DETAILED
FEASIBILITY REPORT

FOR MANUFACTURE OF

COKE	144,000 TPA
FERRO ALLOYS	14,400 TPA
POWER PLANT	2 x 9 MW

IN ASSAM

Submitted By:
ANJANEY COKE & ALLOYS PVT. LTD.
4th FLOOR IDEAL CENTRE
9, A.J.C. BOSE ROAD
KOLKATA – 700 017

CONTENTS

CHAPTER – I
EXECUTIVE SUMMARY

PROJECT HIGHLIGHTS

NAME OF THE COMPANY	:	ANJANEY COKE & ALLOYS PRIVATE LIMITED
DIRECTORS	:	SRI SUBHAS CHANDRA AGARWALLA SRI MADHUR AGARWALLA
REGISTERED OFFICE	:	4th FLOOR, IDEAL CENTRE 9, A.J.C. BOSE ROAD KOLKATA - 700 017
CITY OFFICE	:	C/o MAITHAN ALLOYS LIMITED, MEGHA PLAZA, 2nd FLOOR, BASISTHA CHARIALI BELTOLA, GUWAHATI – 781 029
LOCATION	:	AIDC INDUSTRIAL GROWTH CENTER AT NH 46 MORNOI, MATIA BLOCK, GOALPARA, ASSAM
PROJECT	:	FERRO ALLOYS & COKE PLANT WITH POWER PLANT
FINAL PRODUCT	:	FERRO SILICON, COKE AND POWER
PROPOSED CAPACITIES (IN 2 PHASES)	:	COKE: 144,000 TPA FERRO ALLOYS: 14,400 TPA POWER PLANT: 2x9 MW
KEY ADVANTAGES	:	• READY SOURCE OF MAJOR RAW MATERIALS • READY MARKET FOR THE PRODUCT • PROMOTERS WELL EXPERIENCED IN THE BUSINESS LINE • USAGE OF PROVEN AND UNIVERSALLY ACCEPTED TECHNOLOGY.
SPACE AVAILABILTY	:	45 ACRES
NEAREST RAILWAY	:	KRISHNAI 8 km / GOALPARA 19 km

ROAD CONNECTIVITY	:	LOCATED ON NH 46 (Goalpara Matia Dudhnoi Road)
NEAREST AIRPORT	:	GUWAHATI
WATER AVAILABILITY	:	FROM BRAHMAPUTRA RIVER (1-2 KM AWAY)

COST OF PROJECT **(Rs. In Lacs)**

	Particulars	**Total**
1.	Land & Land Development Cost	727.50
2.	Shed & Building	974.00
3.	Plant & Machinery	23900.00
4.	Miscellaneous Fixed Assets	300.00
5.	Interest during construction	2400.00
6.	Provision For Contingencies	1258.70
7.	Preliminary & Pre-Operative Expenses	300.00
8.	Margin for Working Capital	937.62
	TOTAL	**30797.82**

MEANS OF FINANCE **(Rs. In Lacs)**

	Particulars	**Total**
1.	Share Capital	10797.82
2.	Term Loan	20000.00
	Total	**30797.82**

OPERATIONS	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Capacity Utilization	75%	85%	85%	85%
Coke Production (TPA)	54000	61200	61200	122400
FeSi Production (TPA)	5400	6120	6120	12240
Power (lac units)	591	670	670	1340
Net Turnover (Rs. in crores)	128	146	147	293

GENERAL:

M/s Anjaney Coke & Alloys Private Limited proposes to set up a ferro alloy plant with cove oven battery and power plant in Matia in Assam. In phase one 7,200 MT per annum Ferro Alloys manufacturing 9 MVA Submerged arc furnace, 72,000 MT per annum coke oven and 9 MW CPP will be installed. In phase two another set of above mentioned capacity Ferro Alloys, Coke Oven and Power Plant will be installed.

The total capacity of the proposed plant shall be 144,000 TPA Coke oven, 14,400 TPA Ferro Alloys plant and 2 x 9 MW CPP.

MARKET DEMAND:

Ferro Alloys are an important component added to Steel for enhancement of its properties. The demand for Steel is increasing vis-a-vis production in India. Hence, the demand for Ferro Alloys, which is a necessary addition, is bound to increase. Each tonne of Mild Steel produced requires a minimum of 8-10 kg of Ferro Alloys. The corresponding requirement for stainless steel are about 200 kg of ferro chrome and an almost equal quantity of other ferro alloys.

Our group supplies Ferro Alloys to almost all the leading steel manufactures in India like SAIL (DSP, ASP, RSP, BSL, BSP, SSP), VSP, JSL, JSW, JSPL etc. We export ferro alloys to more than 20 countries like Japan, Korea, Taiwan, Italy, Spain, Kuwait, Brazil, Argentina etc. Marketing of Ferro Silicon will not propose challenge as the demand is growing at healthy rate.

Low ash metallurgical coke is required in manufacturing of ferro alloys and also used in blast furnaces for manufacturing of pig iron. Looking at the projection of availability and demand of low ash sized metallurgical coke suitable for ferro alloys use, there is a considerable gap. Our group requirement of Coke is about 60,000 MT per annum which will be met by the proposed plant. The balance will be sold of to various companies like Graphite India Limited, India Carbon Limited, Ballasore Alloys Ltd, Bhutan Ferro Alloys Limited, Bhutan Carbide & Chemicals Ltd, Druck Ferro Alloys Limited, FACOR, IMFA, JSL, Shyam Ferro Alloys Ltd, etc.

To meet the demand, new capacities have to be created. As such setting up a ferro alloy plant by M/s Anjaney Coke & Alloys Private Limited is commercially suitable.

RAW MATERIALS:

The major raw materials plant shall require friable Coke, Coal & Quartz. The annual requirement of various raw materials is given in table below:

Raw Materials requirements			
Sl. No.	**Items**	**Annual**	**Daily**
1.	Coal	290880 MT	796 MT
2.	Quartz	25920 MT	74 MT
3.	Charcoal	2160 MT	6 MT
4.	Millscale	6192 MT	17 MT

Note : In case non availability of charcoal Coal / LAM Coke will be used

Provision shall be made for storage of raw material to meet requirement of 90 days. It is assumed that the material shall be received in the yard by truck. Material from the stockyard shall be conveyed to the day-bins by dumper & pay-loader.

UTILITIES AND SERVICES:

Water Supply Facilities: The estimated additional requirement of water for various purposes is 2700 KL per day.

The total requirement of fresh water to meet process make-up and drinking needs shall be met through dedicated pipeline drawn from the Brahmaputra river.

Necessary facilities shall be provided for supply of industrial water, soft water as per requirement.

Compressed air facilities – Facilities has been provided for supply of industrial quality compressed air and dry quality instrumentation air as per requirement at 7kg per cm^2.

Power supply and distribution – The captive power plant shall generate power at 11KV. This shall be suitably stepped up/down to meet the requirement of the various equipment as well as for proper grid synchronization. The power plant shall run with grid synchronization. Excess power generated shall be exported to the grid. Power required for start up of power plant and other critical load during blackout will be imported from the grid. Necessary arrangement shall be made for supply of emergency power for safe shutdown to critical equipment by DG.

Instrumentation – Adequate instrumentation has been foreseen for better process control. All inputs from instruments shall be available in the control room.

Quality control facilities – A quality control laboratory has been foreseen for the following function:

- Analysis of raw materials
- Analysis of product
- Testing of water and gas samples.

Ventilation and air conditioning – Building and shops will generally be provided with natural ventilation. The control rooms of plants shall be provided with window type air conditioner to maintain the temperature as per requirements.

Fire protection facilities – To combat fire internal and yard hydrants shall be provided at suitable locations. Besides portable fire extinguishers shall be kept at strategic locations.

Pollution control facilities – All measures have been provided to contain water air and noise pollution inside plant premises to acceptable limits.

MANPOWER:

The category-wise approximate break-up of manpower required is given below:

Sl. No.	Category	No. of Employees
01.	Managerial	18
02.	Supervisory	18
03.	Skilled	117
04.	Semi – Skilled	48
	Sub Total (Direct)	**201**
06	Contract Workers	190
07	Security Personnel	20
	Sub Total (Direct)	**210**
	Total	**411**

PROJECT IMPLEMANTATION SCHEDULE:

The time of implementation for Phase 1 shall be 24 months from Zero Date (i.e. after obtaining management clearance, environmental clearance and financial closure). Phase 2 will start commercial production 3 years thereafter.

CHAPTER – II
COMPANY PROFILE

Anjaney Coke & Alloys Private Limited is a company with its registered office is at 4th Floor, Ideal Centre, 9 A.J.C. Bose Road, Kolkata 700017. The promoters have a rich heritage in the form of a sound industrial background, with widely varying experience in Coke Manufacturing, Power Plants, Ferro Alloys, Refractories, Iron & Steel, Coal Mining and International Trade.

The group as a whole currently enjoys a leadership position as far as the manganese alloys industry is concerned. This new project being undertaken for backward integration to meet the group's requirement of metallurgical coke and will further consolidate the group's position in the entire basket of ferro alloys. The ideal location selected on the basis of closeness to raw material source.

<u>BIO - DATA of Sri Subhas Chandra Agarwalla</u>

Date of Birth	:	27/11/1951
Present Address	:	P.O. Salanpur - 713 357, Dist. Burdwan (W.B.)
Educational Qualification	:	B.Com (Hons.)
Experience Details	:	37 Years experience in various businesses such as Coal Mining, Coke Manufacturing, Refractories & Ferro Alloys.

<u>BIO - DATA of Sri Madhur Agarwalla</u>

Date of Birth	:	11/01/1982
Present Address	:	P.O. Chirkunda - 828 208, Dist. Dhanbad (Jharkhand)
Educational Qualification	:	B. Engg. + M.B.A.
Experience Details	:	10 Years experience in various businesses such as Cement, Power Plant, Ferro Alloys, Iron & Steel.

<u>LOCATION:</u> The proposed site for Anjaney Coke & Alloys Pvt. Limited is AIDC Industrial Growth Center at NH-46, Mornoi, Matia Block at Goalpara, Assam.

GROUP COMPANIES MANAGED BY THE PROMOTERS

Name of the Company	Year	Turnover (Rs. In Lacs)
Maithan Alloys Limited, Unit 1 : P.O. Kalyaneshwari-713369, Dist. Burdwan (W.B.) Unit 2: EPIP, P.O. Byrnihat-793101 Dist: Ri-bhoi (Meghalaya)	2009-10 2010-11 2011-12 2012-13 2013-14	49316 61491 64516 86285 81625
Anjaney Ferro Alloys Limited, P.O. Mihijam-813354, Dist. Jamtara (Jharkhand)	2009-10 2010-11 2011-12 2012-13 2013-14	15380 18522 21376 22582 27988
Purbanchal Cement Limited, P.O. Byrnihat-793101, Dist. Kamrup (Assam)	2009-10 2010-11 2011-12 2012-13 2013-14	9552 11297 13057 16962 16133

CHAPTER – III
PROCESS TECHNOLOGY – FERRO ALLOYS

3.1 Ferro Alloys

Process technology selection and manufacturing route are very crucial for achieving efficiency and economy. This project envisages setting up of a Ferro Alloy plant wherein suitable and sized material shall be procured. As such the process technology area relates to only ferro alloy production.

This plant shall be designed for production of Ferro Silicon (Fe-Si). However, provisions shall be kept for production of other ferro alloys (like Si-Mn, Fe-Mn etc) after carrying out some minor modifications. The standard grade Ferro Silicon has Si content of about 70%.

The production of Fe-Si is a continuous slag less process. The oxides of silicon, iron, etc. contained in the raw material charge are reduced by the carbon of charcoal in a submerged electric arc furnace. The reduction of oxide is accompanied by evolution of gases at furnace top.

3.2 Ferro Silicon

Ferro Silicon is an alloy of silicon & iron. It is an alloy used as an additive in the manufacture of steel. It is added to molten steel as silicon imparts strength to steel. The other function of Ferro silicon is of an antioxidant in the molten steel, as silicon combines with entrapped oxygen and migrates to the slag as silica. The concept of the use of Ferro silicon instead of pure silicon metal into the steel is due to its cost effectiveness as it is nearly one-third the cost of silicon metal.

Ferro silicon is produced by the reduction of silica and iron oxides by the carbon present in charcoal/coal.

The chemical reactions taking place in the are as follows:-

Decomposition:

$2\ Fe_2O_3$ => $4Fe + 3O_2$ (at 900^oC)

Reduction:

$SiO_2 + C$ => $Si + CO_2$ (at > 1500^oC)

The Fe and Si thus formed join the alloy.

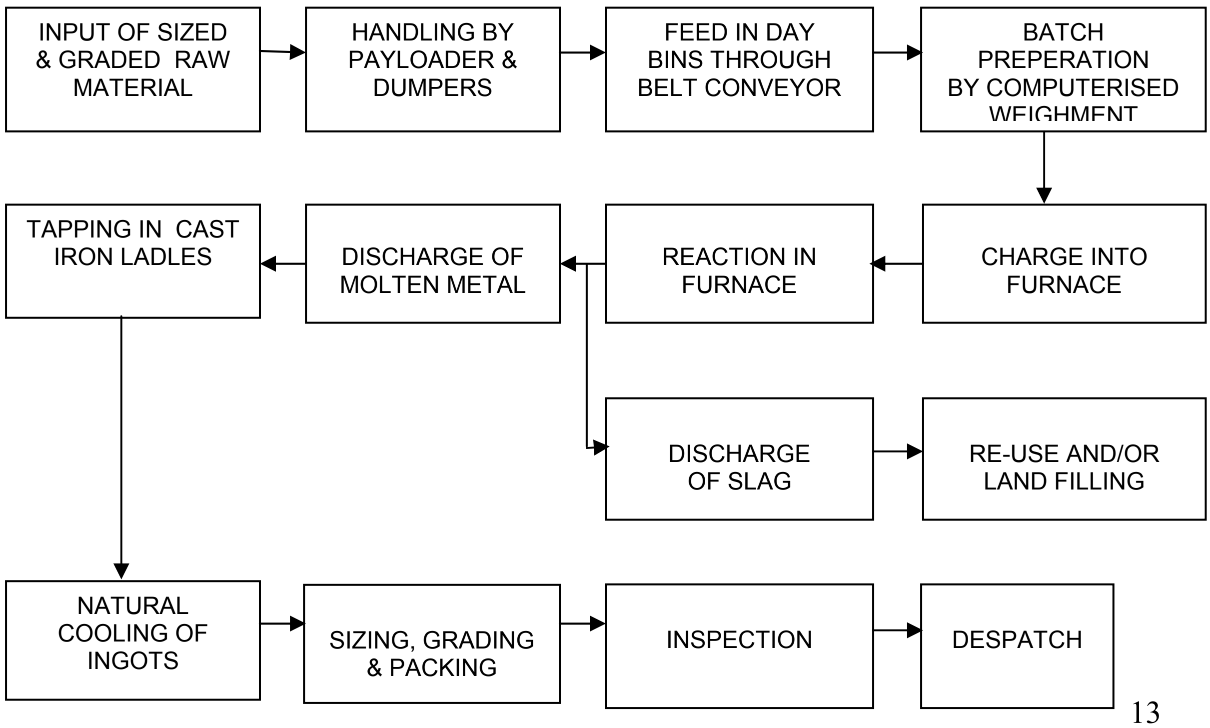
Fluxes may need to be added from time to time to draw out gangue materials, which may be present as impurities in the raw material charge.

Ferro silicon (~ 70% Si%) is smelted in 5000 - 16500 KVA closed top submerged electric arc furnaces with transformer secondary voltage 100 – 150 V. Alloy is tapped 2 - 4 times per shift.

3.3 Selection of Plant Capacity

The plant shall be having two submerged arc furnaces of rating 9 MVA, each capable of producing 20 Tonnes per day of Ferro Silicon. The plant shall work for 360 days in a year and 3 shifts per day.

PROCESS FLOW-CHART



Raw Material Receipt and Storage

Incoming raw material i.e. Coal, Quartz, Charcoal, etc. shall be received by trucks and stacked separately in the stockyard. The material shall be procured in required size range and quality. Appropriate storage methods shall be adopted.

Raw Material feeding system

Raw Material shall be fed to a ground hopper by dumpers. The material shall be drawn from ground hopper to screening station where fines shall be removed. The screened material shall be conveyed to the Bunker house having 32 day bunkers for different materials. The bunkers shall be fed with reversible conveyors.

Each bunker shall be provided with vibratory feeder. Each set of 4 bunkers shall have one set of weigh hopper. Material from each bunker shall be withdrawn and weighed separately in the weigh hoppers and dumped to a common surge hopper provided with a vibratory feeder through a conveyor.

The weight of raw materials in required quantity from the surge hopper shall be fed to the feed hopper provided at the top platform. The material from feed hopper shall be conveyed to 7 charging bins and 1 correction bin, which will be located around the circumference of the furnace. These charging bins shall feed the raw material mix through chutes and slide gates into the furnace.

For smelting of raw materials a submerged arc furnace of following specifications shall be provided.

Mechanical

Shell diameter	-	~ 8000 mm
Shell height	-	~ 5000 mm
Electrode diameter	-	~1000 mm

Electrical

Furnace transformer rating	-	9 MVA
Method of tap changing	-	O.L.T.C.

The furnace shell shall be lined with graphite paste inside. Layers of high heat duty firebricks and insulation bricks will back this. Tapping holes (3 nos at 120^o) will be provided at the hearth level in the refractories. The bottom lining will be thick layer of tamping paste and layers of high alumina brick of 55%, 45% and 35% Al_20_3 and suitable castable refractories. Silicon carbide bricks will be used for tap hole lining.

The furnace shall be provided with water-cooling system for:

- Cooling of current conducting pipes and contact clamp.
- Cooling of electrode holder ring
- Cooling of electrode shell
- Cooling of supporting framework exposed to heat from furnace top.

For furnace tapping, tap hole arcing device (moving around the furnace) shall be provided. Electrical connection to the arcing device shall be made manually after positioning.

The flue gases from the furnace are sucked through an inter-connecting ductwork and gas cleaning system by induced draft fan and exhaust to chimney. The gas is first cooled from 300^{O}C to 120^{O}C in a heat exchanger. The cooled gases will pass through a bag fitter for dust removal before letting it out through chimney.

The tapping fumes are also cleaned through bag filters before letting it out.

Hot Alloy handling

The hot metal tapped from the spout will be collected in a ladle on rails.

The liquid metal from the ladle will be poured into sand moulds with the help of a crane. Manual breaking and packing shall be carried out for despatch.

CHAPTER – IV

PROCESS TECHNOLOGY – COKE OVEN PLANT

4.1 Coke Oven Plant

The coke making process involves carbonization of coal to high temperatures in an oxygen deficient atmosphere in order to concentrate the carbon. The commercial coke making process can be broken into two categories: a) By-product Coke making and b) Non-recovery / Heat Recovery Coke making. A brief description of each coking process is presented below.

1. Recovery type / By-Product coke ovens:

In this system coking coal is indirectly heated in ovens in absence of air. In this way coal is carbonized into coke with evolution of coke oven gas from where we get fuel gas and bye-products like tar, etc. Brief coke making operation is comprised of the following steps.

- Before carbonization, the selected coals are blended, pulverized and oiled for proper bulk density control.
- The blended coal is charged into a number of slot type ovens wherein, each oven shares a common heating flue with the adjacent oven.
- Coal is carbonized in a reducing atmosphere
- The off-gas is collected and sent to the by-product plant where various by-products are recovered.

2. Non- Recovery or Bee-Hive coke Ovens:

In Non-Recovery coke plants, originally referred to as beehive ovens, the coal is carbonized in large oven chambers. The carbonization process takes place from the top by radiant heat transfer and from the bottom by conduction of heat through the sole floor. Primary air for combustion is introduced into the oven chamber through several ports located above the charge level in both pusher and coke side doors of the oven.

Partially combusted gases exit the top chamber through "down comer" passages in the oven wall and enter the sole flue, thereby, heating the sole of the oven. Combusted gases collect in a common tunnel and exit via a stack which creates a natural draft in the oven. Since the by-products are not recovered, the process is called Non-Recovery coke making. The waste gases exit into a waste heat recovery boiler which converts the excess heat into steam for power generation. ANJANEY COKE & ALLOYS PRIVATE LIMITED will adopt the above process which is called non-Recovery / heat recovery type coke production.

The Non-Recovery type (bee-hive ovens) ovens are constructed in the form of a battery. The flat roof of the battery acts as the surface for a mobile (electrically powered) charging car from which, the coal enters each oven through openings along the top. The coke product is pushed from the rear of the oven through the opened front section on to a quenching platform or into railcars that will move the coke through water sprays. The waste gas generated in the process are collected in the common duct and conveyed to a common stack.

In presence of restricted supply of air, coal yields only coke and the by products are burnt to generate heat. This heat is then utilized for carbonization of the coal inside the oven and the fuel gas is released in the atmosphere. These types of coke ovens are popularly known as Bee-hive ovens. The B.P ovens require much higher investment as compared to Non-recovery coke ovens. Today both types of coke ovens co–exist to meet requirements of hard coke for the growing iron, steel, Ferro alloy and other industries considering the very high capital cast of B.P. coke ovens, this project is based on installation of Non-recovery type coke ovens

This type of coke oven when well-designed is capable of providing sufficient waste heat for commercial production of power.

4.2 Comparison between Different types of Non Recovery Type Ovens

Back to Back (Drag Type)	**Pusher Type**
Low productivity & Slightly high cost	High productivity & Low Cost
Higher revenue Cost for operating ovens	Low operating Cost

Higher Cost per Tonne of coke	Lower cost per Tonne in conversion of coal
Low coke yield	High coke yield
Higher Maintenance cost	Lower maintenance cost
Emission of Effluents	No emission of effluents, completely brunt
Polluting Environment	Much lower than the permissible limit
Less cleaning facilities	More space for providing cleaning facilities
Less life	More Life
Coke having low hardness	Coke having high hardness
Max temperature at 1150 Deg C	Max. Temperature at 1350 Deg C
No Scope of utilizing waste heat	Scope of utilizing waste heat
More charging time	Less charging time
No Provision for pre heating air	Heat efficiency due to pre-heating air
Residual V.M is more	Residual V.M is very less
Carbonization does not from all sides	Carbonization from all side

4.3 <u>Process Technology</u>

Non-recovery coke oven is a way of producing metallurgical coke where the evolved gas (volatile matter) is fully burnt and the waste gas is released through the stack. The ovens are unique in nature such that no external heat source is required. All the energies for carbonization are supplied by burning the gaseous volatile products, released from the coal charge during carbonization. The combustion air (oxygen) is drawn into each chamber through primary air flue and secondary air flue. The heat generated by the combustion of the volatile product is in high temperature zone in the free space above the coal charges. This heat is radiated back into the coal charges so inducing downward carbonization. The product of combustion is drawn through gas exit flues down into a series of sole flues located below the oven floor. As the hot combustion products pass through sole flue, they give up some of their heat, which results in carbonization occurring in an upward direction. Part of hot gas travelled through side walls which results in carbonization occurring both the sides in horizontal directions. The gases leave the sole flues through connecting flues and pass along common gas flue to a discharge stack. Hence, carbonization results from application of heat all the sides of the charge. This results in reducing the coking cycle and the better coke is produced from the optimum portion of coal charge.

Technical features:

(a) Clean type heat recovery top charge coke oven is operated under negative pressure and adopt upper and lower oven door structure, which can avoid dispersion of fume and dust emission.

(b) The volatile maters produced during coal carbonization is completely burnt

(c) There is no wastewater with harmful chemical components coming from the process and quenching make-up water can be recycled after settlement. Thus true zero draining is realized.

(d) This coal cake charged in oven has the thickness of 1000 mm and coking time is around 52 hours. The coke produced is with standard size, less fines, high strength and homogeneous quality.

(e) This coke oven technology adopts large volume carbonization chamber and stamp charging process, which change the flow channel of chemical products and oven gas produced during coking. Large quantity of weakly caking coal can be blended. The coke oven carbonization chamber belongs to large volume type with average charging quantity of 9.33 tonne. This large volume carbonization chamber coke oven possess the advantages of producing large size coke, average quality coke, no fume & dust dispersion, low power consumption, increase the life cycle of coke oven, etc.

(f) Stamping machine is the key equipment for stamping coke oven of which performance characteristics can directly affect the coal cake quality and normal operation of oven. This type of coke oven adopts advanced hydraulic stamping device developed in house. The advantages of stamping machine are that thick and average bulk density and flat coal cake surface, low noise and less maintenance etc.

(g) Clean type heat recovery stamping charge coke oven adopts coke receiving horizontally technique instead of using the conventional top charging car, which effectively reduces the dust emission during charging and increases the lump size of coke.

(h) All the matters produced during coking process can be burnt completely into waste gas with high temperature, which is used for power generation by heat recovery boilers or for other usage.

(i) Quenching tower and quenching car is incorporated in the system resulting low consumption of water and to reduce quenching emission.

4.4 Advantages of Non-Recovery Type Coke-Oven

A) Environmental

Environmental Protection Agency, USA, has issued a Green field License and as per the regulation vide, the Gazette of Indian (MOE&F) notification dated 31.10.1997, adoption of non recovery coke ovens for coke making is in itself a LOW-EMISSION PROCEDURE ensuring control of emissions and maintain environmental quality in work zone area, due to the following features:

- All the hydrocarbons (volatile material) are burnt in the non-recovery ovens, thus no hazardous explosive gases to be handled
- There is no phenolic water to be dealt with as in the case of coke making through By Products Recovery Coke non Process Technology.
- There are no corrosive by-product chemicals to be handled either
- As the entire process is under negative pressure, there are no gas leaks or shooting flames from the doors of the oven chambers. The “Haze factor“ is therefore negligible
- The Stamp charging eliminates coal dust emissions
- The waste heat from the coke ovens can be utilized to generate power, thereby reducing emissions of equivalent CO2 to atmosphere.

B) Low Cost Features:

- Low investment
- Low operational and maintenance cost
- Low raw material cost due to high yield during conversion process

4.5 Description of Plant Facilities:

a) Receipt and storage of raw material at coal crusher area.

The coal shall be brought from port by trucks and unloaded in the stockyard and stacked near the coal crusher feed conveyor. The coal from the stockyard would be fed into the ground hoppers using Front end loaders and Tractor / Tippers. The coal is feed into different hoppers and the belt feeder speed is adjusted as per the required ratio to maintain the blending. Then coal would be conveyed to the crusher to get the desired feed size of –3 mm. From bunker coal would be fed to the stamping unit for stamping.

The coal handling section consists of coal stockyard, receiving pits, primary crushing house and secondary crushing house, blending hoppers (3 feed hopper with feeder belt frequency drive control system) to improve blending right mix, transfer station, overhead trestle etc. The provision of an electromagnet has been proposed to remove tramp Iron from the raw coal. Crushed coal (100% below 3 mm) from crusher is fed into a belt conveyor to carry coal up to the overhead bunker which acts as overhead storage to feed stamping unit as & when required. The crushed coal is conveyed to the over head bunker which will have capacity to store coal for 20 hours requirement

In order to utilize maximum non-coking coal resources, we need to lower the cost of raw material consumption and thus to improve the quality of coke, the coal handling adopts two step crushing process i.e. coal is crushed in two stages according to the hardness of the raw coal. Through primary and secondary crushing, the requirement of granularity less than 3 mm is maintained. Thus with two stage crushing, the coal is even with small granularity which avoids concentration of big grain and plays a major role in increasing accuracy of coal blending, adopting weak caking coal and improves the quality of coke.

b) The Coke Oven

The coke oven to be installed is designed for high temperature carbonization of coal and will produce coke suitable for use in industrial furnace. The coke oven under normal operating conditions

- Receives the compressed coal cake from the Pusher side door carried by charging car with the help of charging plate directly into the ovens. The charging car would be electrically controlled.
- It will use the heat generated by combustion of the volatiles in the oven.
- The ovens will utilize pre-heated air instead of cold atmospheric air for combustion.
- Deliver heat to maintain the oven and sole temperature to make the process self sufficient.
- Discharge coke after carbonization by pusher car.

c) Oven proper

Clean type heat recovery coke oven battery is mainly composed of carbonization chamber, Four-link combustion chamber under the sole, down comer flue, oven sole, oven top and end wall, etc.

(1) Carbonization chamber

Following the trend of coking industry in the world, large volume coking chamber is adopted for clean type heat recovery coke oven battery. The refractory bricks of the coking chamber are mainly high alumina brick, and shaped bricks will guarantee the strength and tightness of the oven body and increase its working life.

(2) Four-link tile- top combustion chamber under the sole:

Four-link tile - top combustion chamber is located under the sole of the coking chamber, with an interlocking structure. In order to guarantee its strength, the top part of four link combustion chamber is made of tiles structure, which is made of shaped bricks. At the lower part of four-link combustion chamber, secondary air inlet channel are arranged regularly and longitudinally. This combustion chamber is made of alumina bricks, with the tongue groove structure for locking purpose.

In the coke making chamber the volatile matter evolved during carbonization (containing Hydrogen, Hydrocarbons etc) are not burnt completely and conducted into the four link combustion chamber through the down comer flue, where these matters are to be burnt completely because a required amount of air injected through the secondary air inlets which are regularly distributed in the length direction at the chamber. After complete burning, the waste gas at high temperature (around 900^{o}C) goes through the flue tunnels to the waste heat boilers / stack.

(3) Down Comer Flue of Chief Wall

The down comer flue with squire section is distributed regularly along the coke making chamber chief wall. The number of the flue and the area of its section are subjected to the state of negative pressure distribution. The function of down comer flue of chief wall is to conduct the gaseous chemical products, CO and other matters produced during incomplete combustion into the four-link combustion chamber for complete combustion and to get the hot gas distributed evenly to reduce resistance.

(4) Oven sole

Oven sole is located at the bottom of the Four-link combustion chamber. It is composed of secondary air inlet channel, thermal isolation layer and air-cooling channel, etc. The materials of the oven sole are fireclay brick, and insulating brick. Air holding structure is constructed between oven sole and oven foundation to protect the coke oven mat against overheats.

(5) Arch top/ Oven top

Arch top is of arch structure, in which adjustable primary air inlet ports are evenly arranged. The refractory bricks used for the arch are high alumina bricks & fireclay bricks. For the surface of the oven top, a slope is designed for water discharge. Structures of refractory bricks guarantee the tightness and strength of the oven top.

In accordance with distribution state of negative pressure in the carbonization chamber, let the primary air come in regularly to get the coke oven gas and chemical products created during destructive distillation burns incompletely under deoxidizing atmosphere above coal cake. By means of regulating the negative pressure and the restricted volume of primary air, dry distillation of coking coal can be realized due to the volatile matter created on the surface of coal cake cannot contact excess air and forms a protective layer of waste gas.

(6) End wall

There are end walls between the two ends of each bank and pinion walls on oven base. The end wall is used to ensure the body strength and lower the temperature of pinion wall. The refractory materials of end wall are clay brick with high strength. There is channel in the end wall for draining during baking of oven.

(7) Charging System

From the overhead storage bunker coal is discharged into U-mixer, where water is added, and then it goes to the stamping station, where cake is formed, this coal cake is collected by charging car and placed inside the oven through the door with the help of charging plate.

(8) Coke Pushing System

Once the coke is ready for pushing as per proper pushing sequence, the pusher car would travel on rail to the particular oven and align itself in front of the coke oven door. Two travel speeds, fast and slow has been provided in the pusher car. Slow travel will help in precise alignment of the pusher beam. Once aligned, the pusher beam would travel and push the coke mass from one side of the oven and out from the door on the other side.

4.6 Coking Process Flow

The blended coking coal coming from the coal preparation workshop is sent to the discharging belt of turning type at the coal tower through which the coking coal is discharged evenly into the coal tower, in which there is a vibration pipe to prevent blocking and ensure smooth going through, from where the coal coming into the coal box of stamping machine through a gate and a coal distribution hopper, whose function is to ensure coal is spread evenly in the coal box. The stamping is hydraulically driven and there is a stamping unit on each side of the coal distribution hopper's coke side. Each stamping unit consists of multiple cylinders.

The stamped coal cake is sent back from the stamping station to the coal charging and coke pushing car. When the coal charging and coke pushing car arrives at the front of the designated coke oven, it makes alignment with the center line of the coke making chamber, the door-open device set on the coal charging and coke pushing car takes out the lower door of the oven and then the coke is pushed by the coke pushing rod into the coke receiving/quenching car at the coke side of the oven.

After that, the coal charging and coke pushing car starts the alignment for the second time, and then the coal cake is pushed into the coke making chamber, after that, the coal carrying plate withdraws. Finally, the coal charging car and coke-pushing car makes alignment again and the door-open device put the lower door back and closes it tightly. There is a track scale set on the track of the coal charging and coke pushing car and the signal is sent back to the central control room. At last, the coal charging and coke-pushing car goes back to the coal tower for the next operation.

When coke receiving/quenching car arrives at the front of the designated coke oven, it makes alignment with the center line of the coke making chamber, the door-open device set on the coke receiving / quenching car takes out the lower door of the oven and the coke receiving / quenching car makes the alignment for the second time and the coke receiver moves to the front of carbonization chamber to receive horizontally the coke pushed out by the coal charging and coke pushing car.

Finally, the coal charging and coke pushing car makes alignment again and the door-open device put the lower door back and close it tightly. At last, the coke receiving / quenching car goes back to the coke-quenching tower for quenching operation.

At the top of coke making chamber the volatile matters produced during coking process, conducted into the four-link arch combustion chamber through the down flue, where these matters burn completely because there are secondary air inlets which are regularly distributed in the length direction at the bottom of the chamber. After burning completely, the waste gas comes through the flue tunnels to the heat recovery boiler for power generation. The waste gas with high temperature can also conducted through by-pass flue into the chimney of 50m high for a short time.

The coke oven will stand on foundation made of combination of RCC and refractory work. Arrangement for foundation cooling will be provided. The coke oven will be built mainly of refractory. Special high alumina refractory will be used in heat zones and abrasive zones to ensure stability and long life. Buck stay made of steel structural will support individual ovens and also hold the door lifting arrangement.

The pusher car travelling on rail tracks in some cases multiple rails are used but two rail system gives the pusher proper stability. It will push the coke from one side of the oven door and Coke will come out from the other side door of the oven. The finished coke is discharged directly into a quenching car which will take the hot coke for water quenching below a quenching tower, or the coke can be discharged on the coke platform for manual quenching.

Coke Oven Control

The objective of the automatic combustion control is to guarantee the operational stability of the coke batteries based on the control of the coking time and consequently, maximize the useful life of the ovens

A control room will be installed near the coke oven for safe operation. Discrete control system is envisaged for trend recording, and control of process parameters. From Coke oven control room the following controls are performed:

- Oven Temperature
- Draught recording for damper control

The following parameters are trend recorded:

- Sole Flue temperature of individual ovens
- Oven temperature

- Draught

Quenching Car System

Coke mass is pushed in the platform of the coke quench car. The quench car aligns itself on the door opposite to the pushing side. The quench car travels with the coke mass below the quenching tower where the coke is quenched using high pressure nozzles. The quenched coke is then pushed out of the quenching car by a stationary pushing system into the coke hopper.

Coke Screening and Sizing System

Coke from quench car will be taken into ground hopper. The coke will be fed in the primary screen through conveyor over size material shall be fed into coke cutter for sizing. From the coke cutter the sized material shall be fed into a secondary screen where under size fractions shall be separated.

Sump and Water Circulating System

The system consists of a water sump with electric pumping system to feed water to quench tower through suitable diameter M.S. pipes to quench the coke in the quench car. After quenching the coke breeze and ash contaminated water sends to the settling tank for settling. This water will be further used for quenching. Make up water added to the tank as and when required.

4.8 Gas Flow Calculations

Rich COG Generation Data:

Volatile Matter evolved in case of the proposed oven depends on the quantity of coal charged per oven & the VM content of the coal which is 40% in case of Assam coal. Estimated evolution of VM from the suggested coking coal blend is expected to be around 480-500 Nm3/ MT of dry coal charge.

1) Coal Charged / day into the Ovens = Dry charge /oven x pushing/day
= 8.4 x 80 = 672 TPD dry coal
Say 680

2) Rich Coke oven Gas generation per MT of dry Gas coal = 500 Nm3 / MT

3) Rich Coke oven Gas generation per day = 500 x 672 Nm3/day
= 3, 36,000 Nm3/ day

Waste Gas Generation Data:

Assuming complete combustion of the volatile matters inside the ovens expected flue gas generation with about 30% excess air would be about 6-7 times the volume of the rich gas. Accordingly:

1) Waste flue gas generation per day = 3,36,000 x 6= 20,16,000 Nm3

2) Approximate Wase gas generation/ Hr = 84000 Nm3 / Hr

3) Temperature of Flue Gas = 900ºC

CHAPTER –V
PROCESS TECHNOLOGY – POWER PLANT

5.0 POWER PLANT

The proposed two number power plants will generate an aggregate power of 2 x 9000 kW. Each power plant, will have two waste heat recovery boilers of designed capacities 2 x 20 TPH Two Coke Oven Waste heat boilers & One (1) extraction cum condensing turbogenerators of 9 MW nominal capacity operating in 64 Ata 485 Deg.C steam cycle.

5.1 Gas handling system

The waste heat recovery boilers are designed to operate only with the thermal energy in the waste gases from the coke ovens and these boilers do not need any supplementary or auxiliary fuel firing. There is no fuel handling system for the waste heat recovery boilers, as there is no fuel usage in the waste heat recovery boilers. The waste gases from the coke oven batteries will be conveyed to the waste heat boilers through hot gas ducts. Proper refractory lining shall be given for the ducting as the gases will be coming at high temperatures in the range of 750 to 1000°C. Necessary expansion joints, insulation shall be provided as required. An isolation gate shall be provided at the boiler inlet duct so that in case of maintenance of the boiler, with the coke oven battery working, it may be possible to attend to within the boiler

5.2 Steam Cycle for the Power Plant

The steam cycle defines the transformation of the heat energy to the mechanical energy at the turbine shaft, through the various thermodynamic processes that are capable of producing the net heat flow or work when placed between the energy source and energy sink. The heat energy is derived from using heat energy already available in the hot waste gases. The cycle needs a working fluid and steam is viewed as the most favoured working fluid mainly because of its unique combination of high thermal capacity, high critical temperature, wide availability at cheaper cost and non toxic nature.
All the steam based power plants operate under the Rankine Cycle. Simply the Rankine Cycle is described as the combination of the various processes like the isentropic compression of water in the boiler feed water pumps, reversible heat addition to the

working fluid through the liquid, two phase and super heat states, isentropic expansion of the working medium in the turbine and the constant pressure heat rejection to the atmosphere through the condenser and the cooling water system. The cycle to be adopted for this project will be a modified Rankine Cycle with the addition of a Regenerative feed water heating. To improve the efficiency of the cycle the feed water from the condenser is heated with the steam extracted from the turbine. Because of the size of the plant there are limitations in the use of the number of stages for heating the feed water, and for this project only one stage of heating is done in a deaerator.

Thermodynamically, energy recovery from the Rankine Cycle is more dependent on the steam inlet temperature than the pressure and the higher the inlet steam temperature, higher the cycle efficiency. However, because of the nature of the working medium, which is steam, the pressure also plays a major role in ensuring the optimum extraction of the useful energy from the working medium and hence, the increase in the steam temperature should be accompanied by the matching increase in the pressure. Anyhow, the practically attainable limits of temperatures are influenced by the metallurgy of the boiler tubing, piping and the turbine components and the complexity of the Creep fatigue interaction for the materials at higher temperatures.

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It is extremely important that the selection of the temperature is done keeping in mind the nature of the industry. Considerations such as cost, maintainability, provision of adequate safety margins, the experience of the industry so far and the level of the operating personnel available in the industry, enable us to select the practical limit on the steam temperature for the plants of the subject size and nature. Considering the above, it is proposed to install boilers with outlet steam parameters of 67 Ata and 490 Deg C. The steam inlet to the turbine will be 64 Ata and 485 Deg C, with the difference in the pressure and the temperature accounting for the losses in the steam piping from the boiler to the turbine.

5.3 Description of the Power Plant Scheme:

As explained in above the thermal energy available from the waste gases of each coke oven batteries is as follows:

Sensible heat to be recovered in Boilers	:	22.85 M Kcal /Hr
Total	:	22.85 MKCal/Hr

This amount of heat will be able to generate 32.55 TPH steam from both WHRBs. The Boilers will be sized 10% higher than the calculated to take care of variance in the steam generation due to variance in Flue Gas Flow & Temperature. So each Boiler will be sized for as 20 TPH.

There are two coke oven batteries it is proposed to install one WHRB for each battery. With this heat quantity, it is possible to generate about 32.55 TPH of steam at 67 Ata and 495 Deg.C, with feed water inlet temperature of 140 Deg.C, However, it is planned to install 2 nos. Coke Oven Waste heat boilers for a steam generation capacity of 20 TPH each and the single Turbogenerator capacity is fixed at 9 MW with 10 % VWO (Valve wide open) built in design to take care of variances that can happen in actual operation.

In addition to this there will be 50% on line steam Dumping in the condenser to avoid stoppage of Boilers in case of Turbine tripping. This design feature will enable immediate start up of the Turbine & start Power generation.

The high temperature ducting from the coke oven batteries handling the waste gases connecting to the boilers will be refractory lined. Each coke oven battery will be connected to a single boiler and there are no interconnections between coke oven batteries.

The power plant will supply power to the coke oven batteries and auxiliaries of the power plant. The surplus power generated at 11 kV will be utilized in the main plant.

The waste heat boilers will operate entirely with the high temperature waste gases generated from the coke oven batteries, and no supply firing is envisaged. The feed water management program shall ensure the supply of good quality make up water to the system. In the proposed power cycle most of the steam supplied to the turbine will come back as the condensate from the water cooled condenser and through the feed water heating system. The make up required will be approximately 3 % of the steam generated in the boiler, which includes all the losses in the system and the blow down in the boiler. The complete make up required for the plant operation will be treated water. RO - DM water treatment plant of adequate capacity will be provided. The make up for the cycle will be added in the condenser hotwell & Deaerator and the quantity of make up will be controlled by the Hotwell & deaerator level control stations.

The power plant turbine will be a double extraction cum condensing machine. There will be two wandering uncontrolled extraction at 4.6 Ata. The turbine steam inlet parameters will be 64 Ata and 485±5 Deg.C. The extraction quantity will meet with the requirements of the de-aerator. The steam required for the ejector and gland steam which is about 0.5 TPH at 11 Ata level, will be taken from the main steam line through PRDS station. The Power plant cycle will be provided with a deaerator serving the dual purpose of deaerating the feed water as well as heating the feed water with the extraction steam drawn through the uncontrolled extraction. The deaerator will be operating at 2.0 Kg/Sqcm (a) pressure, with the deaerated feed water temperature at 140 Deg.C.

The power generation in the power plant will be at 11 kV level. The power plant will be operating in parallel with local grid feeding the surplus power after meeting the power requirements of coke oven plant & auxiliaries of power plant. ***There will be provisions for parallel operation as well as island operation of the Power Plant***.

EMERGENCY POWER / START UP POWER

There will be 100% redundancy for start up power ie Grid as well as DG power is planned for the emergency & black start-up of the Power Plant. There will be 3x500 KVA, 415 Volts DG Sets installed for Black Start , this selection is done to have economical start ups & shut downs.

5.4 Plant Operation

The expected steam generation from each Coke oven waste heat recovery boiler is 16.3 TPH. The total steam generation from two waste heat recovery boilers is expected to be (keeping in mind the variation of operation) 33.56 TPH (This is the steam generation in best conditions however the Turbine will be sized as 9 MW which will have a demand of 36.90 TPH).

Steam generated is fed to the common steam header from two boilers. About 0.5 TPH steam is used for the ejector & turbine gland sealing after pressure and temperature reduction to 11 Ata and 250 Deg.C Around 0.092 TPH of feed water is used as spray to bring down the temperature. About 32 to 36 TPH of steam is available for feeding to the extraction cum condensing turbine. The uncontrolled extraction from the turbine at 4.6 Ata gives 4.0 TPH of steam at a temperature of 180-190 Deg.C. This steam is used in the deaerator, for heating up the feed water to temperature of 140 Deg.C.

A quantity of TPH of steam, being the difference between the input and the extracted steam quantity is exhausted at 0.1 Ata to the Air Cooled / Water cooled condenser of the power turbine. The condensate from the condenser hotwell of the Air Cooled / Water Cooled condenser is then pumped to the feed water system by the condensate extraction pumps. In addition to the above quantity, the condensate from the gland steam condenser and the ejector condensers amounting to a total approximate quantity of 0.3 TPH is added to the feed water system through the condenser hotwell.

With the power plant operating at the rated capacity, the gross power generation will be approximately 9000 kW at 11 kV level. However the Turbogenerator capacity is selected as 9.0 MW to take care of increased steam flow from the boiler due to variation in flue gas flow and temperature from the coke oven batteries.

FUEL BALANCE:

For the waste heat boilers, no additional fuel is required as the heat available in the waste gases generated from the coke oven batteries are used.

POWER BALANCE:

The total power generation in the plant will be approximately 9000 kW in each phase. The following gives the detailed break-up of the auxiliary power consumption in the power plant and balance power utilization for phase 1.

Boiler auxiliaries	:	500 kW
Turbogenerator auxiliaries	:	60 kW
Wet cooling tower (MCW Pumps, ACW Pumps, Cooling tower fans)	:	300 kW
Misc pumps (Raw water pumps, make-up water pumps for cooling tower make up pumps for power plant)	:	15 kW
Air compressors	:	36 kW
Water treatment plant	:	20 kW
AC & Ventilation	:	15 kW
Lighting	:	25 kW
Transformer and other losses	:	15 kW
Total connected load for power plant	:	986 kW
Considering 85% loading on the Connected load		838.00 KW
For Export or Coke Oven & Ferro Alloys Plant Consumption	:	8100 kW

5.5 Plants and Machinery for the Power Plant

General

The proposed power plant at ACAPL will generate an aggregate power of 9000 kW. The power plant, as discussed in the previous sections of this report, will have two waste heat recovery boilers of designed capacities 2 x 20TPH Two Coke Oven Waste heat boilers & One (1) extraction cum condensing turbo-generator of 9.0 MW nominal capacity operating in 64 Ata 485 Deg.C steam cycle. This section of report describes the plant and machinery for the power plant.

Steam generating system

The steam generating system for the power plant will consist of two waste heat recovery boilers with a Maximum Continuous Rating (MCR) of two Coke oven waste heat boilers 2x 20 TPH, each with steam outlet parameters of 67 ata & 490 Deg.C. The tolerance on the superheater outlet temperature of the steam generator shall be 490 + 5 Deg.C. The flue gas temperature at the outlet of waste heat Boiler will be at 180°C.

The dust concentration in the flue gas leaving the boiler shall be a maximum of 30-40 mg/N.Cu.m which is well in the limits of norms prescribed by state pollution control board.

The design of the waste heat boilers shall be of vertical configuration single drum, natural circulation, radiant chamber with water cooled membrane walls, two stage superheater with inter stage Desuperheater and induced draft. The boiler shall be top supplied and shall be of outdoor type.

The steam generator shall be designed with the following design parameters:

Number of Coke Oven Waste heat Boilers	:	Two (2)
Maximum Continuous Rating (MCR) (T/hr) (Of each Coke Oven Waste heat Boiler)	:	20 TPH
Superheater Outlet Pressure (ata)	:	67
Superheater Outlet Temperature (Deg C)	:	490+5
Feed Water Inlet Temperature (Deg C)	:	140
Boiler Outlet Flue Gas Temperature (Deg C)	:	180

The tentative waste gas data from each coke oven battery is given below:

Gas flow (NCuM/hr)	:	43000
Gas temperature (°C) (Considered higher from Design Point of view)	:	950-1050

Coke Oven gas analysis (% by vol.)

Carbon di oxide	:	5-6
Moisture (Varies)	:	10-12
Nitrogen	:	70-80
Oxygen	:	8-10
Sulphur di oxide (Varies)	:	150 Mg/Nm3

The Feed Water Quality Requirement for the boiler shall be

pH	:	7.8
Dissolved Oxygen	:	0.007 ppm (max)
Total Hardness as Caco3	:	336
Total Iron	:	0.06 ppm (max.)
Total Silica	:	0.02 ppm (max.)
Specific Electrical Conductivity at 25°C measured after Cation exchanger in the H + form and after CO2 removal (max)	:	752 micro ohms/cm
Oil	:	Not allowed

With the above feed water quality, the boiler shall be capable of giving the following steam purity.

Total Dissolved Solids content	:	0.25 ppm (max.)
Silica as Sio2	:	0.02 ppm (max.)

The **STEAM GENERATOR** shall be provided with a single drum of fusion welded type. The drum shall be provided with Torrispherical / Semi-Ellipsoidal / Hemispherical spinned dished ends. The steam drum shall be liberally sized to assure low steam space loading, with adequate space to accommodate the internals. The steam drum internals shall be provided with internals of proven design and the internals shall be of bolted connection. The necessary nozzle connection for the steam outlets, safety valves, feed water inlets, down comers, continuous blow down, level indicators, chemical dosing, sampling connection, drains and vents shall be provided on the drum. All nozzle connections shall be of welded type.

The **RADIANT CHAMBER** envelope shall be constructed of fully water cooled membrane / fin welded walls and they shall be adequately supplied. The construction shall be gas pressure tight and the radiant chamber shall be strengthened by providing backstays and tie-bar system. The radiant chamber design shall incorporate necessary man holes. The down comers, supply pipes and risers sizing shall be based on circulation calculations.

The **EVAPORATOR** design shall be of inline arrangement. There shall be adequate approach space to the tubes for easy maintenance. Suitable number of soot blowers (if required) shall be provided to cover the maximum surface area of the evaporator. The sealing at the tube penetrations shall be 100% leak tight. The tubes shall be of seamless construction.

SUPERHEATER SYSTEM shall be of two-stage design with inter-stage de-superheating to achieve the rated steam temperature between 60% and 100% MCR. The super-heater shall be of convection type. The tube spacing of the super heater shall be designed to minimize bridging and tube erosion and shall be suitable for proper on load cleaning by means of soot blowers (if required). Suitable spacers shall be provided for both along and transverse to the gas flow direction. The super-heater system shall be complete with seamless pipe headers, interconnecting piping, tube spacers, valves, fittings, supports, vents and drains etc. The sealing at the super-heater tube penetrations with the boiler membrane wall shall be 100% leak tight. The tubes shall be of seamless construction.

An **INTER STAGE ATTEMPERATOR** of spray type shall be located between the two (2) super-heater stages to control the final steam temperature between 60% and 100% MCR load. The system shall be complete with control valve, isolating valves, interconnecting piping, supports, etc.

The **ECONOMISER** shall be located downstream of the evaporator. The economiser shall be of bare tube construction, inline arrangement, counter flow type and the economiser shall be designed for feed water inlet temperature of 126 Deg.C. Suitable number of soot blowers shall be located in the economiser for effective cleaning of the heat transfer areas. Economisers may be divided into suitable number of banks to accommodate the soot blowers and for maintenance of the soot blowers. The economiser gas path shall be pressure tight construction with proper design of the seals at the tube penetrations with the casing. The economiser shall be complete with seamless inlet / outlet headers with drains and vents, coil supports, supporting structures for the complete economiser, interconnecting piping, access galleries, stairs etc. The tubes shall be of seamless construction.

The steam generator shall be designed to recover heat from waste gases from coke oven batteries. The waste gas from the coke oven batteries will be led to the waste heat boiler through refractory lined hot gas ducts. Necessary expansion joints, regulating type diverter damper, blanking plate, insulation shall be provided.

Sampling facility with sample coolers for feed water, superheated steam and boiler blowdown water. The **SAMPLE COOLERS** shall be individual for the above application with the associated sampling lines, valves, cooling water lines, etc.

Each Steam generator shall be provided with **HIGH PRESSURE (HP) & LOW PRESSURE (LP) DOSING SYSTEM**. The HP dosing system shall be based on ‘trisodium phosphate’ dosing and this shall be dosed in boiler water to take care of the ingress of the hardness salts and to increase the boiler water pH. Each HP dosing system comprising of positive displacement pumps, tanks, agitators, required interconnection piping, valves, fittings, etc. The complete dosing system shall be skid mounted.

Boiler **REFRACTORY, INSULATION** with Aluminium cladding with all fixing material for boiler, ducting, piping, valves , fittings and equipment’s etc.

HANDLING SYSTEM including mono rails, lifting tackles, support structure for monorails, etc. for handling ID fan, Feed pumps and drive motors etc.

SUPPORTING STRUCTURES, steel work, platform, ladders, galleries, staircases with fabricated floor grating including complete roof, side cladding above the drum operating floor level along with cladding structures for protection against rain and other climatic conditions.

Saddle support, staircase, platform etc. for de-aerator and deaerated water storage tank

The boiler **INSTRUMENTATION AND CONTROL SYSTEM** shall be based on the Distributed Control System (DCS) philosophy. All the control, monitoring and interlock functions will be taken care of by the DCS system

2 x 100% **ID FAN** for each waste heat recovery boiler with variable frequency drive motor and complete, with necessary base frames, base plate, foundation bolts, supports, covers, couplings, lubrication system, etc.

Flue gas **DUCTING** from economiser to ID fan and ID fan to the common stack with required stiffeners, expansion joints, guide vanes for bends, dampers, insulation, cladding, suPports etc.

Chimney connecting flanges, counter flanges, expansion joints near chimney and all fasteners for the connections.

One **CONTINUOUS BLOW DOWN TANK** (CBD) Blow down tank shall be provided common for two WHRBs. The flash steam from the CBD tank shall be vented to the atmosphere. The CBD tank design, material selection and manufacturing shall be as per requirements of the IBR.

One (1) common **DE-AERATOR** for three WHRB's of deaerating capacity equal to 10% higher than the gross MCR steam generation capacity of both the boilers with a deaerated water storage tank of net useful capacity (Normal water level to Low water level) equivalent to twenty minutes (20 minutes) of MCR generation.

3 x 50% Boiler **FEED WATER PUMPS** (two working and one standby) with soft starter (with energy saver) drive motors, bed plates, sole plate, coupling, coupling guard, automatic re-circulation valves, suction strainers, lubrication system for pump and motor, vent and drain connections, balancing leak off lines. All integral piping and valves, thermal insulation and painting, foundation bolts, lifting and handling provisions and connecting flanges.

One **LOW PRESSURE (LP) DOSING SYSTEM FOR DE-AERATOR** shall be provided. The LP dosing system shall be based on 'hydrazine' dosing and this is dosed in the feed water to scavenge the last traces of oxygen and to increase the feed water pH. The LP dosing system comprising of positive displacement pumps, tank, agitator, required interconnection piping, valves, fittings, etc.The complete dosing system shall be skid mounted.

2 x 100% **DM WATER TRANSFER PUMPS** along with constant speed drive motors, bed plates, sole plate, coupling, coupling guard, piping, suction strainers etc. for pumping the DM water from the DM Storage tank to the de-aerator. The level of the de-aerator will be controlled in Auto mode by a De-aerator level control valve getting control signal generated by the De-aerator level transmitter.

Steam Turbines and Auxiliary System

This Captive power project envisages 2 x 9 MW **EXTRACTION CUM CONDENSING TURBO GENERATOR**. The turbine will be designed for the operation with the inlet steam parameters at 64Ata and 485 Deg.C. It will be designed to provide one uncontrolled extraction steam at 4.5 Ata. The balance of the steam supplied to the turbines flows through the LP section of the turbines into the surface condenser at a pressure of 0.10 Ksc (a).

The turbine shall be a horizontal, single cylinder, single extraction, and condensing type. There shall be two uncontrolled wandering extraction from turbine. Necessary spray water pressure reducing station and de-superheater in the exhaust line for maintaining the extraction steam parameters. All casings and stator blade carriers shall be horizontally split and the design shall be such as to permit examination of the blading without disturbing shaft alignment or causing damage to the blades. The design of the casing and the supports shall be such as to permit free thermal expansion in all directions.

The turbine shall have solidly forged and machined rotor with integral disks. The rotor after fully machined and bladed shall be dynamic balanced accurately in the shop and shall be given a over speed test under vacuum. None of the critical speeds of the rotor shall fall within the range of 20% above and 20% below the normal running speed of the rotor. The rotor shall be designed to withstand the maximum shock loading that may occur during any power system disturbance. Such shock loading values shall be taken for the design of the generator rotor.

The blading shall be designed to withstand all vibrations, thermal shocks, and other loading that may be experienced during service and system disturbances. The blades shall be machined from forged bars or die forged and the materials used shall be chromium steels consistent with proven experience and standards.

The glands shall preferably be of labyrinth type and sealed with steam. The gland packing shall be of 13% chromium stainless steel. Required gland steam condenser with the suction fans shall be provided. Steam leaving the glands shall be condensed in the gland / vent steam condenser using condensate from surface condenser.
The turbine shall be provided with liberally rated hydrodynamic radial and thrust bearings. The radial bearings shall be split, for ease of assembly, and of the sleeve or pad type, with steel shell backed, babitted replaceable pins and shall be positively secured in the axial direction. The thrust bearing shall be of, Mitchell tilting pad type, with steel backed babbitted multiple segment, designed for equal thrust capacity in both directions.
A liberal flow of lube oil under pressure shall be supplied to all the bearings for lubrication and cooling.

A pressure lubrication and control oil system shall be furnished for the turbo generator unit to supply oil at the required pressure to the steam turbine, generator bearings and governing system. For the hottest ambient conditions of 45 Deg.C, to be encountered at the site the oil outlet temperature at any bearing shall neither exceed the maximum permissible temperature for the bearing metal nor the maximum safe operational temperature of the oil.

The **OIL SYSTEM** shall include the following:

- One Hundred percent (100%) capacity centrifugal / gear type, main oil pump driven by the turbine shaft / low speed gear shaft.
- One (1) No. of one hundred percent (100%) capacity AC motor driven auxiliary oil pump, of centrifugal type, arranged to cut in automatically if the oil pressure falls to a preset value. This pump shall also meet the requirements during the start-up and shut down.
- One (1) D.C. Motor driven, centrifugal type, emergency oil pump of adequate capacity to provide adequate lubrication in the event of a failure of the AC motor driven pump. This pump also shall cut in automatically at a preset value of the oil pressure.

- Emergency gravity lube oil system comprising of overhead tank with SS lining and the complete piping shall be SS 304.
- Three nos. of one hundred percent (100%) capacity (one working and two standby) water cooled oil coolers.
- Two (2) nos. one hundred percent (100%) duty oil filters arranged in such a way that it is possible to clean one oil filter while the other is in service. The filters and the coolers shall be arranged with continuous flow transfer valves.
- Oil storage and settling tank with adequate reservoir capacity, duplex strainers, level indicators with float switches and alarm contacts, vent and oil mist eliminators.
- Flow and temperature indication for oil from every bearing.
- Centrifugal oil purifier, with drives all piping valves and fittings.

Supply of the flushing oil and first fill of lube oil for the turbine and accessories shall be the responsibility of the TG supplier and preferably from the Indian Maker. The interior of oil reservoirs shall be desalted and rust proofed. Reservoirs with top mounted equipment shall be with sufficient rigidity. All openings for piping shall be made dust and water proof. The oil reservoir shall be so located to permit draining of the content by gravity and shall be equipped with fine and coarse mesh strainers.

A centrifugal type oil purifier shall be provided for the removal of water, sediments and other oxidation products. The purifier shall be a separate package, mounted on a skid, complete by itself with drive motor, piping, valves and fittings. The capacity of the purifier shall be at least two (2) percent of the rate of normal flow through the reservoir.

The **TURBINE GOVERNING SYSTEM** shall be electro-hydraulic designed for high accuracy, speed and sensitivity of response. The electrical / electronic and hydraulic components of the control system shall be selected on the basis of reliability over a wide range of operating conditions. All components used shall be well proven to assure overall system reliability and shall be designed for easy and quick replacement when necessary. The governor shall be configurable in the field. The governing system shall have the following important functions:

- Speed Control
- Overspeed Control

- Load Control
- Steam Pressure Control

As a minimum requirement the turbine shall be designed to withstand the external forces and moments calculated in accordance with the requirements of NEMA SM. 23.
The steam turbine and the other high temperature parts, including piping supplied, shall be insulated with low conductivity inert material, where required, reinforced by stainless steel wire net between applied layers. The insulation shall be so arranged that it can be removed for access to the flange bolting, control valves and other parts that require periodic maintenance.

The turbine, shall be provided with a **BARRING GEAR** of mechanical type driven by an AC motor, to rotate the turbine and generator after shutdown to prevent thermal distortion of the rotor. The barring gear shall be capable of starting the rotor from rest and run it continuously at low speeds. The barring gear shall be interlocked with the lubrication system to prevent its operation without lubrication.
The system shall be capable of manual engagement and automatic disengagement when the turbine speed goes above the normal barring gear speed. The system shall also have facility for manual turning in case of AC supply failure.

The **CONDENSER** shall be non-contact surface type condenser designed as per the requirements of the Heat Exchange Institute Standards for steam surface condensers and ASME Sec.VIII Div.1. The condenser shall be sized to condense 1.5 times the normal exhaust steam quantity with the inlet cooling water temperature at 32°C. Suitably designed condenser air evacuation system shall be provided. The design shall be of divided water box construction.

Two numbers hundred percent (100%) capacity **CONDENSATE EXTRACTION PUMPS** to pump the condensate from the condenser hotwell shall be provided. One of the pumps will be operating and the other one will be a standby. The pump shall be selected for a normal continuous flow rate equivalent to the maximum steam flow to the condenser under all the operating conditions.
The turbine control shall be through the DCS system. The control system shall provide redundancy for key functions by use of separate sensors and monitors. The control system shall include all the standard control monitoring and alarming. Only proven equipment that have been used in similar systems before shall be provided. Control

panels shall be supplied fully wired and complete with all necessary special wiring for interconnection of panels. Vibration detectors/ proximity meters/ axial position detectors monitors shall be provided for all bearings including the bearings of the generator. Solid state annunciation units wherever located shall be of the first out type. Individual alarm windows shall be provided for all critical points parameters. The alarm sequence shall be as per international standards. Separate windows shall be provided for pre-alarm and shutdown with simultaneous alarm.

Crane for the Turbogenerator Building

A manually operated overhead travelling (EOT) crane with a span of 13 Meters, with the main hook lifting capacity of 20 Tonnes and an auxiliary hook lifting capacity of 5 tonnes shall be provided to facilitate erection and maintenance of the Turbogenerator and their auxiliaries. The crane travel will cover the entire length of the Turbogenerator building.

The crane shall be electrically operated, bridge type and shall be designed and equipped for indoor operation complete with accessories. The crane bridge shall consist of bridge girders each one carrying a rail on which a wheeled trolley is to run. The bridge trucks and trolley frames shall be fabricated from structural steel. Access walkways with safe hand railing are required along the full span length on either side of the bridge girders. Bridge and trolley trucks shall be of cast steel or fabricated structural steel sections. Wheel trucks of cast or welded construction shall be stress relieved as per accepted standards. Spring buffers shall be provided on the trolley and bridge structural frames at suitable places to absorb the shock of impact without transferring to the structural frame.
Electro-magnetic brake and electro thrust or brake shall be provided for each of main and auxiliary hoists. One electro-magnetic brake shall be provided for each of the cross travel and long travel motions. Brakes shall be provided on the high speed side of the gear reducer. It can also be located on the input shaft / extension of input shaft of gear reducer. Bridge and trolley track wheels shall be of forged steel and shall be double flanged with cylindrical 'straight' tread and shall have hardness of the steel not less than 250 HB. The wheel diameter and rail sizes shall be to meet the requirements of wheel loading suitable for the duty class of the crane.

Hooks shall be solid forged heat treated alloy or carbon steel suitable for the duty service. They shall have swivels and operate on ball or roller thrust bearings with hardened races. Locks to prevent hooks from swivelling shall be furnished. The lifting hooks shall comply with the requirements of BS: 2903 or BS: 3017 and if required, shall have a safety latch to prevent rope coming off the hook.

Hoist ropes shall be extra flexible, improved plough steel rope with well lubricated hemp core and having six strands of 37 wires per strand with an ultimate tensile strength of 160/180 kg/sq.mm of right hand ordinary (RHO) lay construction.
Rope drums shall be grooved and shall be either cast iron Gr.25 or above or cast steel of class-1 or welded steel conforming to IS: 3177 or BS: 466. The ratio of diameters of drum to rope and lead angle of rope shall also be as per IS: 3177 or BS: 466.
Gears shall be cut from solid cast or forged steel blanks or shall be of stress relieved welded steel construction. Pinions shall be of forged carbon or heat treated alloy steel. Strength, quality of steel, heat treatment, face, pitch of teeth and design shall conform to BS:436, BS:545 and BS:721.

Centralised grease lubrication unit with hand operating grease pump shall be provided for anti-friction bearings, one unit for line shaft anti friction bearings in bridge platform and another unit on trolley for top sheave and drum anti-friction bearings. The main drives for long and cross travel of the crane as well as for main and auxiliary hoist shall be totally enclosed, AC variable speed, slip ring, reduction motors, suitable for operation on a 415 V, 3 phase, 50 Hz, AC system. Motors for creep speed operation for hoisting, long and cross travels and thrust brake, however, may be squirrel cage type. Motors shall conform to 'crane duty' class, as per relevant standards. Motor winding insulation shall be Class 'F' with the temperature rise restricted to Class-'B'.

The crane motors and control circuit components for the long and cross travel motions of the crane shall be suitable for reversing plugging control. Electrical brakes provided for long and cross travel motions shall operate when the power is off. Speed control of various motors shall be achieved by adjusting the resistances in the rotor circuit of the drive motors.

Resistors shall be suitable for speed control duty cycle and inching operation, as required. Pendant type push button shall be supported independently of the electrical cable, and the arrangement shall be facilitate the operator to operate the crane standing away from the load. All control equipment for the crane shall be housed in dust tight, sheet steel cabinets.

Compressed Air System

The requirement of compressed air for instruments and the control systems of the power plant will have two (2) instrument air compressors with one (1) working and one (1) standby. Each of the compressors shall be rated for adequate capacity hr at 7 kg/sq.cm (g). The air compressor shall be provided with accessories like Inter cooler, After cooler, Moisture separators, Air driers, Air receivers and control panel.

The air compressor shall be rotating screw, lubricating type. The design of the reciprocating compressor shall be in accordance with API 618. The rotating parts shall be dynamically balanced according to the standard.

The heat exchangers (inter and after coolers) shall be designed as per 'TEMA-C' and coolers shall be mounted horizontally. The cooling water flow shall be through tubes and the tubes shall be of copper. The internal surfaces of the cooler shall be galvanised. The coolers shall be fitted with moisture separators and all necessary accessories.

The air drier unit shall comprise of 2 x 100% absorber towers with one of the towers in operation and the other one in regeneration mode (automatic changeover). The towers shall be fabricated from SA 515 Gr.70 or IS: 2002 material and filled with Alumina. The air drier shall be provided with sequence timer for automatic changeover and change over valves. The entire drying system shall be skid mounted.

The air receiver capacity shall be 4 Cu.m, fabricated from SA 515 Gr. 70 or IS: 2002 material. The internal surface shall be galvanised. The air receiver shall be fitted with all accessories including safety valves, moisture separators, etc.

The control system of pressure switches solenoid valves, regulators for automatic loading and unloading of compressors shall be mounted on a local control panel.

Service Air Compressors

The service air requirement being very low will also be met by the instrument air compressors. However, the service air will be directly tapped off from the air receiver bypassing the dryer units

Air Conditioner System

The main plant control room housing the controls for the boiler, turbo generator and balance of plant shall be air conditioned with ductable package air-conditioners, which will be located in a plant A.C. room, adjacent to the control room. The condensers will be located above the plant A.C. room at the 11.0 M elevation and the conditioned air will be distributed by means of ducting in the control room. Suitable humidity control devices shall be provided. A temperature of 22.2°C + 1.1°C and a relative humidity of 55 + 5% will be maintained in the control rooms.

Compressor shall be of hermetically sealed, scroll type. Condensers shall be air cooled type. The cooling fans shall be of higher diameter and a lower speed. Cooling coil shall be fin and tube type with aluminium fins firmly bonded to the tube. Air handling fan shall be of centrifugal type with forward curved blades. Package unit filters shall be cleanable polythene type. Refrigerant piping shall be carried out between package unit and condenser out of hard copper pipe of minimum 10 G thick sufficient thickness.
All ducts shall be fabricated from GSS confirming to IS: 277 grade VI. Fabrication of ducts shall confirm to the latest issue of IS: 655. Thermal insulation shall be out of 25 mm thick aluminium foil faced glass wool or equivalent. Wool shall be stuck to the outer surface of the duct by a thick coat of bituminous adhesive. Acoustic Insulation shall be out of 12 mm thick rigid glass wool covered with perforated 26 G aluminium sheet with minimum 30% area perforated. Grilles and diffusers shall generally be out of sufficiently thick powder coated extruded aluminium.

Ventilation System

The ventilation requirement for various areas in the TG building in power plant can be broadly classified under two sections:

Area which need positive pressure to avoid outside air infilteration, which is to be achieved by continuous fresh supply.

Area which need exhaust and have adjacent sufficiently large wall to fix exhaust fans.

Pressurization & Ventilation System

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The areas which require maintaining the positive pressure are the 11 kV switch gear room, PCC and MCC room. The temperature inside shall not increase considerably (not more than 4-5°C under maximum load conditions) due to the equipment load inside;

further area where infiltration is to be avoided shall be maintained at slight positive pressure to ensure the same. Frequency of door opening in these areas can be considered to be minimum.

Two centrifugal fans of each 60 % capacity will be able to supply the air to the areas which requires positive pressurisation. These fans shall draw air through a bank of coarse filters and then through a bank of 10 micron filters and discharge into a large plenum. Separate branch for each of the areas which requires positive pressurisation shall begin from this plenum. Each branch shall have a volume control damper at the branch off point. Designed quantity of air shall be taken to respective area by G.I. or Aluminium Ducting and air shall be distributed through side through grilles.

Exhaust Ventilation System

The areas which require maintaining the exhaust ventilation system are the compressor room, cable gallery, TG hall at three levels, battery room, toilets and Pantry. Exhaust fan of sufficient size and numbers shall be installed in these areas which need exhaust by propeller fans. These areas shall have sufficient air intake opening in the opposite wall where fans are to be fixed. These opening will enable drawing air from the TG bay.

The central TG bay where there are hardly any external wall will have exhaust due to propeller fan fixed in the adjacent area. Supporting the same there shall be tube axial fans fixed on the side walls. However, the central TG bay will have opening at various places, stair case etc. to allow air intake.

Fire Protection System

The fire protection system for the proposed Power Plant shall be consisting of

- Hydrant System for all the areas of the plant.
- High velocity water spray system for Transformers
- Automatic fire detection and alarm system
- Manual fire alarm system
- Portable fire Extinguishers

The components of the fire protection system, wherever applicable shall be BIS marked /TAC approved type. The system shall be designed based on safety requirements and generally conforming to Tariff Advisory Committee (TAC) regulations, and National Fire Protection Association of America.

The hydrant, water spray and the deluge system shall be provided with a motor driven water pump and a diesel engine driven stand by pump. Two Jockey pumps will be provided to keep the water system under pressure. The fire water storage shall be for a minimum of two hours pumping capacity of the pumps. The diesel and motor driven pump capacity will be 273 Cu.m/hr, with a head of 70 MWC. The jockey pump capacity will be 10.8 Cu.m/hr with the head of 70 MWC. The underground piping for the hydrant system shall be of carbon steel of suitable size with proper anti-corrosive wrapping and coating. Top of the underground line will be one and half meter below the ground level.

All hydrant accessories such as Hydrant valves, water monitor, and branch pipes with nozzles and hose boxes shall be provided.

The high velocity water spray system shall consist of necessary automatic deluge valves with strainer, test and drain connections, high velocity nozzles, quartzoid bulb detectors, solenoid valves and annunciation panel.

The fire detection and alarm system shall be designed according to IS 2189 standards. The system shall consist of addressable type one loop fire alarm panel located at the control room, addressable type smoke detectors (ionization and optical), addressable type heat detectors, manual call points, electronic hooters, junction boxes and cables.
Portable type fire extinguishers of DCP type shall be located in the TG building, control room, MCC rooms, fire pump house etc.

Main Steam, Medium pressure and Low Pressure Steam Systems

The outlet steam from each of the boilers will be conveyed through alloy steel main steam piping to a common main steam header. The main steam piping from the header conveys the steam to the Turbogenerator. Adequate number of motorised stop valves, non-return valves & isolating valves shall be suitably placed in the piping. The piping system shall be complete with necessary hangers, supports & specialities. Steam flow meters shall be placed in the piping, from the boiler, to measure the boiler steam flow.

Main steam from the header is conveyed to the turbo generator and the piping shall be complete with stop valves, Instruments, Flow meters, hangers, supports & specialities.

There will be a pressure reducing and de-superheating stations (PRDS). The high pressure steam from the common steam distribution header will be piped to the PRDS. The PRDS will reduce the pressure from 67 Ksc (a) and the steam from the downstream of the PRDS will be piped to the Deaeraator pressure control valve (D/A PCV), where the pressure will be further reduced to the pressure required by Deaerator (i.e. 2.0 Kg/sqcm

All valves in the piping system shall be suitable for the service conditions i.e., flow, temperature and pressure under which they are required to operate and those performing similar duties shall be interchangeable with one another unless otherwise approved. All gate valves shall be of the full way type and when in the full open position the bore of the valve shall not be obstructed by any part of the gate. Globe valves shall have curved or spherical seating and the discs shall be free to revolve on the spindle. All non-return valves shall have an arrow cast or embossed on the side of the valve body to indicate the direction of the flow. For severe service conditions cushioned check valves are preferred to obviate valve clatter. In the case of swing-check valves the body seat shall be inclined at such an angle to the vertical as will facilitate closing and prevent chatter. The insulating materials for the piping system or / and any component of the piping system shall not react chemically singly or in combination, with water or moisture to form substances which are more actively corrosive to the applied surface than water or moisture alone. The materials shall not offer sustenance to fungus or vermin and must not pose a health hazard. For mineral wool material the application density of insulation for temperature upto and including 400 Deg.C shall be 100 Kg/Cu.m. The application density for temperatures above 400 Deg.C shall be 125kg/Cu.m.

The sheeting material for all insulated piping and equipment shall be aluminium conforming to IS codes.

Gas handling system

The waste heat recovery boilers are designed to operate only with the thermal energy in the waste gases from the rotary kilns and these boilers do not need any supplementary or auxiliary fuel firing. There is no fuel handling system for the waste heat recovery boilers, as there is no fuel usage in the waste heat recovery boilers. The waste gases from the coke oven batteries will be conveyed to the waste heat boilers through hot gas ducts. Proper refractory lining shall be given for the ducting as the gases will be coming at high temperatures in the range of 750 to 1000°C. Necessary expansion joints, insulation shall be provided as required. An isolation gate shall be provided at the boiler inlet duct so that in case of maintenance of the boiler, with the coke oven battery working, it may be possible to attend to within the boiler.

Water system

The water system consists of the following sub-systems.

- Raw water system
- Circulating water system
- Condensate system
- Water treatment system
- Service and potable water system
- Raw water system

The area where the power plant will be located has a good water potential both in the form of surface water and in the form of ground water. Source of raw water for Power Plant will be from Brahmaputra River.

The 9 MW power plant needs about 1000 cum raw water per day in case of water cooled condenser and 100 cum per day (for ACC case) of raw water for meeting its make up water requirements. This make up includes the make up for the cooling tower, power plant and other service water for the Power Plant.

The power plant will be designed with a raw water storage tank. All the requirements of the raw water for the power plant will be drawn from this storage reservoir, through raw water pumps.

Auxiliary Cooling Water System

This system caters to the cooling water requirements of the:

- Air Cooler of turbo generator
- Oil Coolers.
- Compressors

- DG Sets

A two cell, induced draft cross flow **COOLING TOWER** with all the cells operating will meet the requirement , the circulating cooling water requirement of about 300 Cum/hr for the above. The hot water returning from the auxiliaries are cooled in the cooling tower designed for a cooling range of 9 Deg.C and an approach of 5 Deg.C while operating under the atmospheric wet bulb temperature of about 29 Deg.C. The cooling tower shall be of RCC construction. The RCC frame of the tower shall be integral with the basin. The structure shall be designed for wind and other loads as per IS: 1875 and earthquake resistance as per IS: 1893. Basin shall be water tight without the use of any fillers, paints or sealing compounds.

To prevent / minimize the growth of algae in the cooling water system chlorine dosing is proposed. Provision will be made for shock dosing at 3 ppm or continuous dosing at 1 ppm. Adequate number of one (1) tonne capacity chlorine cylinders to meet fifteen (15) days requirements will be provided.

There will be three (2) cooling water pumps of each capacity 330 cum/hr, one (1) working and one (1) standby.

Condensate System

The only source of condensate for the plant is from the Air Cooled condenser. The losses in the system by way of blow down in the boiler, steam traps, vents and leakages in the system will be compensated by the make up water to be added to the system. This make up water will be the treated water and this make up is let into the deaerator.

The condensate from the Hotwell of Condenser is pumped by the condensate extraction pumps to the deaerator. The deaerator will be equipped with a deaerated feed water storage tank having a minimum storage capacity equivalent to 20 minutes of MCR requirement of all the boilers. The level inside the deaerated feed water storage tank shall be maintained at a constant set value by controlling the quantum of make up water supplied to the deaerator. The deaerated feed water from the feed water storage tank will be supplied to the steam generator by means of boiler feed water pumps, driven by electric motors. There will be 3 x 50 % boiler feed water pumps (2 working +1 standby) for each WHRB. The approximate capacity of each boiler feed water pump will be 25 Cu.m / hr.

Water Treatment System

The type of water treatment plant has to be decided based on water analysis during detailed engineering stage. For the feasibility study, RO water treatment plant have a capacity of 6.0 m3/hr is considered to meet the make-up water requirement of steam generator turbine cycle,

The RO plant involves the following:
Undissolved impurities like turbidity, silt, mud, dirt and other suspended matter shall be removed using a Multigrade filter. The filtered water, after dosing, is taken to RO system. Antiscalant dosing system is considered to prevent scaling formation in the RO membranes. Decolourization is ensured by SMBS dosing.

The RO system will be complete with built in chemical cleaning system, which consists of cleaning pump, HDPE tank, cartridge filters etc. The complete RO skid will be fabricated from rolled steel and protected with epoxy paint.

The RO system will have a conductivity meter in the product system, pressure gauges at the inlet / outlet of the system, low pressure switch to safeguard the pump, high pressure switch to safeguard the membranes, etc

RO system employs a semi-permeable membrane for separating pure water from the raw water. Osmosis is the flow of solvent through a semi-permeable membrane, from a dilute solution to a concentrated solution. This flow results from the driving force, called the Osmotic Pressure between the two solutions. Reverse Osmosis is created, when sufficient pressure greater than the Osmotic pressure is applied on the concentrated solution and results in the flow of pure solvent from the concentrated solution to the other side through the semi-permeable membrane. In the water treatment plant based on reverse Osmosis, the pure water from the raw water flows to the other side of the membrane leaving behind dissolved salts with the raw water. The required pressure on the raw water side applied by the RO feed water pumps

In the RO system, about 70% to 80% of the feed water will be recovered as RO permeate water (product water). The balance of the pre-treated water will be the reject (brine stream) from the system. Flow meters will be provided in the product and the reject lines to give flow indications.

Mixed bed polishing units are also considered downstream of the RO Unit to further treat the RO permeate water. The MB units remove a substantial part of the silica and other dissolved solids and ensure that the constituents are well within the permissible limits. Limitation on the dissolved solids is required to ensure conductivity less than 0.2 micro siemens/m2 in the feed water going to the boiler. The mixed bed units contains a mixture of strong acid cation exchange resin and strong base anion exchange resin which produce infinite cycles of cation and anion resins which makes the demineralised water ultra pure.

The above demineralisation process reduces the pH of the demineralised water. The demineralised water from the outlet of mixed bed unit will be further dosed with Ammonia / Organic compound to increase the pH to about 7.

The success of Reverse Osmosis technology has been due to mostly the economics of its operation, simplicity and system capability to operate over vide range of dissolved solids.

The source of water for the RO plant will be the reservoir. It will be pumped through two 10 m3/hr capacity for raw water pumps with one working and the other remaining as standby. Raw water from the outlet of these pumps shall be taken to the RO plant.

ONE no DM Storage Tank of 100CuM Capacity will be installed cater the make-up water requirement for the Steam & Condensate cycle.

Effluent Treatment & usage of waste water

A neutralising pit for the treatment of the effluents from the RO plant is envisaged and after neutralisation the water will be used for Coke quenching, cleaning, gardening etc.

Service and Potable Water System

The service water system supplies water to toilets, general washing, gardening, dust suppression system, make up water for air conditioning plant etc. To meet the service-water requirements of the plant, water will be pumped directly from the neutralising pit or cooling tower blow downs to the user end, in case of non availability of above raw water from reservoir will be pumped to the user end.

The potable water requirements of the plant will be met by drawing off water from Bore wells & will be treated to potable water standards.

5.6 Plant and Machinery for Electrical Systems

The scheme of the electrical power generation for the power plant project will consist of two no. 11 kV, 50 Hz, 3 Phase, 0.8 PF Synchronous generators having nominal capacity of 9 MW each. The generator shall operate in parallel as well as island mode with state grid. A portion of the power generated in the turbo generator will meet the power requirements of the coke oven & ferro alloys plant, and the power plant auxiliary loads at 415 V level, through step down transformer.

Generator

The Generator will have nominal rating of 9.0 MW with the generation voltage of 11 kV, three phase, 50 Hz, at a rated power factor of 0.8 (lag). The machine will run at 1500/3000 rpm, and will operate with the Voltage and Frequency variation of +10 % and +5 % respectively. The enclosure will be of dust, vermin and water proof. The generator will meet other requirements as stipulated in IEC: 60034 and IS: 5422. The generator will be complete with base frame, closed air circuit external water (CACW) cooling system, brushless exciter, automatic voltage regulator, neutral grounding cubicle, LAVT (lightning arrestor & surge capacitor and voltage transformer) panel, relay, metering and control panels, instrumentation control and safety devices and other accessories, spares and special tools that will be required for satisfactory erection and efficient operation of the station. The generator coupled to the steam turbine will be suitable in all aspects for operating in parallel with grid. The generator will match with the turbine in respect of speed, over speed, moment of inertia, overload capacities, coupling and other relevant requirements.

The stator and the rotor of the generator will have class 'F' insulation but the temperature rise will not exceed the limits specified for class 'B' insulation. The generator will be fitted with RTDs (min. 2 per phase, for monitoring the temperatures), space heaters and temperature indicators.

The generator terminals will be suitable for connecting to switchgear panel through XLPE cables. The current transformers for metering and protection will be housed in the 11 kV switchgear panel and NGR cubicle.

Excitation System & Synchronizing Panels

The excitation system will be of brushless type and will be provided with the following features:

- Generator voltage control
- Excitation current control
- Excitation build-up during start-up and field suppression on shutdown
- Limiter for the under excited range and delayed limiter for overexcited range
- PT fuse failure detection and auto changeover
- Auto power factor control

The system will have double auto and manual channels, with bumpless changeover facilities. Alarms will be arranged for AVR fault, AVR automatic changeover to second auto channel / manual mode and for diode failure.

Swinging / trolley type synchronizing bracket complete with running and incoming voltmeters, running and incoming frequency meters, synchroscope, synchronizing check and guard relays, no volt relays, synchronizing cut off switch, lamps etc. will be provided. Automatic synchronizing with inputs to governor and AVR control will be made possible.

Unit Control Panel

The unit control panel will comprise of control and metering system, synchronizing system, protective relays, start / stop system, alarm / annunciation and temperature measurement system. The control panel will have provision for closing / synchronizing through the generator breaker and tie breaker. Dead bus closing arrangement will also be provided in the control panel. The panels may be split up into control panel, metering panel and relay panel for convenience.

Each panel will have digital / electronic TVM, ammeters, voltmeters, frequency meter, power factor meter, kW and kVA meters. All meters shall be hooked-up to DCS system through RS485 ports for data logging. The following minimum protections will be provided for the generator, with multifunctional relays in main and back-up configuration:

- Over voltage, under voltage relay
- Voltage restrained over-current relay
- Field failure relay
- Reverse power (active & reactive) relay
- Differential protective relay

- Stator earth fault relay
- Rotor earth fault relay
- Negative phase sequence relay
- DC failure trip relay
- Under/Over frequency relay
- Over load relay
- LAVT and NGR Cubicles

The LAVT cubicle will house surge capacitors, potential transformers for protection (class 3P), metering (class 0.5) & AVR sensing / excitation supply, lightning arrestors, cable box etc. The NGR cubicle will comprise of current transformers (class 0.5 and 5P10), neutral isolating switch and grounding resistor (punched grid type stainless steel grids). The enclosure for the panels shall be of cold sheet of 3 mm thick for from and back and 2.5 mm thick for rest.

11 kV Switchgear Panel

The 11 kV indoor switchgear board will be metal clad, free floor standing, totally enclosed, dust and vermin proof with draw out type vacuum circuit breakers. The boards will conform to IS: 3427 and the breaker will conform to IS: 13118 / IEC: 56. Each breaker will have distinct positions for service, test and isolation mode and will have independent earth switch for earthing the cable side terminals. All panels will have earth switch with interlock or separate earthing trolley. The panels will be suitable for bottom cable entry. Details of incomer and outgoing feeders shall be as in the schematic diagram enclosed to this report. Current and Potential transformers will conform to IS: 2705 / IEC: 185 and IS: 3156 / IEC: 186, respectively.

The switchgear panels will be complete with necessary CTs and PTs for metering and protection which will be of cast resin type conforming to relevant Indian standards. Neutral displacement relay will be provided in bus to detect earth fault conditions when the system is operated without neutral (i.e. operated with grid supply when generator is out of service). The auxiliary transformer feeders will be provided with the necessary relays and meters as shown in the protection scheme

LT Distribution System

One (1) number 2 MVA, 11 / 0.433 KV distribution transformer shall be provided for meeting the power requirement of the Power Plant auxiliary loads.

Plant Start-up

The plant shall be started by drawing the start-up power from the proposed 3 x 500 kVA capacity DG set as well as through grid.

Earthing System

Neutral point of the distribution transformers and neutral grounding resistor of the TG set generators shall be effectively connected to individual earth pits and shall be interconnected, as per IEEE:80 recommendations & IS:3043. Non-current carrying parts of all electrical equipment viz. motors, MCCs, PCCs, distribution boards, control panels, HT switchgears, generators and all lighting fittings shall also be earthed rigidly to ensure safety.

DC supply system

Battery, battery charger and DC board unit will be provided in common for the power house DC load requirements (viz. turbine emergency oil pumps, control & protection), switchyard loads and emergency lighting.

Lead acid stationary battery (110 V) with tubular positive plate, pasted negative plate in hard containers conforming to IS:1651 complete with vent plugs, acid level indicating floats, separators, bolts and nuts, cell insulators, inter cell connectors in dry and uncharged condition.

The battery sizing will be on the basis of the following type of loads:

- Momentary load for 1 min.
- Emergency load for 1 Hrs
- Continuous load for 10 Hrs.

The battery charger will be of SCR controlled with one float cum boost charging (FCBC) and one float charging (FC) equipment housed in a free standing, floor mounting cubicle having hinged half doors made out of 14 SWG CRCA sheets.

AC Auxiliary Supply

AC supplies of single and three phase, needed for internal use for several functions such as Illumination, Battery charging, UPS, Transformer tap-changer drives, Excitation supply, Power supplies for communication equipment, Breakers / Disconnect switch motors, Space heaters in cubicles, generators and marshalling kiosks shall be arranged from minimum two supply sources. For extremely critical AC loads, UPS supply system will be envisaged.

Lighting System

Good lighting in the power plant will be ensured to facilitate normal operation and maintenance activities and at the same time to ensure safety of the working personnel. Lux levels and glare index will be as per recommendations of IS: 3645. The lighting system would com¬prise of normal and emergency power supplies. Main lighting system shall receive supply from reliable supply sources and the emergency lighting system will be supplied from battery units. Emergency lighting will be provided at strategic points in the plant. Main lighting loads shall be supplied through lighting transformers.

Lightning Protection

Building lightning protection system will be provided as per IS:2309 and Indian Electricity rules. The protections consisting of roof conductors, air terminals and down conductors will be provided for the power house structure and other taller structures of the plant.

Switch yard & Generator Transformer

The proposed 33 kV switchyard in the plant premises will have a single bus arrangement with one generator transformer of rating 12 MVA, 11 kV / 33 kV with control and protection arrangement (breaker, CT, PT, LA, Isolators, etc). CTs, PTs, Las, isolators and TVM for system measurement will be provided as given in the scheme.

Plant Communication system

Communication system available for the coke oven plant shall be extended to the control room and strategic points of the power plant.

CHAPTER – VI

RAW MATERIALS AND SOURCES

The quality of raw materials is key factors for effective plant operation.

The raw materials, required for ferro silicon production are:

Quartz:

Quartz of below-mentioned quality is available from nearby sources.

SiO2	-	98% (min)
P	-	0.02% (max)
Size	-	25 – 75mm

LAM Coke:

Ash	-	14-18%
Size	-	5-20 mm

Metallurgical coke produced in-house shall be used.

Charcoal:

Ash	-	7% (max)
Size	-	6-100 mm

Charcoal of above quality shall be procured from Andhra Pradesh & Tamil Nadu

Coal:

Ash	-	10% (max)
Size	-	0-50 mm

Shall be procured from Assam, Nagaland and Meghalaya

Millscale :

Fe	-	70%
Size	-	0-10 mm

Shall be procured from Assam, Nagaland and Meghalaya

Note : In case non availability of charcoal Coal / LAM Coke will be used

CHAPTER – VII

ENVIRONMENT PROTECTION AND WASTE MANAGEMENT

7.1 FERRO ALLOYS:

7.1.1 Pollution control facilities:

With increasing environmental awareness, it is imperative that due attention is paid to this aspect right at the planning stage. Of the three major identified areas of pollution viz. air, water & noise, the extent of water pollution & noise pollution in ferro alloy manufacturing units is negligible.

As regards air pollution, while gaseous emission are naturally well within the stipulated limits, necessary control measures will be put in place to ensure that particulate emission from the furnaces are also well below acceptable/prescribed safety norms.

7.1.2 Air pollution control

Particulate emission consists mainly of manganese ore dust, coal & coke fines emanating mainly from the furnace exhaust gases & transfer points of conveying and handling equipment. The gas emanating from the furnace will be picked up in the 'Hood' above the Furnace and is sucked into the system by negative pressure. It is shall be first passed through a heat exchanger wherein it shall be air cooled. The air coming out of the cooler at a temperature of about 120^{o}C shall be then passed through a modular type 'Pulse Jet' Bag Filter where fine dust particles will be separated and clean filtered air having emission less than 100 mg/Nm3 will be vented out through the stack via an ID fan. The dust collected in the bag house would primarily consist of fines of manganese ore, coke, coal and other raw materials fed to the furnace. This would be processed by the briquetting and/or sintering plants and would be fed back to the furnaces.

The main areas of fugitive gas emission are:

a) Above the open hearth of the furnace.

b) At the Slag Port and Tapping spout. But the fumes here are negligible.

However control measures to maintain the ambient air quality will be incorporated.

7.1.3 Noise pollution control

To avoid noise pollution, the DG sets and compressors shall confirm to laid down norms of the pollution control board.

7.2 COKE

As the heat is generated due to the combustion of hydrocarbon evolved during carbonization and no coal particle is burnt directly, the pollution created by the system is different from the conventional coal burning where coal is used as source of fuel. The system operates at high temperature (1200°C). Hence, any external apparatus cannot be used for pollution control. The system for pollution control is integrated with the construction of the ovens. Moreover, the complete coke oven works at negative pressure. Hence there is no leakage of hot gases from the oven. There are two types of pollutants present in the combustion system in this type of oven:

1. Hot Gases like CO2, CO, NOx, SOx etc.
2. Suspended particulate Matter (SPM)

To minimize pollution, following measures have been proposed in the design:

Hot Gases: These are generated due to combustion of hydrocarbons released during carbonization. When hydrocarbons come in contact with oxygen, it breaks into carbon dioxide, carbon mono oxide, nitrous oxide and other variants. A system of recuperator has been incorporated with the design to generate hot air from the waste heat. This hot air is injected as primary air inside the oven, as secondary air inside various points of sole flue, waste heat tunnel and main tunnel for almost complete combustion of gases generated. Throughout the system, fuel: air ratio is maintained at 1:5 as per the norms for complete combustion. As a result, only traces of NO_x, SO_x are recorded from the chimney.

SPM: These are generated in very small quantity during the process. It should be well understood that in this process coal as such is not being burnt as fuel and no ash is being generated. However, method of expansion and contraction is adopted to separate SPM from the waste gases at various stages. The hot gas generated in the oven is brought down to sole flue through a relative small duct under high pressure. As soon as it enters into sole flue, the cross section of the flue is increased by at least three times to induce capillary action as in refrigeration. Due to sudden increase in volume, the pressure of the gas drops and it releases temperature and SPM. This SPM get settled in the bottom of the flue, which is cleaned periodically. Same principle is applied in the waste heat tunnel and main tunnel. In addition to this, baffle wall is constructed inside the flue channels to trap any SPM present in the waste gas. All these measures control the pollution as required.

The waste heat from the coke ovens can be utilized to generate power, thereby reducing emissions of equivalent CO_2 to atmosphere.

General measures

- Stack height of all the APCS will be as per CPCB norms.
- Green belt along the boundary and inside the premises will be developed to arrest the dust from fugitive emissions.
- Water sprinkling will be done in vehicle movement, loading and unloading areas. Also all roads within the premises will be made pucca.
- Enclosures will be provided for noise generating equipments
- Eco-friendly and silent DG sets will be installed.

Noise pollution control

To avoid noise pollution, the DG sets and compressors shall confirm to laid down norms of the pollution control board.

Thermal pollution control

There will also be no Thermal Pollution as the entire heat generating equipments are water cooled and/or thermally insulated with Refractory materials. Hot gas from furnace cools down in the Gas Hood due to dilution with ambient air.

However, the operational area around the furnace will be hot to warm up to a distance of 3-5 Meters.

7.2.2 Environmental Management Plan:.

1) **STACK EMMISSION:** Since the gases are completely burnt inside the ovens & sole flues, there is no chance of any hazardous contamination like CO or Hydrogen in the waste gas which is released through a 40 meter tall chimney. SOX & NOX will be regularly monitored & the height of the chimney has been kept in accordance with MOEF norm. Suspended particulate matter in Stack is well within the stipulated norm of 50-100 ppm.

2) **ZERO EFFLUENT**: There is absolutely no effluent generation because wet coke quenching is the only activity where water is used for quenching red hot coke. There profuse water vapor formation which is being released from the top of a 30-40 m tall quench tower. It has provision of grit arrestor which arrests entrained particulate matter which comeback to the bottom of the tower due to high pressure water spray in the grit arrestor. The hot water exit the quench tower collects in a settling pond, where coke breeze & ash settle to the bottom & clear water passes through a multi stage settling pond & finally to the quench water pumping pit where make up water is added to make up the evaporation loss in the quenching process.

3) **DUST SUPPRESSION SYSTEM**: Introduction of Stamp charging completely eliminates the Charging time dust emission during top charging. Adequate water spraying system will be provided in the coking coal storage yard to suppress dust generation. Moreover Dry Fog arrangement will be provided at all transfer points as well as coal crusher & coke cutter buildings to suppress fugitive dust. Pushing emission is also eliminated as the receiving tray of the quench car is in the same level as the ovens & the red hot cake of coke comes out smoothly without any disturbance during pushing of ready ovens,

4) **SOLID WASE MANAGEMENT**: There is no solid waste as all forms of solids handled in the plant are saleable. We get the following products, byproducts and solid wastes from the proposed plant:

5) **DOOR LEAKAGES**: The doors are mud sealed and since the ovens are operated under suction emission from the ovens is completely ruled out.

6) **NOISE POLLUTION**: Noise pollution from the crusher house is minimal and the same from the coke cutter building is also kept within permissible limit. Adequate sound barrier to be provided wherever necessary.

7.3 POWER PLANT

The design philosophy of energy conversion systems such as steam generators has evolved from providing the lowest cost energy into providing low cost energy with an acceptable impact on the environment. However, minimizing aqueous discharges and safely disposing of solid by-products are also key issues for power plant systems.

One major redeeming factor about ANJANEY COKE & ALLOYS PRIVATE LIMITED's Power Plant is that the Power Plant is utilising the hot waste gases from the coke oven batteries which would have been discharged into the atmosphere. Also this power plant indirectly prevents a pro-rata quantum of pollutants, being let into the atmosphere from the utility plant, from where otherwise the equal quantum of power would have been generated. ANJANEY COKE & ALLOYS PRIVATE LIMITED's power plant thus being environment friendly deserves encouragement.

Particulate matter and gases

The pollution control regulations limit the particulate matter emission from the power plant,. The proposed power plant operate throughout the year (330 days) using the waste gas from coke oven batteries for the waste heat recovery boiler. It is to be noted that since no firing is involved in the waste heat boilers, additional air pollutants are not generated. The Sulphur-di-oxide (in the Coke Oven Gases) emission is limited to the maximum of 0.0087 %, based on which the stack height has been decided to be 55 meters. The Table-6.3 gives the ambient air quality standards as per the Pollution Control Board.

The total ash quantity generated from all the boilers will be about 135 Mt from Coke Oven Boilers per Annum. As the quantity of ash is very small, manual handling of ash is proposed. This dust being non hazardous will be used for land filling.

Water Pollution

Effluent from water treatment plant

Hydrochloric acid and sodium hydroxide will be used as regenerants in the proposed mixed bed polishers of water treatment plant. The acid and alkali effluents generated during the regeneration process of the ion-exchangers would be drained into a epoxy lined underground neutralizing pit. Generally these effluents are self neutralizing. However, provisions will be made such that the effluents will be neutralized by addition of either acid or alkali to achieve the required pH of about 7.0 to 8.0. The neutralizing pit will be sized appoximately for 5 Cu.m capacity. The rejects from water treatment plant will have high TDS which could be diluted and used for cleaning purposes in the project. This water also could be used for plantation, Coke quenching & dust suppression.***THERFORE THE PLANT IS DESIGNED FOR ZERO DISCHARGE.***

Steam generator blow down

The salient characteristics of blow down water from the point of view of pollution are, the pH and temperature of water since suspended solids are negligible. The pH would be in the range of 9.8 to 10.2 and the temperature of blow down water will be about 95 DegC .The quantity of about 0.40 Tonnes/Hr of blow down from the boilers is very small and hence, it is proposed to reuse the blow down water in the Water treatment plant.

Sewage from various buildings in the plant

Sewage from various buildings in the power plant area will be conveyed through separate drains to the septic tank. The effluent from the septic tank will be disposed in soil by providing disposing trenches. There will be no ground pollution because of leaching due to this. Sludge will be removed occasionally and disposed off as land fill at suitable places. Table-6.2 gives the tolerance limits for the effluents.

Thermal Pollution

A close circuit cooling water system with cooling tower has been proposed. This eliminates the letting out of high temperature water into the canals and prevents thermal pollution. Blow down from the cooling tower will be trenched out and ultimately & will be used for coke quenching, dust suppression, gardening, washing, cleaning of toilets etc.

Noise Pollution

The rotating equipment in the Power plant will be designed to operate with a total noise level of not exceeding 85 to 90 db(A) as per the requirement of Occupational Safety and Health Administration (OSHA) Standards. The rotating equipment is provided with silencers wherever required to meet the noise pollution.

In case of industries where particulate emission control are adopted to the limits prescribed, the stack height can be relaxed to H = 74 Qp0.27 where Qp = Particulate Emissions in Tonnes/hour.

Monitoring of Effluents

The characteristics of the effluents from the proposed plant will be maintained so as to meet the requirements of State Pollution Control Board and the minimum national standards for effluent from thermal power plants. Air quality monitoring will also be undertaken to ensure that the dust pollution level is within limits.

Air Quality Monitoring Programme

The purpose of air quality monitoring is the acquisition of data for comparison against the prescribed minimum standards and thereby assures that the air quality is maintained within the prescribed levels.
The following will be monitored from the stack emissions.

- Suspended Particulate Matter.
- Sulfur-Di-Oxide.

The Laboratory attached to the Power plant will be equipped with the necessary instruments for carrying out air quality monitoring. It is also proposed to monitor the particulate emission at the stack. Adequate sampling openings will be provided in the stack.

IMPACT OF THE POLLUTION ON THE ENVIRONMENT

As all the necessary pollution control measures are taken to maintain the emission levels within the limits , there will be no adverse impact on either the air or water quality in and around the Power plant site on account of the installation of the plant

QUANTITY & QUALITY OF THE EFFLUENTS FROM THE POWER PLANT

The figures given below are for the normal operatio n of the plant for 330 days in a year.

GASEOUS EFFLUENTS FROM THE POWER PLANT

FROM ONE NO. COKE OVEN GAS WASTE HEAT RECOVERY BOILER

Flue Gases from the stack (NCu/hr)	:	43000
Temperature of the gases leaving the Stack (Deg C)	:	120 - 140

SO_2 Emission (Power Plant)	:	< 40
NO_x Emission (Power Plant)	:	Nil
Particulate Emission through flue Gases (mg/nm3) at Coke Oven Boilers stack outlet	:	Less than 40

SOLID WASTES FROM THE PLANT:

Dry ash (Kg/Hr) (max)	:	17-20 (approximately)

LIQUID WASTES FROM THE PLANT

Boiler Blowdown Water (TPH)	:	0.4
Total Dissolved Solids (Power Plant), max	:	100
pH @ 25 Deg.C	:	9.8 to 10.2
*Cooling tower Blowdown Water (TPH)	:	4
Total Dissolved Solids (Power Plant), max	:	Aprox. 1000
pH @ 25 Deg.C	:	8.0 to 9.0
Chlorine	:	0.2
Waste Water from Neutralizing Pit-(TPH), average	:	2
Total Dissolved solids(Power Plant)max	:	< 1000
pH @ 25 Deg.C	:	7.5 – 8.5

NOTE:

Cooling Tower blowdown & other waste water will be used for:

- Coke quenching
- Gardening
- Toilet
- Washing
- Dust suppression (if required)

THE PLANT IS PRACTICALLY ZERO DISCHARGE.

CHAPTER – VIII

UTILITIES AND SERVICES

The following services and utilities shall be required.

8.1 WATER SUPPLY FACILITIES

The water requirement of the entire plant shall be met through a dedicated pipeline from the Brahmaputra river. Industrial water re-circulation cycle shall comprise supply water pumps, cooling towers, swamp, interconnection piping and necessary instrumentations.

Emergency overhead tank shall be provided for critical units.

Particulars	Phase 1	Phase 2	Total
Ferro Alloys	100 Cum / Day	100 Cum / Day	200 Cum / Day
Coke Oven	200 Cum / Day	200 Cum / Day	400 Cum / Day
Power Plant (Water cooled condenser)	1000 Cum / Day	1000 Cum / Day	2000 Cum / Day
Misc	50 Cum / Day	50 Cum / Day	100 Cum / Day
Total	1350 Cum / Day	1350 Cum / Day	2700 Cum / Day

Note:- If the company opts for air cooled condenser in power plant then the total water requirement will reduce to 900 cum / day.

8.2 COMPRESSED AIR FACILITIES

A compressed air system has been provided to cater to the needs of service requirements of various units. This also caters to the need of instrument air of specific quality for various consumers. The requirement of compressed all shall be as follows:

- Industrial quality at 7Kg per cm^2

Necessary facility for air compressors and air dryer with receiver has been envisaged.

8.3 ELECTRIC POWER SUPPLY AND DISTRIBUTION:

8.3.1 Power Requirement

POWER PLANT - CONNECTED LOADS (PHASE 1):

Boiler auxiliaries	:	560 kW
Turbogenerator auxiliaries	:	60 kW
Wet cooling tower (MCW Pumps, ACW Pumps, Cooling tower fans)	:	272 kW
Misc pumps (Raw water pumps, make-up water pumps for cooling tower make up pumps for power plant)	:	15 kW
Air compressors	:	18 kW
Water treatment plant	:	20 kW
AC & Ventilation	:	15 kW
Lighting	:	25 kW
Transformer and other losses	:	15 kW
POWER REQUIREMENT OF ENTIRE PLANT (PHASE !)		
Total Generation for power plant	:	9000 kW
Power Plant Auxiliaries	:	800 kW
Coke Load	:	500 KW
Ferro Alloys Load	:	7500 KW
Lighting and misc plant load	:	100 KW

However, grid connectivity is required to obtain start-up power of CPP, Safe shutdown power, exporting power generated (if required) and to draw/throw small quantities of power if there is a mismatch between generation and consumption. The plant shall receive the power from the state grid to meet its requirements initially.

8.3.2 Basic Design Parameters

System Voltage

Distribution to MCC - 440V, 3ph, 50Hz and 415V, 3 ph, 50Hz

For Illumination - 230V, 1ph, 50 Hz

8.3.3 Power Distribution Facilities

HT Switchgear:

The HT Switchgear would be of outdoor type with minimum oil circuit breaker, with three-phase symmetrical short circuit rating of adequate capacity. The circuit breakers would be electrically operated (battery operated type) and operated from 24V DC control source.

Transformer:

The transformer would be mineral oil filled with ONAN cooling. It would be designed for temperature rise not exceeding 50^{O} C in winding and 40^{O} C in oil over ambient temperature.

Substation facilities:

Complete substation facilities and accessories such as battery banks and associated battery charging equipment, DC distribution board, fire fighting equipment, ventilation equipment and complete earthing will be provided.

8.3.4 Cabling

Power inside the plant would be distribution by insulated cables, which would be generally laid underground. The cables used for LT power distribution would be of 1100V grade, heavy duty with Aluminium conductors. All control cables shall be of 2.5 sq. mm copper.

8.3.5 Motor control center

Drives:

AC motors will normally be used in all areas of plant except in places where the speed control and torque requirements call for DC motors. Slip-ring induction motor would be considered for intermittently running drives requiring frequent switching operations and for heavy-duty drive application requiring speed control. In all other cases, squirrel case induction motors have been considered. The motors would be suitable for direct on line starting with full voltage on.

Control:

The control systems would be confirmed as a distributed hierarchical concept with the following three control levels.

- Individual drive control level
- Functional group control level
- Technological plant control level

For this purpose the contractors and relays techniques would be adopted for individual drive control at the bottom level in hierarchical structures. These will essentially take care of the connection (ON), disconnection (OFF) and individual error signaling of a drive.

Automation:

The automation of operations shall be achieved through programmable logic controllers (PLC) from the central control room. It shall be possible to operate any motor in remote mode from the control room. To monitor the state of all drive motors VDU's shall be provided in the control room. The technological drives shall be grouped in logical control blocks for the purpose of sequence of operation, monitoring and fault annunciations. Mimic display of the status of various drives is also foreseen.

Earthing and lightning protection

All electrical equipment would be provided with two district earth connections as per Indian electricity rules. A ring main earthing system shall be provided for each shop/unit for this purpose. All buildings would be provided with necessary lightning protection arrangements. GI strips/flats and GI electrodes will be used for earthing and lightning protection.

Illumination

The illumination level envisaged for the different areas indoor and outdoor will be as per international norms for industrial production units to ensure comfort and safety. High-pressure sodium vapor lamps with reflectors will be used or high bay lighting and road lighting. Flood lighting will be used for open storage areas. Florescent lamps with will be used for low bays of production departments, office building, electric rooms, laboratory and stores. Emergency lights along with batteries will be provided for strategic units and control rooms to ensure safety.

8.4 VENTILATION AND AIR CONDITIONING:

Building and shops will generally be provided with natural ventilation. Mechanical ventilation shall be provided where adequate ventilation cannot be provided by natural means. The control rooms of plants shall be provided with window type air conditioner to maintain the temperature as per requirements.

8.5 FIRE PROTECTION FACILITIES:

In order to combat any occurrence of fire the following fire protection facilities have been envisaged for the plant. Internal and yard hydrants along with hose boxes and hoses complete in all respects at suitable intervals. Adequate number of suitable types of portable extinguishers shall be provided in all the units as per the nature of fire. A fire-post with one fire attendant shall be deployed to extend necessary assistance required for fighting fire in any of the plant units.

8.6 QUALITY CONTROL FACILITIES

The plant shall have its own quality control laboratory for following functions:

- Analysis of raw materials
- Analysis of products
- Testing of water and Gas samples

The laboratory shall have following sections:

- Sample preparation unit
- Wet chemical analysis section

CHAPTER – IX
CIVIL AND STRUCTURAL WORK

9.1 Civil Work

The civil work shall comprises of site preparation, design and construction of building structures, under ground structures, foundation for equipment and structures, floors, surface and underground drainage, underground tunnels, roads, boundary wall, fencing etc.

The civil design shall be carried out based on the site contour and soil investigation report. These activities need to be carried out before commencement of civil engineering work.

9.2 Structural Work

Steel structural work shall cover the building structures, conveyor galleries, pipeline supports, roof and side sheeting work and painting.

CHAPTER – X

M A N P O W E R

The operation and maintenance needs for the plant coming up under the proposed project calls for deployment of proper manpower.

The category-wise break-up of manpower that shall be required for the plant is given below-

Sl. No.	Category	No. of Employees
01.	Managerial	18
02.	Supervisory	18
03.	Skilled	117
04.	Semi – Skilled	48
	Sub Total (Direct)	**201**
06	Contract Workers	190
07	Security Personnel	20
	Sub Total (Direct)	**210**
	Total	**411**

The above estimates are tentative have been based on production technology proposed, level of mechanization and automation, number of operating shifts etc.

About 60% of personnel may need other on-job training or training by plant suppliers due to operational needs.

CHAPTER – XI

IMPLEMENTATION SCHEDULE

The project envisages installation of 14,400 TPA Ferro Alloys plant, 144,000 TPA Coke oven and 18 MW CPP in two phases.

Modules	Phase 1	Phase 2	Total
Ferro Alloys - Submerged Arc Furnace	1 x 9 MVA capacity 7,200 TPA	1 x 9 MVA capacity 7,200 TPA	18 MVA capacity 144,00 TPA
Coke Oven	72,000 TPA	72,000 TPA	144,000 TPA
Power Plant	9 MW	9 MW	18 MW

The detailed implementation schedule is as follows:

PARTICULARS	START	COMPLETION for 1st phase	COMPLETION for 2nd phase
Civil Works	Zero date	18 months	54 months
Plant and Machinery			
a. Placement of Orders	3 months	20 months	56 months
b. Fabrication	6 months	20 months	56 months
c. Erection & Installation	15 months	22 months	58 months
Trial Production		23 months	59 months
Commercial Production		24 months	60 months

Note:- The project Zero Date starts once the management gives the 'Go Ahead' approval after MOEF & other statutory clearance are obtained and project's financial closure is done

Projected Implementation

It will be imperative to complete many of the project activities before the zero date and soon afterwards. These include:

- Basic Engineering
- Preparation & Issue of tender document for major technological units.
- Placement of orders for major technological units.
- Financial tie-ups, if any.
- Finalisation of terms with overseas agencies if any.
- Clearance from statutory authorities.
- Land acquisition.
- Site survey and soil investigations.
- Site preparation / leveling work.
- Enabling work like construction of water line, power line and sewerage, labour camp and communication facilities.

It will be necessary to ensure selection of capable and reputed construction and erection agencies and mobilization of requisite resources of men, material and construction machinery as well as construction and erection expertise on modern and advance trends, to adhere to the proposed schedule. It will also be necessary to ensure timely availability of the site infrastructure of the work execution at site.

CHAPTER – XII
FINANCIAL ANALYSIS

The operational parameters of the unit as a whole over a period of 6 years in the perspective have been computed on the basis of the operational data given in the following Annexures. All the financial working is based on expected prices of various raw materials and finished goods.

PROJECT COST

The total project cost for the facilities is given in **Annexure - 1.** The total project cost comes to Rs. 308 crores. The Debt Equity ratio considered for the project is 1.86

PROJECTED PROFITABILITY ANALYSIS

Projected profitability of the unit at different levels of capacity utilization envisaged over a period of 6 years in the perspective have been computed and presented in **Annexure-II.**

PROJECTED CASH FLOW ANALYSIS

The projected cash flow analysis of the unit for a period of 6 operational years in the perspective have been computed and presented in **Annexure – III.**

WORKING CAPITAL

The requirement of working capital for the unit has been computed on the basis of minimum level of inventories to be maintained for input raw materials, consumables and fuel, provision for stock of work in process and finished goods as per the norms laid down for similar companies in the industry for smooth and uninterrupted operation of the plant. The details of the working capital requirements are given in **Annexure – IV.**

INTEREST

Interest on the proposed term loan from financial institution of Rs. 200 crores has been computed considering an interest rate of 12.00% p.a. with the repayments being made on a quarterly basis in 20 installments with a moratorium period of 12 months. The interest is being calculated on the balance outstanding thereof. Details of annual interest calculation on the proposed term loan have bee given in **Annexure - V.**

Interest on bank borrowings for working capital has been considered at 12.00% p.a.

DEPRECIATION

The depreciation has been calculated on Straight Line Method as per Companies Act & Written Down Value Method for Income Tax purposes. However, a higher rate of depreciation has been considered as the equipment are not expected to have a useful life assumed in the Companies Act and will require a major overhauling in less than a decade. The Fixed Assets of the company have been broadly classified into three heads for the purpose and applicable rates of depreciation have been charged. Detailed calculations of the depreciation charged on the assets have been calculated and annexed as **Annexure – VI.**

INCOME TAX

Income Tax payable has been estimated as per the current provisions of Income Tax Act. The details of income tax calculations for the unit is given **in Annexure – VII**.

DEBT SERVICE COVERAGE RATIO

In order to ascertain the debt serviceable capacity of the project Debt Service Coverage Ration has been worked out for each year of operation till the repayment of proposed Term Loans and it has been found to be satisfactory for each year. DSCR calculation is shown in **Annexure-VIII.**