar) provision at suitable public places in and around the nearby villages (235 nos @ Rs. 25,000/- per Solar Light)	**Physical Nos. & village**	40 nos- Lachhmanpur 20 nos- Siulibari	15 nos- Digardhi 20 nos- Shikratyar	60 nos- Senera 30 nos- Talshankra	15 nos- Jarukhamar 15 nos- Maharajnagar	10 nos- Jarka 10 nos- Shimlon	**58.75**
		Budget in Lakhs	15	8.75	22.5	7.5	5	
	YEAR WISE EXPENDITURE		**298**	**234**	**315**	**203**	**190**	**1238.75**
2	**Education**							
	i) Providing Sports kits to Schools/ Sports club (10 nos @ 100000 per Kit)	**Physical Nos. & village**	1 no- Lachhmanpur 1 no- Siulibari	1 no- Digardhi 1 no- Shikratyar	1 no- Senera 1 no- Talshankra	1 no- Jarukhamar 1 no- Maharajnagar	1 no- Jarka 1 no- Shimlon	**10**
		Budget in Lakhs	2	2	2	2	2	
	ii) Providing Model Anganwadi Centre/ renovation of existing center in consultation with State Govt (10 nos @ 3000000 per Center)	**Physical Nos. & village**	During 1st Year Lachhmanpur & Siulibari will be covered for renovation / provision of Model Anganwadi Center.	During 2nd Year Digardhi & Shikratyar will be covered for renovation / provision of Model Anganwadi Center.	During 3rd Year Senera & Talshankra will be covered for renovation / provision of Model Anganwadi Center.	During 4th Year Jarukhamar & Maharajnagar will be covered for renovation / provision of Model Anganwadi Center.	During 5th Year Jarka & Shimlon will be covered for renovation / provision of Model Anganwadi Center.	**300**
		Budget in Lakhs	60	60	60	60	60	
	iii) Providing furniture, computers, library, etc. for nearby local schools of villages (10 nos @Rs. 20.0 Lakhs per School)	**Physical Nos. & village**	During 1st Year Lachhmanpur & Siulibari will be provided with the facilities mentioned.	During 2nd Year Digardhi & Shikratyar will be provided with the facilities mentioned.	During 3rd Year Senera & Talshankra will be provided with the facilities mentioned.	During 4th Year Jarukhamar & Maharajnagar will be provided with the facilities mentioned.	During 5th Year Jarka & Shimlon will be provided with the facilities mentioned.	**200**
		Budget in Lakhs	40	40	40	40	40	

	iv) Digital education Class rooms in Govt. Schools (10 nos @ 1500000	**Physical Nos. & village**	One no of classroom in each of the village (i.e. Lachhmanpur & Siulibari) will be equipped with digital facilities.	One no of classroom in each of the village (i.e. Digardhi & Shikratyar) will be equipped with digital facilities.	One no of classroom in each of the village (i.e. Senera & Talshankra) will be equipped with digital facilities.	One no of classroom in each of the village (i.e. Jarukhamar & Maharajnagar) will be equipped with digital facilities.	One no of classroom in each of the village (i.e. Jarka &Shimlon) will be equipped with digital facilities.	**150**
		Budget in Lakhs	30	30	30	30	30	
	YEAR WISE EXPENDITURE		**132**	**132**	**132**	**132**	**132**	**660**
3	**Health Facilities**							
	i) Regular health camps for local inhabitants specially for women & children. Outside workers would be tested for communicable disease.	**Physical Nos. & village**	Health checkup camps shall be organized in 12 nos nearby villages for general body, eyes, blood test and donation along with mass vaccination for polio, dengue, typhoid, malaria, etc. For this purpose, one doctor along with 2 – 3 assistants shall be deputed.					**1000**
		Budget in Lakhs	200	200	200	200	200	
	ii) Sanitation facility in existing schools, parks and other installations (10 nos @1500000 per Village)	**Physical Nos. & village**	Sanitation facilities to be provided to the village Lachhmanpur &Siulibari during 1st Year.	Sanitation facilities to be provided to the village Digardhi & Shikratyar during 2nd Year.	Sanitation facilities to be provided to the village Senera & Talshankra during 3rd Year.	Sanitation facilities to be provided to the village Jarukhamar & Maharajnagar during 4 th Year.	Sanitation facilities to be provided to the village Jarka & Shimlon during 5 th Year.	**150**
		Budget in Lakhs	30	30	30	30	30	
	iii) Sanitary Napkins Vending Machine in High Schools/ common facilities (10 nos @ 300000 per Facility)	**Physical Nos. & village**	Machines will be installed in schools / common facilities of village Lachhmanpur, Siulibari during 1st Year.	Machines will be installed in schools / common facilities of village Digardhi & Shikratyar during 2 nd Year.	Machines will be installed in schools / common facilities of village Senera & Talshankra during 3rd Year.	Machines will be installed in schools / common facilities of village Jarukhamar & Maharajnagar during 4th Year.	Machines will be installed in schools / common facilities of village Jarka & Shimlon during 5th Year.	**30**
		Budget in Lakhs	6	6	6	6	6	

	iv)Drainage Network for Domestic sewage in Villages	**Physical Nos. & village**	During 1st Year drainage network to be made/ strengthen in 2 nos of village i.e Lachhmanpur & Siulibari.	During 2nd Year drainage network to be made/ strengthen in 2 nos of village i.e village Digardhi & Shikratyar.	During 3rd Year drainage network to be made/ strengthen in 2 nos of village i.e Senera & Talshankra.	During 4th Year drainage network to be made/ strengthen in 2 nos of village i.e Jarukhamar & Maharajnagar.	During 5th Year drainage network to be made/ strengthen in 2 nos of village i.e Jarka & Shimlon.	**280**
		Budget in Lakhs	150	50	30	30	20	
	v) RWH pits in the surrounding villages & De-siltation of ponds	**Physical Nos. & village**	2 nos of RWH pits to be made in Shikratyar & Siulibari and available ponds to be desilted.	2 nos of RWH pits to be made in Senera & Talshankra and Ponds to be desilted in Senera, Talshankra, Jarukhamar & Maharajnagar.	One no of RWH pits to be made in Jarka, & Shimlon	Desiltation of Settling Pits/ponds	Desiltation of Settling Pits/ponds	**330**
		Budget in Lakhs	40	100	40	100	50	
	YEAR WISE EXPENDITURE		**426**	**386**	**306**	**366**	**306**	**1790**
B). Based on Public Hearing								
1	**Regarding Control measures for abatement of Air Pollution due to the proposed project**	**Physical Nos. & village**	The physical Target for the entire activities shall be achieved in 3 years					**NA**
		Budget in Lakhs	Included in the EMP Cost					
2	**Development work in local schools, provision of study material & scholarships to be provided to meritorius students**	**Physical Nos. & village**	Schools of Lachhmanpur & Siulibari will be facilitated during 1st Year.	Schools of Digardhi & Shikratyar will be facilitated during 2nd Year.	Schools of Senera & Talshankra will be facilitated during 3rd Year.	Schools of Jarukhamar & Maharajnagar will be facilitated during 4th Year.	Schools of Jarka & Shimlon will be facilitated during 5th Year.	**270**
		Budget in Lakhs	80	60	50	40	40	
3	**Construction of Primary Health Center**	**Physical Nos. & village**	5 bedded Primary Health Center assisted by qualified Doctor and requisite para medical staffs for preliminary treatment of villagers and employees.					**800**
		Budget in Lakhs	200	200	150	150	100	
4	**Restoration of closed schools**	**Physical No. & Village**	Restoration of closed school of Digardhi and other villages to impart better education to school children.					**250**
		Budget in Lakhs	100	50	50	25	25	

5	**Construction of alternative water bodies & grazing field for animals**	**Physical No. & Village**	Construction of alternative water bodies and grazing grounds for animals in near by villages					**400**
		Budget in Lakhs	100	100	100	50	50	
6	**Repair and maintenance of existing village roads.**	**Physical No. & Village**	In Lachhmanpur & Siulibari villages	In Digardhi & Shikratyar villages	in Senera & Talshankra villages	in Jarukhamar & Maharajnagar villages	in Jarka & Shimlon in vilages.	**450**
		Budget in Lakhs	100	200	50	50	50	
7	**Greenbelt development As avenue and block plantation in villages**	**Physical No. & Village**	4 Kms of avenue plantation / 2000 Sqm of block plantation to be developed & maintained for 3 years in village Lachhmanpur, & Siulibari during 1st Year.	4 Kms of avenue plantation / 2000 Sqm of block plantation to be developed & maintained for 3 years in village Digardhi & Shikratyar 2nd Year.	4 Kms of avenue plantation / 2000 Sqm of block plantation to be developed & maintained for 3 years in village Senera &Talshankra during 3rd Year.	4 Kms of avenue plantation / 2000 Sqm of block plantation to be developed & maintained for 3 years in village Jarukhamar & Maharajnagar during 4th Year.	4 Kms of avenue plantation / 2000 Sqm of block plantation to be developed & maintained for 3 years in village Jarka & Shimlon during 5th Year.	**550**
		Budget in Lakhs	150	100	100	100	100	
8	**Development of local village roads**	**Physical No. & Village**	In Lachhmanpur & Siulibari villages	In Digardhi & Shikratyar villages	in Senera & Talshankra villages	in Jarukhamar & Maharajnagar villages	in Jarka & Shimlon in vilages.	**500**
		Budget in Lakhs	**150**	**100**	**100**	**75**	**75**	
	YEAR WISE EXPENDITURE		**880**	**810**	**600**	**490**	**440**	**3220**
	YEARWISE TOTAL EXPENDITURE		**1,736**	**1,562**	**1,353**	**1,191**	**1068**	**6909**

Annexure - 7

REPORT

ON

“**AWARENESS PROGRAMME**

CONDUCTED ON

THE BAN OF SUP”

IN ORDER TO ENSURE

THE COMPLIANCE OF NOTIFICATION

PUBLISHED ON 12/08/2021

Amendments in Plastic Waste Management Rules, 2016 to understand the actual requirement at site: -

Plastic Waste Management Rules, 2016

(Published in the Gazette of India, Part-II, Section-3, Sub-section (i)) on 18.03.2016 by the Government of India in the erstwhile Ministry of Environment and Forests. Further draft rules to amend the Plastics Waste Management Rules, 2016, were published in the Gazette of India, dated the 11th March, 2021 vide notification number GSR 169 (E), inviting objections and suggestions from all persons likely to be affected thereby within a period of sixty days. Considering objections and suggestions received within the aforesaid period Government of India made the following rules to amend the Plastic Waste Management Rules, 2016 on 12.08.2021 through vide notification number GSR 571 (E).

Amendments majorly suggests the insertion of few technical words in the existing rule 3 such as: -

1. Non-woven plastic bag
2. Plastic waste processing
3. Single-use plastic commodity
4. Thermoset plastic
5. Thermoplastic

Amendments in Rule 4 suggests following physical changes in use of carry bags: -

1. Carry bag made of virgin or recycled plastic, shall not be less than fifty microns in thickness and subsequently amended to "seventy-five microns in thickness with effect from the 30th September, 2021and one hundred and twenty (120) microns in thickness with effect from the 31st December, 2022"

2. Non-woven plastic carry bag shall not be less than 60 Gram Per Square Meter (GSM) with effect from the 30th September, 2021."

Statutory compliance of condition stipulated in Environment Clearance granted by MoEF on 28.02.2023 for establishment of Greenfield Integrated Steel Plant at Parcel – II of Jangal Sundari Karmanagari Project.

In order to comply the specific condition **(xxxiv)**

"The Plastic Waste Management Rules 2016, inter-alia, mandated banning of identified Single Use Plastic (SUP) items with effect from 01/07/2022. In this regard, CPCB has issued a direction to all the State Pollution Control Boards (SPCBs)/Pollution Control Committees (PCCs) on 30/06/2022 to ensure the compliance of Notification published by Ministry on 12/08/2021. The technical guidelines issued by the CPCB in this regard is available at https://cpcb.nic.in/technical-guidelines-3/. All the project proponents are hereby requested to sensitize and create awareness among people working within the Project area as well as its surrounding area on the ban of SUP in order to ensure the compliance of Notification published by this Ministry on 12/08/2021. A report, along with photographs, on the measures taken shall also be included in the six-monthly compliance report being submitted by the project proponents."

We have conducted awareness programme to make the participants understand banning use of Single Use Plastic Items in routine life. Although we have not yet commenced the operation and still in the project phase. We are committed to inculcate the culture of minimal use of plastic material in our daily life by employees and stakeholders since beginning.
Glimpse of awareness programme: -

Annexure - 8

SHYAM STEEL

Shyam Steel Works Private Ltd
Regd. Office Shyam Towers, EN 32, Sector V, Salt Lake, Kolkata 700091
Tel +91 33 4007 4007 Fax +91 33 4007 4010
Mail cs@shyamsteel.com | www.shyamsteel.com
CIN : U28999WB2020PTC241046

CERTIFIED TRUE COPY OF THE RESOLUTION PASSED BY THE BOARD OF DIRECTORS OF SHYAM STEEL WORKS PRIVATE LIMITED HELD AT THE REGISTERED OFFICE OF THE COMPANY AT SHYAM TOWER, EN 32, SECTOR-V, SALT LAKE, KOLKATA – 700091 ON THE 24TH DAY OF DECEMBER, 2021

AUTHORISATION TO MR. DEEPAK CHOWDHARY TO APPLY FOR ENVIRONMENTAL CLEARANCE FOR PROPOSED INTEGRATED STEEL PLANT AT PURULIA

"**RESOLVED THAT** consent of the Board be and is hereby accorded for making application before the concerned officials of Ministry of Environment, Forest & Climate Change, Government of India and other authorities, related to Environmental Clearance for the Company's proposed Integrated Steel Plant to be located at Parcel- II of Jangal Sundari Karmanagari (JSK) project at District- Purulia, West Bengal.

RESOLVED FURTHER THAT Mr. Deepak Chowdhary, be and is hereby authorized to make, sign, execute and submit all such application(s), form(s), letter(s) and all other relevant documents as may be required, to carry out all communication(s), either online or offline, to attend any meetings, to represent the Company before any and all such authorities from time to time, to take decisions, and to do all such acts, things and deeds as may be deemed necessary to give effect to this resolution.

RESOLVED FURTHER THAT the Board be and hereby agrees and undertakes to ratify and confirm that all the action taken by Mr. Deepak Chowdhary shall be binding on the Company.

RESOLVED FURTHER THAT a copy of the resolution be forwarded by any one Director to all concerned."

// certified to be true copy //
For Shyam Steel Works Private Limited,

Govind Beriwal
Director
DIN: 00006100

Specimen Signature

Sl	Name of Authorised Person	Specimen Signature
1	Mr. Deepak Chowdhary	

Attested by:
For Shyam Steel Works Private Limited,

Govind Beriwal
Director
DIN: 00006100

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CORPORATE ENVIRONMENTAL POLICY

"**Shyam Steel Works Private Limited**" has always been conscious about the impact of our activities in spheres of employee welfare measures, social and community initiatives and is forever committed to protect and save the Environment, keeping in mind the Sustainable Development.

This environment policy represents our general position on environmental issues, the policies and practices we adopt for conducting our business. We make continuous efforts to be compliant with all applicable environmental laws and regulations.

Resolution: Shyam Steel Works Private Limited on 08th April 2022, Management has taken a decision on Environment Policy that it is committed to operate the Plant at Jangal Sundari Karmanagari Parcel II, Village/ Mouza Lachhmanpur, Jarukhamar, Siulibari, Digardhi, Shikratyar, Senera & Talshankra, Tehsil/Block-Raghunathpur-1, District-Purulia, West Bengal with the following objectives.

Quality Policy

- Delivering the required products at the right place, at the right time and at the right cost from our Plant form the very backbone of our Principles of Manufacturing.
- We view improvement as a continuous process and is constantly aspiring to achieve for betterment of our core processes, be it manufacturing, quality control, sales or delivery. There is a joint effort to achieve manufacturing excellence.
- We commit towards efficient and sustainable utilization of natural resources.
- Strict monitoring and compliance of the conditions stipulated in Environmental clearance & Environment Protection Act & Rules
- Strict monitoring and compliance of the conditions stipulated in Consent to Establish issued by SPCB.
- Ensuring Implementation and regular operation of air emission control measures.
- Periodical monitoring of all environmental parameters such as Ambient air quality, water quality, noise levels, soil quality, etc. and submission of the same to statutory authorities.
- Maintaining good housekeeping practices.
- The compliance of the EC conditions / SPCB norms will be reported to the Board of Directors at every Six (6) months.
- Appropriate corrective measures will be taken along with sanction of the budget.

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Corporate Environment Responsibility Policy

As a Corporate, We believe that it is our primary responsibility to give best to the society. Giving and sharing what we have received is embedded deeply in us. We will actively pursue to raise the quality of life of people around us. We hold hands in our joint effort to create better tomorrows.

Occupational Health & Safety Policy

We follow the occupational health and safety policy as below

- Create an environment which is safe and secure for everyone in its vicinity, be it a worker, contractor, visitor and even the local community. All identifiable risks and hazards will be treated with the gravest concern.
- To constantly endeavour towards the highest level of health and safety such as injuries, waste and emissions are reduced to the bare minimum.
- Train all employees to work safely and responsibly and thus preventing injury to themselves and others.
- Ensure that optimum conditions exist for the proper execution of all the stipulated health and safety norms.

Compliance Review Mechanism

- Environment Officer will inform Non Compliances to G.M. (Environment)
- G.M. (Environment) will then further inform to Unit Head. The Action plan and target date to close the non-compliance will be formulated by Unit Head in consultation with concern and Environment department.
- Unit head will then inform to the Director (Technical) within 2 days.
- Director (Technical) will inform the Board of Directors about the Non-compliances and Action plan within 3 days.
- Subsequently it will be discussed in the Board Meeting and necessary fund allocation will be approved in the board meeting and accordingly corrective measures will be taken upon in priority basis.
- General Review of compliance on Environmental Clearance / SPCB conditions by the Board of Directors will be carried out at every Six months.

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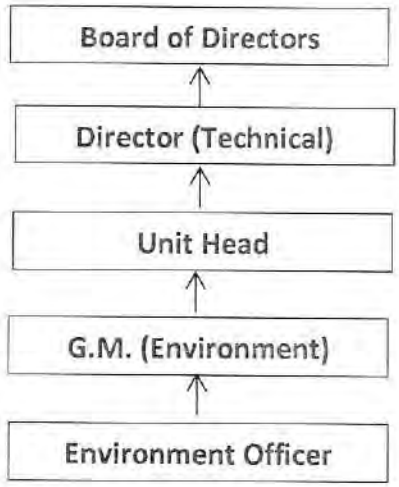
The following will be the communication chart for flow of the information pertaining to Environment Policy.



Place: Kolkata
Date : 21-07-2022

For: Shyam Steel Works Private Limited

DIRECTOR

INDIAN EXPRESS DATED 02.03.2023

PUBLIC NOTICE

Shyam Steel Works Private Limited, Parcel II of Jangal Sundari Karmanagri Project, Village- Lachhmanpur, Block- Raghunathpur-1, PS-Raghunathpur, PO-Ramkanali, Mouza-145, DAG No-290, District- Purulia, PIN Code -723142, West Bengal.

This is to inform that Shyam Steel Works Private Limited has been accorded the Environmental Clearance from MOEF&CC for the establishment of Integrated Steel Plant (Iron Ore Beneficiation Plant (2 x 1.5 MTPA)- 3.0 MTPA, Pellet Plant (2 x 1.2 MTPA) – 2.4 MTPA, Producer Gas Plant (14 x 5000 NM3/Hr.)- 588 MNM3 per annum, DRI Kilns (8 x 600 TPD) – 1.68 MTPA, WHRB Power through DRI kilns – (8 x 15 MW)-120 MW, Through BF - 18 MW, Through Coke Oven- 15 MW and CFBC based Power Plant of (2 x 15 MW)- 30 MW, SMS – IF (18 x 20 T) with LRF(6 X 20 T)- 1.26 MTPA, BOF (1 x 50 T) with LRF (1 x 50 T) and VD unit (1 x 50 T)- 0.525 MTPA and EAF (1 X 50 T) with LRF (1 x 50 T) - 0.175 MTPA, Rolling Mill through hot charging (3 x 1000 TPD) - 1.05 MTPA, Sinter Plant (1 x 100 m2) – 1.092 MTPA , Blast Furnace (1 x 750 m3) – 0.7875 MTPA, Coke Oven Plant (Non recovery) – 0.5 MTPA, Ferro Alloys (4 x 9 MVA)- 0.084 MTPA, Oxygen Plant (1 x 250 TPD) - 0.087 MTPA, Lime & Dolomite Plant (1 x 450 TPD) – 0.1575 MTPA, Brick Manufacturing Unit - 350 Million Bricks/Year and Slag Recycling Plant (1 x 150 TPD) – 0.0525 MTPA) proposed at Jangal Sundari Karmanagri – Parcel II, Village / Mouza-Lachhmanpur, Jarukhamar, Siulibari, Digardhi, Shikratyar, Senera & Talshankra, Tehsil / Block-Raghunathpur-1, District-Purulia, West Bengal. EC Identification No.–EC23A008WB145455 dated 28/02/2023. The copy of the said clearance is available with the PARIVESH portal of MoEF&CC.

AAJKAL DATED 02.03.2023

সাধারণ বিজ্ঞপ্তি

শ্যাম স্টিল ওয়ার্কস প্রাইভেট লিমিটেড, জঙ্গল সুন্দরী কর্মনগরী প্রকল্পের পার্সেল II, গ্রাম-লছমনপুর, ব্লক-রঘুনাথপুর-1, পিএস-রঘুনাথপুর, পোস্ট-রামকানালি, মৌজা-145, দাগ নং-290, জেলা-পুরুলিয়া, পিন কোড-723142, পশ্চিমবঙ্গ।

সকলকে জানানো যাচ্ছে যে শ্যাম স্টিল ওয়ার্কস প্রাইভেট লিমিটেডকে ইন্টিগ্রেটেড স্টিল প্ল্যান্ট স্থাপনের জন্য MOEF&CC থেকে পরিবেশগত ছাড়পত্র দেওয়া হয়েছে (Iron Ore Beneficiation Plant (2 x 1.5 MTPA)- 3.0 MTPA, Pellet Plant (2 x 1.2 MTPA) - 2.4 MTPA, Producer Gas Plant (14 x 5000 NM3/Hr.)- 588 MNM3 per annum, DRI Kilns (8 x 600 TPD) - 1.68 MTPA, WHRB Power through DRI kilns - (8 x 15 MW)-120 MW,Through BF - 18 MW, Through Coke Oven- 15 MW and CFBC based Power Plant of (2 x 15 MW)- 30 MW, SMS - IF (18 x 20 T) with LRF(6 X 20 T)- 1.26 MTPA, BOF (1 x 50 T) with LRF (1 x 50 T) and VD unit (1 x 50 T)- 0.525 MTPA and EAF (1 X 50 T) with LRF (1 x 50 T) - 0.175 MTPA, Rolling Mill through hot charging (3 x 1000 TPD) - 1.05 MTPA, Sinter Plant (1 x 100 m2) - 1.092 MTPA, Blast Furnace (1 x 750 m3) - 0.7875 MTPA, Coke Oven Plant (Non recovery) - 0.5 MTPA, Ferro Alloys (4 x 9 MVA)- 0.084 MTPA, Oxygen Plant (1 x 250 TPD) - 0.087 MTPA, Lime & Dolomite Plant (1 x 450 TPD) - 0.1575 MTPA, Brick Manufacturing Unit - 350 Million Bricks / Year and Slag Recycling Plant (1 x 150 TPD) - 0.0525 MTPA) করার জন্য জঙ্গল সুন্দরী কর্মনগরী-পার্সেল II, গ্রাম / মৌজা-লছমনপুর, জাড়ুখামার, শিউলিবাড়ি, দিগারডি, শিকরাট্যাঁড়, সেনেড়া ও তল সাকরা, তহসিল / ব্লক-রঘুনাথপুর-1, জেলা-পুরুলিয়া, পশ্চিমবঙ্গ-এ প্রস্তাবিত। EC সনাক্তকরণ নম্বর-EC23A008WB145455 dated 28/02/2023. উল্লিখিত ছাড়পত্রের অনুলিপি MoEF&CC-এর PARIVESH পোর্টালে উপলব্ধ।

SHYAM STEEL

Shyam Steel Works Private Ltd
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Tel +91 33 4007 4007 / +91 33 6666 4646
Mail communication@shyamsteel.com | www.shyamsteel.com
CIN : U28999WB2020PTC241046

SSWPL/2023-24/GM/010 Date: 17.04.2023

To,
The District Magistrate,
Office of the District Magistrate,
Collectorate Administrative Building,
PO- Purulia, District: Purulia,
723101 (WB).

Sub: Request for display of Environment Clearance granted by MOEF&CC for our proposed "Greenfield project comprising of Iron Ore Beneficiation Plant 2x1.5 MTPA) - 3.0 MTPA, Pellet Plant (2 x 1.2 MTPA) – 2.4 MTPA, Producer Gas Plant (14 x 5000 NM^3/Hr.)- 588 MNM^3 per annum, DRI Kilns (8x600 TPD) – 1.68 MTPA, WHRB Power through DRI kilns – (8 x 15 MW)-120 MW ,Through BF - 18 MW , Through Coke Oven- 15 MW and CFBC based Power Plant of (2 x 15 MW)- 30 MW, SMS – IF (18 x 20 T) with LRF (6 X 20 T)- 1.26 MTPA, BOF (1 x 50 T) with LRF (1 x 50 T) and VD unit (1 x 50 T)- 0.525 MTPA and EAF (1 X 50 T)with LRF (1 x 50 T) - 0.175 MTPA, Rolling Mill through hot charging (3 x 1000 TPD) - 1.05 MTPA, Sinter Plant (1x 100 m^2) – 1.092 MTPA ,Blast Furnace (1x750 m^3) – 0.7875 MTPA, Coke Oven Plant (Non recovery) – 0.5 MTPA, Ferro Alloys (4 x 9 MVA)- 0.084 MTPA, Oxygen Plant (1x250 TPD) -0.0875 MTPA, Lime & Dolomite Plant (1x 450 TPD) – 0.1575 MTPA, Brick Manufacturing Unit -350 Million Bricks/Year & Slag Recycling Plant (1 x 150 TPD) – 0.0525 MTPA" – ***Submission of copy of environment clearance to the heads of local bodies, panchayats and municipal bodies in addition to the relevant offices of Government.*** – Reg.

Ref: 1. Environment clearance letter issued by MoEF & CC vide **EC Identification No.EC23A008WB145455**), dated 28th February 2023.

Dear Sir,

This has reference to the captioned subject and cited reference, we have been granted environment clearance for our proposed greenfield project at Parcel II of Jangal Sundari Karmanagari Project, Village- Lachhmanpur, Block-Raghunathpur-1, PS- Raghunathpur, PO-Ramkanali, Mouza- 145, DAG No - 290, District- Purulia, PIN Code - 723142, West Bengal. We are herewith submitting the copy of environment clearance to display the same for 30 days and comply the General Condition (X Miscellaneous- Point no-2) to the heads of local bodies, panchayats and municipal bodies in addition to the relevant offices of Government.

SHYAM STEEL

Shyam Steel Works Private Ltd
Regd. Office Shyam Tower, Premises No. 03-319, DH-6/11, Action Area- 1D, Street No 319, New Town, Kolkata-700156
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Mail communication@shyamsteel.com | www.shyamsteel.com
CIN : U28999WB2020PTC241046

We request your good selves to kindly acknowledge the receipt of copy of environment clearance for displaying the same at your respective office for necessary compliance of stipulated condition of Environmental Clearance.

Thanking you,

Yours faithfully,
For SHYAM STEEL WORKS (P) LTD.

Acknowledged 19-04-2023 Pradhan Khajura Gram Panchayat Raghunathpur-I P.S., Dist.-Purulia

Bipul Panigrahi
General Manager -Commercial
91-8145285021

Received Without Verification Dt.- R.N.Pur-I Dev. Block

Sub-Divisional Officer RECEIVED But Contents are not verified 19/04/2023

Pradhan 19/4/2023 Nutandih Gram Panchayat Raghunathpur-I No. B

Encl: As Above
Copy to:

I) **The Sabhadhipati,** Office of the Sabhadhipati, Purulia Zila Parishad, District – Purulia (WB).

II) **The Additional District Magistrate,** Office of the Additional District Magistrate (LR), District – Purulia (WB)

III) **The Sub-Divisional Officer,** Office of the Sub-Divisional Officer, PO & PS- Raghunathpur, District – Purulia (WB).

IV) **The Block Development Officer,** Office of the Block Development Officer, PO&PS- Raghunathpur, Block- Raghunathpur-1, District- Purulia (WB).

v) **The General Manager,** Office of the General Manager, DIC, District – Purulia (WB).

VI) **The Sabhapati,** Office of the Sabhapati, Raghunathpur – 1 Panchayat Samity, District – Purulia (WB).

VII) **The Khajura Gram Pradhan,** Khajura, PO- Senera, PS- Raghunathpur, Block- Raghunathpur-1, District: Purulia (WB).

VIII) **The Nutandih Gram Pradhan,** Nutandih, PO- Uparsankra,PS- Raghunathpur,Block- Raghunathpur-1, District: Purulia (WB).

...T LAND & LAND REFORMS ... RECEIVED But Contents are not verified Date. 18.4.23

OFFICE OF THE GENERAL MANAGER RECEIVED 18/4/23 Contents not verified

...ULIA ZILLA PARISHAD 18.04.23 PURULIA

ENVIRONMENTAL CLEARANCE

PARIVESH

(Pro-Active and Responsive Facilitation by Interactive, and Virtuous Environment Single-Window Hub)

Government of India
Ministry of Environment, Forest and Climate Change
(Impact Assessment Division)

To,

The VP
SHYAM STEEL WORKS (P) LIMITED
SHYAM TOWER, EN 32, SECTOR-V, SALT LAKE,
KOLKATA,,Kolkata,West Bengal-700091

Subject: Grant of Environmental Clearance (EC) to the proposed Project Activity under the provision of EIA Notification 2006-regarding

Sir/Madam,

This is in reference to your application for Environmental Clearance (EC) in respect of project submitted to the Ministry vide proposal number IA/WB/IND1/408696/2022 dated 04 Jan 2023. The particulars of the environmental clearance granted to the project are as below.

1.	**EC Identification No.**	**EC23A008WB145455**
2.	**File No.**	IA-J-11011/228/2021-IA-II(IND-I)
3.	**Project Type**	New
4.	**Category**	A
5.	**Project/Activity including Schedule No.**	3(a) Metallurgical industries (ferrous & non ferrous)
6.	**Name of Project**	Integrated Steel Plant
7.	**Name of Company/Organization**	SHYAM STEEL WORKS (P) LIMITED
8.	**Location of Project**	West Bengal
9.	**TOR Date**	N/A

The project details along with terms and conditions are appended herewith from page no 2 onwards.

Date: 28/02/2023

(e-signed)
Dr. R. B. Lal
Scientist F
IA - (Industrial Projects - 1 sector)

Note: A valid environmental clearance shall be one that has EC identification number & E-Sign generated from PARIVESH.Please quote identification number in all future correspondence.

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IA-J-11011/228/2021-IA-II(IND-I)
Government of India
Ministry of Environment, Forest and Climate Change
(I.A. Division – Industry I sector)
***

Indira Paryavaran Bhawan
Vayu Wing, 3rd Floor,
Jor Bagh Road, Aliganj,
New Delhi – 110003

Dated: 28th February, 2023

To,

M/s Shyam Steel Works (P) LTD,
Shyam Tower, En 32, Sector-V, Salt Lake,
Kolkata-700091
West Bengal
Email: purulia@shyamsteel.com

Project: Greenfield project comprising of Iron Ore Beneficiation Plant 2x1.5 MTPA) - 3.0 MTPA, Pellet Plant (2 x 1.2 MTPA) – 2.4 MTPA, Producer Gas Plant (14 x 5000 NM3/Hr.)- 588 MNM3 per annum, DRI Kilns (8x600 TPD) – 1.68 MTPA, WHRB Power through DRI kilns – (8 x 15 MW)-120 MW ,Through BF - 18 MW , Through Coke Oven- 15 MW and CFBC based Power Plant of (2 x 15 MW)- 30 MW, SMS – IF (18 x 20 T) with LRF (6 X 20 T)- 1.26 MTPA, BOF (1 x 50 T) with LRF (1 x 50 T) and VD unit (1 x 50 T)- 0.525 MTPA and EAF (1 X 50 T)with LRF (1 x 50 T) - 0.175 MTPA, Rolling Mill through bot charging (3 x 1000 TPD) - 1.05 MTPA, Sinter Plant (1x 100 m2) – 1.092 MTPA ,Blast Furnace (1x750 m3) – 0.7875 MTPA, Coke Oven Plant (Non recovery) – 0.5 MTPA, Ferro Alloys (4 x 9 MVA)- 0.084 MTPA, Oxygen Plant (1x250 TPD) -0.087 MTPA, Lime & Dolomite Plant (1x 450 TPD) – 0.1575 MTPA, Brick Manufacturing Unit -350 Million Bricks/Year & Slag Recycling Plant (1 x 150 TPD) – 0.0525 MTPA by M/s Shyam Steel Works (P) LTD., located at Jangal Sundari Karmanagri- Parcel II, Lachhmanpur, Jarukhamar, Siulibari, Digardhi, Shikratyar, Senera & Talsbankra Village/ Mouza, Raghunathpur-1 Tehsil/Block, Purulia District, West Bengal–Grant of Environmental Clearance.

Sir,

This refers to your proposal no. **IA/WB/IND1/408696/2022**dated **04-01-2023** received through PARIVESH Portal for grant of **Environmental Clearance (EC)** for the project mentioned above. Further PP has uploaded the information on Parivesh portal on 03.02.2023.

2. As per the provisions of the Environment Impact Assessment (EIA) Notification, 2006, the above-mentioned project/activity is covered under category '**A**' of schedule no. 3(a) Metallurgical industries (ferrous & non-ferrous) and 1(d) Thermal Power Plants under Category "A" of the schedule of the EIA Notification, 2006 and appraised at Central Level.

3. The above mentioned proposal was considered in the 21st meeting of the EAC for Industry-I sector held on **16-17th January, 2023**, wherein the Committee, after detailed deliberations, recommended the proposal. The minutes of the meeting and all the project documents are available on PARIVESH portal which can be accessed at https://parivesh.nic.in .

4. The details of the proposal are as per the EIA/EMP report submitted by the proponent. The salient features of the proposal as presented during the above-mentioned meetings of EAC (Industry 1 Sector) are as under: -

<table>
<tr><th>S. No.</th><th>Particulars</th><th>Details submitted by PP</th></tr>
<tr><td>a.</td><td>Terms of Reference for undertaking EIA study</td><td>27th January 2022</td></tr>
<tr><td>b.</td><td>Period of baseline data collection</td><td>1st March 2022 to 31st May 2022.</td></tr>
<tr><td>c.</td><td>Date of Public Consultation</td><td>28th September 2022</td></tr>
<tr><td>d.</td><td>Action plan to address the PH issues</td><td>An amount of Rs. 69.09 Crores has been earmarked to address the issues raised during public hearing and need based activity. Detail of activities proposed attached as Annexure 1.</td></tr>
<tr><td>e.</td><td>Location of the project</td><td>Jangal Sundari Karmanagri- Parcel II, Lachhmanpur, Jarukhamar, Siulibari, Digardhi, Shikratyar, Senera & Talshankra Village/ Mouza, Raghunathpur-1 Tehsil/Block, Purulia District, West Bengal</td></tr>
<tr><td>f.</td><td>Latitude and Longitude of the project site</td><td>
<table>
<tr><th>Points</th><th>Latitude</th><th>Longitude</th></tr>
<tr><td>Pt-1</td><td>23°35'03.75"</td><td>86°43'56.92"</td></tr>
<tr><td>Pt-2</td><td>23°35'30.64"</td><td>86°43'33.09"</td></tr>
<tr><td>Pt-3</td><td>23°35'35.96"</td><td>86°43'27.93"</td></tr>
<tr><td>Pt-4</td><td>23°35'36.54"</td><td>86°43'23.3"</td></tr>
<tr><td>Pt-5</td><td>23°35'35.82"</td><td>86°43'19.45"</td></tr>
<tr><td>Pt-6</td><td>23°35'34.23"</td><td>86°43'18.1"</td></tr>
<tr><td>Pt-7</td><td>23°35'32.50"</td><td>86°43'21.24"</td></tr>
<tr><td>Pt-8</td><td>23°35'24.08"</td><td>86°43'19.10"</td></tr>
<tr><td>Pt-9</td><td>23°35'23.89"</td><td>86°43'20.86"</td></tr>
<tr><td>Pt-10</td><td>23°35'16.72"</td><td>86°43'16.96"</td></tr>
<tr><td>Pt-11</td><td>23°35'09.11"</td><td>86°43'19.59"</td></tr>
<tr><td>Pt-12</td><td>23°35'01.54"</td><td>86°42'56.14"</td></tr>
<tr><td>Pt-13</td><td>23°34'38.64"</td><td>86°42'45.5"</td></tr>
<tr><td>Pt-14</td><td>23°34'33.73"</td><td>86°42'47.31"</td></tr>
<tr><td>Pt-15</td><td>23°34'29.12"</td><td>86°42'32.64"</td></tr>
<tr><td>Pt-16</td><td>23°34'16.46"</td><td>86°42'31.62"</td></tr>
<tr><td>Pt-17</td><td>23°34'15.99"</td><td>86°42'37.63"</td></tr>
<tr><td>Pt-18</td><td>23°34'26.63"</td><td>86°42'40.64"</td></tr>
<tr><td>Pt-19</td><td>23°34'32.46"</td><td>86°43'01.35"</td></tr>
<tr><td>Pt-20</td><td>23°34'42.53"</td><td>86°42'58.23"</td></tr>
<tr><td>Pt-21</td><td>23°34'51.62"</td><td>86°43'01.04"</td></tr>
<tr><td>Pt-22</td><td>23°34'44.05"</td><td>86°43'16.41"</td></tr>
<tr><td>Pt-23</td><td>23°34'26.86"</td><td>86°43'23.07"</td></tr>
<tr><td>Pt-24</td><td>23°34'25.23"</td><td>86°43'39.11"</td></tr>
<tr><td>Pt-25</td><td>23°34'28.83"</td><td>86°43'52.66"</td></tr>
<tr><td>Pt-26</td><td>23°34'37.91"</td><td>86°43'51.48"</td></tr>
<tr><td>Pt-27</td><td>23°34'45.1"</td><td>86°43'52.48"</td></tr>
<tr><td>Pt-28</td><td>23°34'48.1"</td><td>86°43'45.99"</td></tr>
<tr><td>Pt-29</td><td>23°35'4.62"</td><td>86°43'45.05"</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>S. No.</th><th>Particulars</th><th>Details submitted by PP</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><td>Pt-30</td><td>23°35'15.68"</td><td>86°43'47.47"</td></tr>
<tr><td>Pt-31</td><td>23°35'14.93"</td><td>86°43'52.00"</td></tr>
<tr><td>Pt-32</td><td>23°35'27.21"</td><td>86°43'53.82"</td></tr>
<tr><td>Pt-33</td><td>23°34'35.53"</td><td>86°43'54.04"</td></tr>
</table>
</td></tr>
<tr><td>g.</td><td>Total land</td><td>242.81 hectares. (600 Acres).</td></tr>
<tr><td>h.</td><td>Land acquisition details as per MoEF&CC O.M. dated 7/10/2014</td><td>Land has been allotted & physical possession given.</td></tr>
<tr><td>i.</td><td>Existence of habitation & involvement of R&R, if any</td><td>Project site: No habitation exists in the plant site.
Hence R&R not applicable.
Study Area
No habitation exists in the project site
<table>
<tr><th>Habitation</th><th>Distance</th><th>Direction</th></tr>
<tr><td>Maharajnagar</td><td>0.02 Kms.</td><td>SE</td></tr>
<tr><td>Lachhmanpur</td><td>0.03 Kms</td><td>E</td></tr>
<tr><td>Shikratyar</td><td>0.06 Kms</td><td>S</td></tr>
<tr><td>Digardhi</td><td>0.05 Kms</td><td>SE</td></tr>
<tr><td>Jarukhamar</td><td>0.54 Kms</td><td>NW</td></tr>
<tr><td>Talshankra</td><td>1.7 Kms</td><td>SW</td></tr>
<tr><td>Senera</td><td>0.85 Kms</td><td>S</td></tr>
</table>
</td></tr>
<tr><td>j.</td><td>Elevation of the project site</td><td>129 m to 160 m AMSL</td></tr>
<tr><td>k.</td><td>Involvement of Forest land if any.</td><td>No involvement of Forest Land.</td></tr>
<tr><td>l.</td><td>Water body exists within the project site as well as study area</td><td><u>Project Site</u> :
<table>
<tr><th>Water Body</th><th>Distance</th></tr>
<tr><td>2 nos. of Ponds in Digardhi Village</td><td>Within the site</td></tr>
<tr><td>1 no. of pond in Lachhmanpur Village</td><td>Within the site</td></tr>
<tr><td>1 no. of pond in Siulibari Village</td><td>Within the site</td></tr>
</table>
Stream is passing along South West Boundary toward North direction approaching Panchet Reservoir

<u>Study area:</u>
<table>
<tr><th>Water Body</th><th>Distance</th><th>Direction</th></tr>
<tr><td>UttalaNadi</td><td>3.5 Kms</td><td>NW</td></tr>
<tr><td>Panchet Reservoir</td><td>8.0 Kms</td><td>NNE</td></tr>
<tr><td>Panchet Dam</td><td>9.0 Kms</td><td>NNE</td></tr>
<tr><td>Ramachandrapur Reservoir</td><td>10.2 Kms</td><td>E</td></tr>
<tr><td>Maharajnagar Village Pond</td><td>0.4 Kms</td><td>SE</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>S. No.</th><th>Particulars</th><th>Details submitted by PP</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><td>Sikratyar village pond</td><td>Adjacent</td><td>S</td></tr>
<tr><td>Kelahi village pond</td><td>0.5 Kms</td><td>W</td></tr>
<tr><td>Durmut Village Pond</td><td>2.9 Kms</td><td>W</td></tr>
<tr><td>Garh Panchkot Village Pond</td><td>3.8 Kms</td><td>NEE</td></tr>
</table>
Few seasonal nalas, ponds exist within the study area</td></tr>
<tr><td>m.</td><td>Existence of ESZ / ESA / national park / wildlife Sanctuary / biosphere Reserve / tiger reserve / elephant reserve etc. if any within the study area</td><td>Nil
List of Reserved and protected forests.
<table>
<tr><th>Name</th><th>Distance</th></tr>
<tr><td>Senara R.F.</td><td>0.05 Kms. (S)</td></tr>
<tr><td>Indira Pahari P.F.</td><td>0.12 Kms. (SSW)</td></tr>
<tr><td>Panchet R.F</td><td>2.8 Kms. (NNE)</td></tr>
<tr><td>Bindabanpur P.F.</td><td>2.0 Kms. (SE)</td></tr>
<tr><td>Muktipur P.F.</td><td>4.0 Kms. (SEE)</td></tr>
<tr><td>Bheti P.F.</td><td>5.5 Kms. (SEE)</td></tr>
<tr><td>Dubrajpur PF</td><td>6.5 Kms. (SEE)</td></tr>
<tr><td>Dandahit PF</td><td>11.6 Kms. (SEE)</td></tr>
<tr><td>Unnamed PF</td><td>0.65 Kms. (SW)</td></tr>
<tr><td>Unnamed PF</td><td>1.6 Kms. (NW)</td></tr>
</table></td></tr>
<tr><td>n.</td><td>Project cost</td><td>The capital cost of the project is Rs. 4591 Crores</td></tr>
<tr><td>o.</td><td>EMP cost</td><td>
<table>
<tr><th>Type</th><th>Capital (Rs. in Crores)</th><th>Recurring (Rs. in Crores)</th></tr>
<tr><td>Proposed</td><td>182.5 Crores</td><td>Rs. 40.0 Crores</td></tr>
</table></td></tr>
<tr><td>p.</td><td>Employment opportunity</td><td>The employment generation from the proposed project is 8,000 nos.</td></tr>
<tr><td>q.</td><td>Water and Power requirement</td><td>Water – Estimated as 30,743 KLD
The power requirement for the project is estimated as 256.60 MW</td></tr>
</table>

Unit configuration and capacity:

S. No.	Unit (product)	Unit configuration	Production capacity
1	Iron ore beneficiation plant (I/O concentrate)	2 x 1.5 MTPA	3.0 MTPA
2	Pelletization Plant (pellets)	2 x 1.2 MTPA	2.4 MTPA
3	Producer Gas Plant (Producer Gas)	14 X 5000 NM^3/HR	588 MNM^3 /annum
4	DRI Kiln (Sponge Iron)	8 x 600 TPD	1.68 MTPA
5	Power generation through WHRB from DRI Kiln	8 x 15 MW	120 MW
6	Power generation through WHRB from Blast Furnace	1 x 18 MW	18 MW
7	Power generation through WHRB from Coke Oven	1 x 15 MW	15 MW
8	Power generation through CFBC Boiler	2 x 15 MW	30 MW
9	SMS {IF+LRF} – (Hot Billets / M.S.Billets)	18 x 20 T	1.26 MTPA
10	SMS {BOF+LRF*+ VD} - (Hot Billets / M.S.Billets)	1 x 50 T	0.525 MTPA
11	SMS (EAF+LRF*) - (Hot Billets / M.S.Billets)	1 x 50 T	0.175 MTPA
12	Rolling Mill through Hot charging (Rolled	3 x 1000 TPD	1.05 MTPA

S. No.	Unit (product)	Unit configuration	Production capacity
	products i.e. TMT bars / Angles / Channels e.t.c) 85% Hot charging + 15% through RHF		
13	Blast Furnace (Pig Iron)	1 x 750 m^3	0.7875 MTPA
14	Coke oven plant (Coke)	1 x 0.5 MTPA	0.5 MTPA
15	Sinter Plant (Sinter)	1 x 100 m^2	1.092 MTPA
16	Ferro Alloy Unit (FeMn (or) SiMn (or) FeCr (or) Pig Iron)	4 x 9 MVA	0.084 MTPA
17	Oxygen Plant	1 x 250 TPD	0.0875 MTPA
18	Lime & Dolomite Plant	1 x 450 TPD	0.1575 MTPA
19	Brick Manufacturing plant	10 Lakh Bricks /day	350 Million Bricks /annum
20	Slag Recycling Plant	1 x 150 TPD	0.0525 MTPA
Note - * Mentioned LRF is common for BOF & EAF **Note: Briquetting plant of 400 Kg/hr will be provided for effective dust emission management.**			

5. The EAC, in its meeting held **during 16-17th January, 2023,** inter-alia, deliberated the following:

i. The instant proposal is for setting up of a new Integrated Steel plant comprising of Iron Ore Beneficiation Plant (2x1.5 MTPA) - 3.0 MTPA, Pellet Plant (2 x 1.2 MTPA) – 2.4 MTPA, Producer Gas Plant (14 x 5000 NM^3/Hr.)- 588 MNM3 per annum, DRI Kilns (8x600 TPD) – 1.68 MTPA, WHRB Power through DRI kilns – (8 x 15 MW)-120 MW ,Through BF - 18 MW , Through Coke Oven- 15 MW and CFBC based Power Plant of (2 x 15 MW)- 30 MW, SMS – IF (18 x 20 T) with LRF (6 X 20 T)- 1.26 MTPA, BOF (1 x 50 T) with LRF (1 x 50 T) and VD unit (1 x 50 T)- 0.525 MTPA and EAF (1 X 50 T)with LRF (1 x 50 T) - 0.175 MTPA, Rolling Mill through hot charging (3 x 1000 TPD) - 1.05 MTPA, Sinter Plant (1x 100 m2) – 1.092 MTPA ,Blast Furnace (1x750 m^3) – 0.7875 MTPA, Coke Oven Plant (Non recovery) – 0.5 MTPA, Ferro Alloys (4 x 9 MVA)- 0.084 MTPA, Oxygen Plant (1x250 TPD) -0.087 MTPA, Lime & Dolomite Plant (1x 450 TPD) – 0.1575 MTPA, Brick Manufacturing Unit -350 Million Bricks/Year & Slag Recycling Plant (1 x 150 TPD) – 0.0525 MTPA.

ii. The EAC, constituted under the provision of the EIA Notification, 2006 comprising Expert Members/domain experts in various fields, examined the proposal submitted by the Project Proponent in desired format along with EIA/EMP reports prepared and submitted by the Consultant accredited by the QCI/ NABET on behalf of the Project Proponent.

iii. The EAC noted that the Project Proponent has given an undertaking that the data and information given in the application and enclosures are true to the best of his knowledge and belief and no information has been suppressed in the EIA/EMP reports. If any part of data/information submitted is found to be false/ misleading at any stage, the project will be rejected and Environmental Clearance given, if any, will be revoked at the risk and cost of the project proponent.

iv. The Committee noted that the EIA reports are in compliance of the ToR issued for the project, reflecting the present environmental status and the projected scenario for all the environmental components. The Committee deliberated on the proposed mitigation measure towards Air, Water, Noise and Soil pollutions. The Committee suggested that the storage of toxic/explosive raw materials/products shall be undertaken with utmost precautions and following the safety norms and best practices.

v. It was informed by the project proponent that Environment Clearance for the project site mentioned above was accorded by the Ministry vide letter no. J-11011/1283/2007-IA.II(I) dated 5/01/2010. However, the project activity could not be commenced due to financial issues. Subsequently, the land as well as EC was surrendered to WBIDC and MoEF&CC respectively. Therefore, proposed project is a Greenfield project.

vi. The nearest human settlement from the site are Maharajnagar (0.02 Km, SE), Lachhmanpur (0.03 Km, E), Shikratyar (0.06 Km, S), Digardhi (0.05 Km, SE), Jarukhamar (0.54 Km, NW), Talshankra (1.7 Km, SW) and Senera (0.85 Km, S). The EAC advised that Project Proponent shall take appropriate environmental safeguard measures to minimise the impact on the habitation of the locals. The PP shall also include some of these locations in its environmental monitoring programme.

vii. There are 2 ponds in Digardhi village, a pond in Lachhmanpur and a pond in Siulibari village within the project site. There is Stream is passing along South West Boundary toward North direction approaching Panchet Reservoir. Apart from these UttalaNadi (3.5 Km, NW), Panchet Reservoir (8.0 Km, NNE), Panchet Dam (9.0 Km, NNE), Ramachandrapur Reservoir (10.2 Km, E), Maharajnagar Village Pond (0.4 Km, SE), Sikratyar village pond (Adjacent, S), Kelahi village pond (0.5 Km, W), Durmut Village Pond (2.9 Km, W), and Garh Panchkot Village Pond (3.8 Km, NEE) exists within the study area of the project site. The EAC is of the opinion that water body shall not be disturbed. Mitigation measures w.r.t. safeguarding the water body shall be implemented.

viii. 30,743 KLD water will be required for the proposed project; which will be sourced from Panchet Reservoir of Damodar Valley Corporation.

ix. Greenbelt will be developed in 81.94 Ha. (202.5 Acres) out of 242.811 Ha. of land which is about 34% of the total project area. Total no. of plants will be 2,05,000 nos. which is 2500 nos. of plants will be planted per Hectare as per CPCB norms. nurtured within 4 years from the date of receipt of EC. The Committee deliberated on the action plan and budget allocation for green belt development and found it satisfactory.

x. It is proposed to cut 470 nos. of trees as part of proposed project. Tree Cutting Permission has been obtained from Forest Department, Raghunathpur Range, Kangsabati North Division by making required payment. Compensatory afforestation will be taken up @ 5 trees/plant is 2,350 nos. within the project site premises, which accounts to 1.0 Ha. additional Greenbelt.

xi. The Committee has found that the baseline data and incremental GLC due to the proposed project within NAAQ standards.

xii. The committee deliberated details of carbon foot prints and carbon sequestration study w.r.t. proposed project and found them to be satisfactory.

xiii. The Committee also deliberated on the public hearing issues along with revised action plan submitted by the proponent to address the issues raised during the public hearing and found it satisfactory.

xiv. The Committee deliberated upon the written submission of the Project Proponent and found it satisfactory.

xv. The Committee also deliberated upon the letter of State Forest Department w.r.t. non-involvement of forest land and found it satisfactory.

xvi. During deliberation, the stated that there will generation of tailing about 0.5 million ton per year through filter press and they are putting matching capacity brick manufacturing plant to consume the tailing. The PP also appraised that they will maintain a stock of solid tailing production of 45 days in the designated area.

xvii. The EAC deliberated on the proposal with due diligence in the process as notified under the provisions of the EIA Notification, 2006, as amended from time to time and accordingly made the recommendations to the proposal. The Experts Members of the EAC found the proposal in order and recommended for grant of environmental clearance.

xviii. The environmental clearance recommended to the project/activity is strictly under the provisions of the EIA Notification 2006 and its subsequent amendments. It does not tantamount/construe to approvals/consent/permissions etc. required to be obtained or standards/conditions to be followed under any other Acts/ Rules/ Subordinate legislations, etc., as may be applicable to the project. The project proponent shall obtain necessary permission as mandated under the Water (Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of Pollution) Act, 1981, as applicable from time to time, from the State Pollution Control Board, prior to construction & operation of the project.

6. The EAC, in **its 21st meeting of Expert Appraisal Committee (Industry-1 Sector) held on 16-17th January, 2023,** based on information & clarifications provided by the project proponent and after detailed deliberations **recommended** the instant proposal for grant of Environment Clearance subject to uploading the written submission on portal under the provisions of EIA Notification, 2006 subject to the stipulation of following specific conditions and general conditions as per the Ministry's Office Memorandum No. 22-34/2018-III dated 9/8/2018 based on project specific requirements:

7. The MoEF&CC has examined the proposal in accordance with the Environment Impact Assessment (EIA) Notification, 2006 & further amendments thereto and after accepting the recommendations of the Expert Appraisal Committee (Industry-1 Sector) hereby decided to grant **Environment Clearance for instant proposal of M/s Shyam Steel Works (P) LTD** under the provisions of EIA Notification, 2006 subject to the following specific conditions and general conditions:

A. <u>Specific conditions:</u>

(i) The company shall comply with all the environmental protection measures and safeguards proposed in the documents submitted to the Ministry. All the recommendations made in the EIA/EMP in respect of environmental management, and risk mitigation measures relating to the project shall be implemented.

(ii) The project proponent shall utilize modern technologies for capturing of carbon emitted and shall also develop carbon sink/carbon sequestration resources capable of capturing more than emitted. The implementation report shall be submitted to the IRO, MoEF&CC in this regard.

(iii) Tailings from Iron Ore washing plant shall be dewatered in filter press and stored dry maximum for a period of 45 days inside the plant premises.

(iv) Solid waste utilization

a. Maximum 90 days of slag storage area shall be permitted inside the plant.

b. PP shall install a slag crusher to convert steel slag into aggregate for use in construction industry, fine sand for use as flux in steel plant, sand in brick making and as lime in cement making.

c. PP shall recycle/reuse 100 % solid waste generated in the plant.

d. Carbon recovery plant to recover the elemental carbon present in GCP slurries for use in Sinter plant shall be installed.

e. Used refractories shall be recycled as far as possible.

(v) Sinter Plant

a. Sinter cooler waste recovery system shall be installed to generate process steam or power.

b. Equipped with MEROS technology to reduce emission of SO2, NOx and heavy metals.

(vi) Coke Oven Plant

a. Coke Dry Quenching (CDQ) shall be installed.

b. Coke Oven Gas shall be desulfurized.

c. Tar sludge shall be mixed with coal and reused.

(vii) BF shall be equipped with Top Recovery Turbine, dry gas cleaning plant, stove waste heat recovery, cast house and stock house ventilation system and slag granulation facility.

(viii) Secondary fume extraction system shall be installed on converters of Steel Melting Shop.

(ix) Basic Oxygen Furnace (BOF) gas shall be cleaned dry.

(x) Waste Heat Recovery system for charge preheating shall be included for Electric Arc Furnace.

(xi) Action plan for setting up of captive railway siding for transportation of materials shall be implemented.

(xii) Submerged Arc Furnace and Electric Arc Furnace shall be closed type with 4th hole extraction system.

(xiii) 85-90 % of billets/slabs shall be rolled directly in hot stage. Only 10-15 % rolling shall be done through RHF using only Light Diesel Oil or Mixed BF/CO gas.

(xiv) Dust emission from Steel Plant stacks shall not exceed 30 mg/Nm^3.

(xv) The nearest human settlement from the site are Maharajnagar (0.02 Km, SE), Lachhmanpur (0.03 Km, E), Shikratyar (0.06 Km, S), Digardhi (0.05 Km, SE), Jarukhamar (0.54 Km, NW), Talshankra (1.7 Km, SW) and Senera (0.85 Km, S). Project Proponent shall take appropriate environmental safeguard measures to minimise the impact on the habitation of the locals. The PP shall also include some of these locations in its environmental monitoring programme.

(xvi) 30,743 KLD water will be required for the proposed project; which will be sourced from Panchet Reservoir of Damodar Valley Corporation. Necessary permission shall be obtained from the Competent Authority in this regard. No ground water extraction is permitted.

(xvii) There are 2 ponds in Digardhi village, a pond in Lachhmanpur and a pond in Siulibari village within the project site. Action plan for conservation of Digardhi Village Pond and Sikratyar village pond shall be strictly implemented.

(xviii) There is Stream is passing along South West Boundary toward North direction approaching Panchet Reservoir. Apart from these UttalaNadi (3.5 Km, NW), Panchet Reservoir (8.0 Km, NNE), Panchet Dam (9.0 Km, NNE), Ramachandrapur Reservoir (10.2 Km, E), Maharajnagar Village Pond (0.4 Km, SE), Sikratyar village pond (Adjacent, S), Kelahi village pond (0.5 Km, W), Durmut Village Pond (2.9 Km, W), and Garh Panchkot Village Pond (3.8 Km, NEE) exists within the study area of the project site. A robust and full proof Drainage Conservation scheme to protect the natural drainage and its flow parameters; along with Soil conservation scheme and multiple Erosion control measures shall be implemented.

(xix) PP shall undertake village adoption and formulate Village Adoption program consisting of need-based community development activities, shall be prepared to develop them into model villages. PP shall submit details of the villages to be adopted.

(xx) The Action Plan for the Panch-tatva (5 commitments) including fossil fuel reduction road map and net-zero carbon emissions shall be strictly implemented.

(xxi) The proposed project shall be designed as "Zero Liquid Discharge" Plant. ETP shall be installed and there shall be no discharge of effluent from the plant. Domestic effluent shall be treated in Sewage Treatment Plant. MSW waste shall be treated in digester and recovered gas shall be used in the canteen.

(xxii) The company shall also undertake rain water harvesting measures as per the plan submitted in the EIA/EMP report and reduce water dependence from the outside source.

(xxiii) All stockyards shall be having impervious flooring and shall be equipped with water spray system for dust suppression. Stock yards shall also have garland drains to trap the run off material.

(xxiv) All internal and connecting road to the Highway shall be black topped/ concreted with suitable load in term of Million Standard Axle (MSA) as per IRC guidelines.

(xxv) Three tier Green Belt shall be developed covering at least 33% of the total project area maximum in the 1st year with native species all along the periphery of the project site of adequate width and tree density shall not be less than 2500 per ha. Survival rate of green belt developed shall be monitored on periodic basis to ensure that damaged plants are replaced with new plants in the subsequent years. PP shall develop greenbelt in the form of shelter belt comprising of total of 6 rows of 2x2 m plantation with tall trees & broad leaves with thick canopy to act as green barrier for air pollution & noise levels towards the villages namely Maharajnagar (0.02 Kms), Lachhmanpur (0. 03 kms),Shikratyar (0.06 Kins) and Digardhi (0.05 kms) inside the plant premises. Compliance status in this regard, shall be submitted to concerned Regional Office of the MoEF&CC.

(xxvi) Greening and Paving shall be implemented in the plant area to arrest soil erosion and dust pollution from exposed soil surface.

(xxvii) Performance test shall be conducted on all pollution control systems every year and report shall be submitted to Regional Office of the MoEF&CC.

(xxviii) Parking area for trucks/dumpers shall be provided within the steel plant. No truck/dumper shall be parked outside the steel plant premises.

(xxix) Air Cooled condensers shall be used in the captive power plant.

(xxx) A proper action plan must be implemented to dispose of the electronic waste generated in the industry.

(xxxi) The environmental issues arising out from the route for producing of billets shall be controlled and mitigation measures be implemented.

(xxxii) All the recommendations made in the risk assessment report shall be implemented and compliance status in this regard shall be furnished to the Regional Office of the MoEF&CC along with the six monthly compliance report.

(xxxiii) All the commitments made to the public during the Public Hearing/Public Consultation shall be satisfactorily implemented. The action plan based on the social impact assessment study of the project as per the EMP in accordance to the Ministry's OM dated 30.09.2020 shall be strictly implemented and progress shall be submitted to the Regional Office of MoEF&CC.

(xxxiv) The Plastic Waste Management Rules 2016, inter-alia, mandated banning of identified Single Use Plastic (SUP) items with effect from 01/07/2022. In this regard, CPCB has issued a direction to all the State Pollution Control Boards (SPCBs)/Pollution Control Committees (PCCs) on 30/06/2022 to ensure the compliance of Notification published by Ministry on 12/08/2021. The technical guidelines issued by the CPCB in this regard is available at

https://cpcb.nic.in/technical-guidelines-3/. All the project proponents are hereby requested to sensitize and create awareness among people working within the Project area as well as its surrounding area on the ban of SUP in order to ensure the compliance of Notification published by this Ministry on 12/08/2021. A report, along with photographs, on the measures taken shall also be included in the six monthly compliance report being submitted by the project proponents.

(xxxv) The project proponent shall adopt the Clean Air practices like mechanical collectors, wet scrubbers, fabric filters (bag houses), electrostatic precipitators, combustion systems (thermal oxidizers), condensers, absorbers, adsorbers, and biological degradation. Controlling emissions related to transportation shall include emission controls on vehicles as well as use of cleaner fuels. Sufficient numbers of additional truck mounted Fog/Mist water cannons shall be procured and operated regularly inside the project premises and also in the surrounding villages to arrest suspended dust in the atmosphere.

B. General conditions

I. Statutory compliance:

i. The Environment Clearance (EC) granted to the project/ activity is strictly under the provisions of the EIA Notification, 2006 and its amendments issued from time to time. It does not tantamount/ construe to approvals/ consent/ permissions etc., required to be obtained or standards/conditions to be followed under any other Acts/Rules/Subordinate legislations, etc., as may be applicable to the project.

II. Air quality monitoring and preservation

i. The project proponent shall install 24x7 continuous emission monitoring system at process stacks to monitor stack emission as well as 06 Nos. Continuous Ambient Air Quality Station (CAAQS) for monitoring AAQ parameters with respect to standards prescribed in Environment (Protection) Rules 1986 as amended from time to time. The CEMS and CAAQMS shall be connected to SPCB and CPCB online servers and calibrate these systems from time to time according to equipment supplier specification through labs recognized under Environment (Protection) Act, 1986 or NABL accredited laboratories.

ii. The project proponent shall monitor fugitive emissions in the plant premises at least once in every quarter through laboratories recognized under Environment (Protection) Act, 1986 or NABL accredited laboratories.

iii. Sampling facility at process stacks and at quenching towers shall be provided as per CPCB guidelines for manual monitoring of emissions.

iv. Appropriate Air Pollution Control (APC) system shall be provided for all the dust generating points including fugitive dust from all vulnerable sources, so as to comply prescribed stack emission and fugitive emission standards.

v. The project proponent shall provide leakage detection and mechanized bag cleaning facilities for better maintenance of bags.

vi. Sufficient number of mobile or stationery vacuum cleaners shall be provided to clean plant roads, shop floors, roofs, regularly.

vii. Recycle and reuse iron ore fines, coal and coke fines, lime fines and such other fines collected in the pollution control devices and vacuum cleaning devices in the process after briquetting/ agglomeration.

viii. The project proponent use leak proof trucks/dumpers carrying coal and other raw materials and cover them with tarpaulin.

ix. Facilities for spillage collection shall be provided for coal and coke on wharf of coke oven batteries (Chain conveyors, land based industrial vacuum cleaning facility).

x. Land-based APC system shall be installed to control coke pushing emissions.

xi. Monitor CO, HC and O_2 in flue gases of the coke oven battery to detect combustion efficiency and cross leakages in the combustion chamber.

xii. Vapor absorption system shall be provided in place of vapour compression system for cooling of coke oven gas in case of recovery type coke ovens.

xiii. Wind shelter fence and chemical spraying shall be provided on the raw material stock piles.

xiv. Design the ventilation system for adequate air changes as per prevailing norms for all tunnels, motor houses, Oil Cellars.

III. Water quality monitoring and preservation

i. The project proponent shall install 24x7 continuous effluent monitoring system with respect to standards prescribed in Environment (Protection) Rules 1986 vide G.S.R 277 (E) dated 31st March 2012 (Integrated Iron & Steel); G.S.R 414 (E) dated 30th May 2008 (Sponge Iron) as amended from time to time; S.O. 3305 (E) dated 7th December 2015 (Thermal Power Plants) as amended from time to time and connected to SPCB and CPCB online servers and calibrate these system from time to time according to equipment supplier specification through labs recognized under Environment (Protection) Aet, 1986 or NABL accredited laboratories.

ii. The project proponent shall monitor regularly ground water quality at least twice a year (pre- and post-monsoon) at sufficient numbers of piezometers/sampling wells in the plant and adjacent areas through labs recognized nnder Environment (Protection) Act, 1986 and NABL accredited laboratories.

iii. The project proponent shall provide the ETP for coke oven and by-product to meet the standards prescribed in G.S.R 277 (E) dated 31st March 2012 (Integrated iron & Steel); G.S.R 414 (E) dated 30th May 2008 (Sponge Iron) as amended from time to time; S.O. 3305 (E) dated 7th December 2015 (Thermal Power Plants) as amended from time to time as amended from time to time;

iv. Sewage Treatment Plant shall be provided for treatment of domestic wastewater to meet the prescribed standards.

v. Garland drains and collection pits shall be provided for each stock pile to arrest the run-off in the event of heavy rains and to check the water pollution due to surface run off.

vi. Tyre washing facilities shall be provided at the entrance of the plant gates.

vii. Treated water from ETP of COBP shall not be used for coke quenching.

viii. Water meters shall be provided at the inlet to all unit processes in the steel plants.

IV. Noise monitoring and prevention

i. Noise pollution shall be monitored as per the prescribed Noise Pollution (Regulation and Control) Rules, 2000 and report in this regard shall be submitted to Regional Officer of the Ministry as a part of six-monthly compliance report.

V. Energy Conservation measures

i. Use torpedo ladle for hot metal transfer as far as possible. If ladles not used, provide covers for open top ladles.

ii. Restrict Gas flaring to < 1%.

iii. Provide solar power generation on roof tops of buildings, for solar light system for all common areas, street lights, parking around project area and maintain the same regularly;

iv. Provide LED lights in their offices and residential areas.

v. Ensure installation of regenerative type burners on all reheating furnaces.

VI. Waste management

i. Oil Collection pits shall be provided in oil cellars to collect and reuse/recycle spilled oil. Oil collection trays shall be provided under coils on saddles in cold rolled coil storage area.

ii. Kitchen waste shall be composted or converted to biogas for further use.

VII. Green Belt

i. The project proponent shall prepare GHG emissions inventory for the plant and shall submit the programme for reduction of the same including carbon sequestration by trees.

ii. Project proponent shall submit a study report on Decarbonisation program, which would essentially consist of company's carbon emissions, carbon budgeting/ balancing, carbon sequestration activities and carbon offsetting strategies. Further, the report shall also contain time bound action plan to reduce its carbon intensity of its operations and supply chains, energy transition pathway from fossil fuels to Renewable energy etc. All these activities/ assessments should be measurable and monitorable with defined time frames", when PP comes for EC proposal. This study shall be formulated keeping in view of India's Net-zero commitment at the COP-26 Climate Summit.

VIII. Public hearing and Human health issues

i. Emergency preparedness plan based on the Hazard identification and Risk Assessment (HIRA) and Disaster Management Plan shall be implemented.

ii. The project proponent shall carry out heat stress analysis for the workmen who work in high temperature work zone and provide Personal Protection Equipment (PPE) as per the norms.

iii. Occupational health surveillance of the workers shall be done on a regular basis and records maintained.

IX. Environment Management

i. The project proponent shall comply with the provisions contained in this Ministry's OM vide F.No. 22-65/2017-IA.III dated 30/09/2020. As part of Corporate Environment Responsibility (CER) activity, company shall adopt nearby villages, based on the socio-economic survey and undertake community developmental activities in consultation with the village Panchayat and the District Administration as committed by tbe PP.

ii. The company shall have a well laid down environmental policy duly approve by the Board of Directors. The environmental policy should prescribe for standard operating procedures to have proper checks and balances and to bring into focus any infringements/deviation/ violation of the environmental / forest / wildlife norms / conditions. The company shall have defined system of reporting infringements / deviation / violation of the environmental / forest / wildlife norms / conditions and / or shareholders / stake holders. The copy of the board resolution in this regard shall be submitted to the MoEF&CC as a part of six-monthly report.

iii. A separate Environmental Cell both at the project and company head quarter level, with qualified personnel shall be set up under the control of senior Executive, who will directly to the head of the organization.

X. Miscellaneous

i. The project proponent shall make public the environmental clearance granted for their project along with the environmental conditions and safeguards at their cost by prominently advertising it at least in two local newspapers of the District or State, of which one shall be in the vernacular language within seven days and in addition this shall also be displayed in the project proponent's website permanently.

ii. The copies of the environmental clearance shall be submitted by the project proponents to the Heads of local bodies, Panchayats and Municipal Bodies in addition to the relevant offices of the Government who in turn has to display the same for 30 days from the date of receipt.

iii. The project proponent shall upload the status of compliance of the stipulated environment clearance conditions, including results of monitored data on their website and update the same on half-yearly basis.

iv. The project proponent shall monitor the criteria pollutants level namely; PM10, SO2, NOx (ambient levels as well as stack emissions) or critical sectoral parameters, indicated for the projects and display the same at a convenient location for disclosure to the public and put on the website of the company.

v. The project proponent shall submit six-monthly reports on the status of the compliance of the stipulated environmental conditions on the website of the ministry of Environment, Forest and Climate Change at environment clearance portal.

vi. The project proponent shall submit the environmental statement for each financial year in Form-V to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently and put on the website of the company.

vii. The project proponent shall inform the Regional Office as well as the Ministry, the date of financial closure and final approval of the project by the concerned authorities, commencing the land development work and start of production operation by the project.

viii. The project proponent shall abide by all the commitments and recommendations made in the EIA/EMP report, commitment made during Public Hearing and also that during their presentation to the Expert Appraisal Committee.

ix. The PP shall put all the environment related expenditure, expenditure related to Action Plan on the PH issues, and other commitments made in the EIA/EMP Report etc. in the company web site for the information to public/public domain. The PP shall also put the information on the left over funds allocated to EMP and PH as committed in the earlier ECs and shall be carried out and spent in next three years, in the company web site for the information to public/public domain.

x. No further expansion or modifications in the plant shall be carried out without prior approval of the Ministry of Environment, Forests and Climate Change (MoEF&CC).

xi. The Regional Office of this Ministry shall monitor compliance of the stipulated conditions. The project authorities should extend full cooperation to the officer (s) of the Regional Office by furnishing the requisite data / information/monitoring reports.

8. The Ministry reserves the right to stipulate additional conditions, if found necessary at subsequent stages and the project proponent shall implement all the said conditions in a time bound manner. The Ministry may revoke or suspend the environmental clearance, if implementation of any of the above conditions is not found satisfactory.

9. Concealing factual data or submission of false/fabricated data and failure to comply with any of the conditions mentioned above may result in withdrawal of this clearance and attract action under the provisions of the Environment (Protection) Act, 1986.

10. Any appeal against this environmental clearance shall lie with the National Green Tribunal, if preferred, within a period of 30 days as prescribed under Section 16 of the National Green Tribunal Act, 2010.

11. The above conditions shall be enforced, *inter-alia* under the provisions of the Water (Prevention & Control of Pollution) Act, 1974, the Air (Prevention & Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986, Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 and the Public Liability Insurance Act, 1991 along with their amendments and Rules and any other orders passed by the Hon'ble Supreme Court of India / High Courts and any other Court of Law relating to the subject matter.

12. This issues with approval of the competent authority.

(Dr. R. B. Lal)
Scientist 'F'/ Director
Tel: 011-20819346
Email-rb.lal@nic.in

Encl. as above at Annexure –I

Copy to: -

1. The Secretary, Department of Environment, Government of West Bengal, Secretariat Kolkata.
2. The Secretary, Department of Forests, Government of West Bengal, Kolkata.
3. The Director General of Forest, Ministry of Environment, Forest and Climate Change, New Delhi.
4. The Principal Chief Conservator of Forests, Government of West Bengal, Block LA, 10A Sector-III, Salt Lake City, Kolkata-700098.
5. The Deputy Director General of Forests (C), Integrated Regional Office, Ministry of Environment, Forest and Climate Change, IB-198, Sector-II, Salt Lake City, Kolkata – 700106
6. The Member Secretary, Central Pollution Control Board, CBD-Cum-Office Complex, East Arjun Nagar, New Delhi-110 032.
7. The Member Secretary, West Bengal State Pollution Control Board, Paribesh Bhawan, 10A-Block LA, Sector –III, Salt Lake City, Kolkata – 700 098.
8. The Member Secretary, Central Ground Water Authority, Jamnagar House, 18/11, Man Singh Road Area, New Delhi 110001.

9. Monitoring Cell, Ministry of Environment, Forest and Climate Change, Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi.
10. District Collector, Puruliа, District, West Bengal.
11. Guard File/Monitoring File/Website/Record File/ Parivesh Portal

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Annexure – 1

Table: Action Plan as per Ministry's O.M. dated 30/09/2020

S. No.	MAJOR ACTIVITY HEADS		YEAR OF IMPLEMENTATION					TOTAL EXPENDITURE (Rs. in Lakhs)
			1st Year (Rs. in Lakhs)	2nd Year (Rs. in Lakhs)	3rd Year (Rs. in Lakhs)	4th Year (Rs. in Lakhs)	5th Year (Rs. in Lakhs)	
A). Based on Need Based & SIA Study								
1	**Community & Infrastructure Development**							
	i) Impart technical training to the local youth and women for skill development @ 100000 per candidate.	**Physical Nos. & village**	100 nos of local youth and women will be imparted training for skill development from 2 nos of villages i.e. Lachhmanpur & Siulibari,	90 nos of local youth and women will be imparted training for skill development from 2 nos of villages i.e. Jarukhamar & Maharajnagar	90 nos of local youth and women will be imparted training for skill development from 2 nos of villages i.e. Senera & Talshankra.	85 nos of local youth and women will be imparted training for skill development from 2 nos of villages i.e. igardhi & Shikratyar.	85 nos of local youth and women will be imparted training for skill development from 2 nos of villages i.e. Jarka & Shimlon.	**450**
		Budget in Lakhs	100	90	90	85	85	
	ii) Construction of Skill Development Training Center.	**Physical Nos. & village**	Skill development to unemployed local youths and women through National Skill Development Corporation, Govt. of India Scheme. Construction of a building along with the necessary infrastructures for this purpose will be developed in 5 consecutive years. During 1st , 2nd & 3rd Year building will be constructed and in 3rd year onwards equipment will be installed					**160**
		Budget in Lakhs	40	40	30	30	20	
	iii) Construction of public toilets in nearby villages (120 nos @ 300000 per toilet)	**Physical Nos. & village**	20 nos- Lachhmanpur 10 nos- Siulibari	10 nos- Digardhi 10 nos- Shikratyar	30 nos- Senera 10 nos- Talshankra	5 nos- Jarukhamar 10 nos- Maharajnagar	5 nos- Jarka 10 nos- Shimlon	**360**
		Budget in Lakhs	90	60	120	45	45	
	iv) Laying of drinking water supply pipeline with overhead tanks in nearby villages (12 nos @ 1750000 per Drinking water supply facility)	**Physical Nos. & village**	2 no- Lachhmanpur 1 no- Siulibari	1 no- Digardhi 1 no- Shikratyar	2 no- Senera 1 no- Talshankra	1 no- Jarukhamar 1 no- Maharajnagar	1 no- Jarka 1 no- Shimlon	**210**
		Budget in Lakhs	52.5	35	52.5	35	35	
	v) Street	**Physical**	40 nos-			15 nos-		**58.75**

S. No.	MAJOR ACTIVITY HEADS		YEAR OF IMPLEMENTATION					TOTAL EXPENDITURE (Rs. in Lakhs)
			1st Year (Rs. in Lakhs)	2nd Year (Rs. in Lakhs)	3rd Year (Rs. in Lakhs)	4th Year (Rs. in Lakhs)	5th Year (Rs. in Lakhs)	
	Lighting (Solar) provision at suitable public places in and around the nearby villages (235 nos @ Rs. 25,000/- per Solar Light)	**Nos. & village**	Lachhmanpur 20 nos- Siulibari	15 nos- Digardhi 20 nos- Shikratyar	60 nos- Senera 30 nos- Talshankra	Jarukhamar 15 nos- Maharajnagar	10 nos- Jarka 10 nos- Shimlon	
		Budget in Lakhs	15	8.75	22.5	7.5	5	
	YEAR WISE EXPENDITURE		**298**	**234**	**315**	**203**	**190**	**1238.75**
2	**Education**							
	i) Providing Sports kits to Schools/ Sports club (10 nos @ 100000 per Kit)	**Physical Nos. & village**	1 no- Lachhmanpur 1 no- Siulibari	1 no- Digardhi 1 no- Shikratyar	1 no- Senera 1 no- Talshankra	1 no- Jarukhamar 1 no- Maharajnagar	1 no- Jarka 1 no- Shimlon	**10**
		Budget in Lakhs	2	2	2	2	2	
	ii) Providing Model Anganwadi Centre/ renovation of existiug center in consultation with State Govt (10 nos @ 3000000 per Center)	**Physical Nos. & village**	During 1st Year Lachhmanpur & Siulibari will be covered for renovation / provision of Model Anganwadi Center.	During 2nd Year Digardhi & Shikratyar will be covered for renovation / provision of Model Anganwadi Center.	During 3rd Year Senera & Talshankra will be covered for renovation / provision of Model Anganwadi Center.	During 4th Year Jarukhamar & Maharajnagar will be covered for renovation / provision of Model Anganwadi Center.	During 5th Year Jarka & Shimlon will be covered for renovation / provision of Model Anganwadi Center.	**300**
		Budget in Lakhs	60	60	60	60	60	
	iii) Providing furniture, computers, library, etc. for nearby local schools of villages (10 nos @Rs. 20.0 Lakhs per School)	**Physical Nos. & village**	During 1st Year Lachhmanpur & Siulibari will be provided with the facilities mentioned.	During 2nd Year Digardhi & Shikratyar will be provided with the facilities mentioned.	During 3rd Year Senera & Talshankra will be provided with the facilities mentioned.	During 4th Year Jarukhamar & Maharajnagar will be provided with the facilities mentioned.	During 5th Year Jarka & Shimlon will be provided with the facilities mentioned.	**200**
		Budget in Lakhs	40	40	40	40	40	
	iv) Digital education Class rooms in Govt. Schools (10 nos @	**Physical Nos. & village**	One no of classroom in each of the village (i.e. Lachhmanpur & Siulibari)	One no of classroom in each of the village (i.e. Digardhi & Shikratyar)	One no of classroom in each of the village (i.e. Senera & Talshankra)	One no of classroom in each of the village (i.e. Jarukhamar & Maharajnagar)	One no of classroom in each of the village (i.e. Jarka &Shimlon)	**150**

S. No.	MAJOR ACTIVITY HEADS		YEAR OF IMPLEMENTATION					TOTAL EXPENDITURE (Rs. in Lakhs)
			1st Year	2nd Year	3rd Year	4th Year	5th Year	
			(Rs. in Lakhs)	(Rs. in Lakhs)	(Rs. in Lakhs)	(Rs. in Lakhs)	(Rs. in Lakhs)	
	1500000		will be equipped with digital facilities.	will be equipped with digital facilities.	will be equipped with digital facilities.	will be equipped with digital facilities.	will be equipped with digital facilities.	
		Budget in Lakhs	30	30	30	30	30	
	YEAR WISE EXPENDITURE		132	132	132	132	132	660
3	Health Facilities							
	i) Regular health camps for local inhabitants specially for women & children. Outside workers would be tested for communicable disease.	Physical Nos. & village	Health checkup camps shall be organized in 12 nos nearby villages for general body, eyes, blood test and donation along with mass vaccination for polio, dengue, typhoid, malaria, etc. For this purpose, one doctor along with 2 – 3 assistants shall be deputed.					1000
		Budget in Lakhs	200	200	200	200	200	
	ii) Sanitation facility in existing schools, parks and other installations (10 nos @1500000 per Village)	Physical Nos. & village	Sanitation facilities to be provided to the village Lachhmanpur & Siulibari during 1st Year.	Sanitation facilities to be provided to the village Digardhi & Shikratyar during 2nd Year.	Sanitation facilities to be provided to the village Senera & Talshankra during 3rd Year.	Sanitation facilities to be provided to the village Jarukhamar & Maharajnagar during 4 th Year.	Sanitation facilities to be provided to the village Jarka & Shimlon during 5th Year.	150
		Budget in Lakhs	30	30	30	30	30	
	iii) Sanitary Napkins Vending Machine in High Schools/ common facilities (10 nos @ 300000 per Facility)	Physical Nos. & village	Machines will be installed in schools / common facilities of village Lachhmanpur, Siulibari during 1st Year.	Machines will be installed in schools / common facilities of village Digardhi & Shikratyar during 2nd Year.	Machines will be installed in schools / common facilities of village Senera & Talshankra during 3rd Year.	Machines will be installed in schools / common facilities of village Jarukhamar & Maharajnagar during 4th Year.	Machines will be installed in schools / common facilities of village Jarka & Shimlon during 5th Year.	30
		Budget in Lakhs	6	6	6	6	6	
	iv)Drainage Network for Domestic sewage in	Physical Nos. & village	During 1st Year drainage network to be made/	During 2nd Year drainage network to	During 3rd Year drainage network to	During 4th Year drainage network to be made/	During 5th Year drainage network to	280

S. No.	MAJOR ACTIVITY HEADS		YEAR OF IMPLEMENTATION					TOTAL EXPENDITURE (Rs. in Lakhs)
			1st Year (Rs. in Lakhs)	2nd Year (Rs. in Lakhs)	3rd Year (Rs. in Lakhs)	4th Year (Rs. in Lakhs)	5th Year (Rs. in Lakhs)	
	Villages		strengthen in 2 nos of village i.e Lachhmanpur & Siulibari.	be made/ strengthen in 2 nos of village i.e village Digardhi & Shikratyar.	be made/ strengthen in 2 nos of village i.e Senera & Talshankra.	strengthen in 2 nos of village i.e Jarukhamar & Maharajnagar	be made/ strengthen in 2 nos of village i.e Jarka & Shimlon.	
		Budget in Lakhs	150	50	30	30	20	
	v) RWH pits in the surrounding villages & De-siltation of ponds	**Physical Nos. & village**	2 nos of RWH pits to be made in Shikratyar & Siulibari and available ponds to be desilted.	2 nos of RWH pits to be made in Senera & Talshankra and Ponds to be desilted in Senera, Talshankra, Jarukhamar & Maharajnagar.	One no of RWH pits to be made in Jarka, & Shimlon	Desiltation of Settling Pits/ponds	Desiltation of Settling Pits/ponds	**330**
		Budget in Lakhs	40	100	40	100	50	
	YEAR WISE EXPENDITURE		**426**	**386**	**306**	**366**	**306**	**1790**
B). Based on Public Hearing								
1	**Regarding Control measures for abatement of Air Pollution due to the proposed project**	**Physical Nos. & village**	The physical Target for the entire activities shall be achieved in 3 years					**NA**
		Budget in Lakhs	Included in the EMP Cost					
2	**Development work in local schools; provision of study material & scholarships to be provided to meritorius students**	**Physical Nos. & village**	Schools of Lachhmanpur & Siulibari will be facilitated during 1st Year.	Schools of Digardhi & Shikratyar will be facilitated during 2nd Year.	Schools of Senera & Talshankra will be facilitated during 3rd Year.	Schools of Jarukhamar & Maharajnagar will be facilitated during 4th Year.	Schools of Jarka & Shimlon will be facilitated during 5th Year.	**270**
		Budget in Lakhs	80	60	50	40	40	
3	**Construction of Primary Health Center**	**Physical Nos. & village**	5 bedded Primary Health Center assisted by qualified Doctor and requisite para medical staffs for preliminary treatment of villagers and employees.					**800**
		Budget in Lakhs	200	200	150	150	100	
4	**Restoration of closed schools**	**Physical No. & Village**	Restoration of closed school of Digardhi and other villages to impart better education to school children.					**250**

S. No.	MAJOR ACTIVITY HEADS		YEAR OF IMPLEMENTATION					TOTAL EXPENDITURE (Rs. in Lakhs)
			1st Year (Rs. in Lakhs)	2nd Year (Rs. in Lakhs)	3rd Year (Rs. in Lakhs)	4th Year (Rs. in Lakhs)	5th Year (Rs. in Lakhs)	
		Budget in Lakhs	100	50	50	25	25	
5	Construction of alternative water bodies & grazing field for animals	Physical No. & Village	Construction of alternative water bodies and grazing grounds for animals in near by villages					400
		Budget in Lakhs	100	100	100	50	50	
6	Repair and maintenance of existing village roads.	Physical No. & Village	In Lachhmanpur & Siulibari villages	In Digardhi & Shikratyar villages	in Senera & Talshankra villages	in Jarukhamar & Maharajnagar villages	in Jarka & Shimlon in vilages.	450
		Budget in Lakhs	100	200	50	50	50	
7	Greenbelt development As avenue and block plantation in villages	Physical No. & Village	4 Kms of avenue plantation / 2000 Sqm of block plantation to be developed & maintained for 3 years in village Lachhmanpur, & Siulibari during 1st Year.	4 Kms of avenue plantation / 2000 Sqm of block plantation to be developed & maintained for 3 years in village Digardhi & Shikratyar 2nd Year.	4 Kms of avenue plantation / 2000 Sqm of block plantation to be developed & maintained for 3 years in village Senera &Talshankra during 3rd Year.	4 Kms of avenue plantation / 2000 Sqm of block plantation to be developed & maintained for 3 years in village Jarukhamar & Maharajnagar during 4th Year.	4 Kms of avenue plantation /2000 Sqm of block plantation to be developed & maintained for 3 years in village Jarka & Shimlon during 5th Year.	550
		Budget in Lakhs	150	100	100	100	100	
8	Development of local village roads	Physical No. & Village	In Lachhmanpur & Siulibari villages	In Digardhi & Shikratyar villages	in Senera & Talshankra villages	in Jarukhamar & Maharajnagar villages	in Jarka & Shimlon in vilages.	500
		Budget in Lakhs	**150**	**100**	**100**	**75**	**75**	
	YEAR WISE EXPENDITURE		**880**	**810**	**600**	**490**	**440**	**3220**
	YEARWISE TOTAL EXPENDITURE		**1,736**	**1,562**	**1,353**	**1,191**	**1068**	**6909**

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Signature Not Verified
Digitally signed by Dr. R. B. Lal
Scientist F
Date: 2/28/2023 6:23:53 PM

SHYAM STEEL

Shyam Steel Works Private Ltd
Regd. Office Shyam Tower, Premises No. 03-319, DH-6/11, Action Area- 1D, Street No 319, New Town, Kolkata-700156
Tel +91 33 4007 4007 / +91 33 6666 4646
Mail communication@shyamsteel.com | www.shyamsteel.com
CIN : U28999WB2020PTC241046

SSWPL/2023-24/GM/12 **Date: 22.04.2023**

To,
The Inspector General of Forests,
Ministry of Environment, Forest and Climate Change,
Integrated Regional Office, Kolkata IB – 198,
Sector-III, Salt Lake City, Kolkata - 700106

Sub: Information regarding final approval by the concerned authorities and commencement of land development work for our proposed greenfield project of integrated steel plant at Parcel II of Jangal Sundari Karmanagari Project, Village- Lachhmanpur, Block- Raghunathpur-1, PS- Raghunathpur, PO-Ramkanali, Mouza- 145, DAG No - 290, District- Purulia, PIN Code - 723142, West Bengal

Ref:
1. Environment clearance letter issued by MoEF & CC vide **EC Identification No.EC23A008WB145455**), dated 28th February 2023.
2. Consent to establish issued by WBPCB vide no **172048 (Memo No- 155-2N-321/2023(E) Dated 04.04.2023)**

Dear Sir/Madam,

This has reference to the captioned subject and cited reference wherein it is apprised that we have been granted environment clearance from MoEF&CC and subsequently consent to establish has also been obtained from WBPCB for our proposed Greenfield Project of Integrated Steel Plant at Parcel II of Jangal Sundari Karmanagari Project, Village- Lachhmanpur, Block- Raghunathpur-1, PS- Raghunathpur, PO-Ramkanali, Mouza- 145, DAG No - 290, District- Purulia, PIN Code - 723142, West Bengal.

The **General Condition (X Miscellaneous- Point no-VII)** stipulated in the granted environment clearance states that-

"The project proponent shall inform the Regional Office as well as the Ministry, the date of financial closure and final approval of the project by the concerned authorities, commencing the land development work and start of production operation by the project."

SHYAM STEEL

Shyam Steel Works Private Ltd
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Action Area- 1D, Street No 319, New Town, Kolkata-700156
Tel +91 33 4007 4007 / +91 33 6666 4646
Mail communication@shyamsteel.com | www.shyamsteel.com
CIN : U28999WB2020PTC241046

Compliance:-

The stipulated condition is partially applicable for us as our proposed project is Greenfield Project. It is apprised that we have been granted environment clearance by MoEF & CC (vide EC Identification No.EC23A008WB145455) on dated 28th February 2023 and Consent to establish (issued by WBPCB vide no 172048 (Memo No- 155-2N-321/2023(E) dated 04.04.2023. Further we would like to inform you that we have commenced the land development work from 10.04.2023 onwards. "

Thus in context of the above, we request your good selves to kindly acknowledge the receipt of necessary compliance of stipulated condition of Environmental Clearance.

Thanking you,

Yours faithfully,
For SHYAM STEEL WORKS (P) LTD.

General Manager -Commercial
91-8145285021

Encl:

1. Environment clearance letter issued by MoEF & CC vide **EC Identification No.EC23A008WB145455**), dated 28th February 2023.

2. Consent to establish issued by WBPCB vide no **172048 (Memo No- 155-2N-321/2023(E) Dated 04.04.2023)**