Study of the Electrical system of the new Power and Blowing Station II

and

Emergency calculations for power requirements in case of power failure

Anshul Dubey (2015A3PS309H)
Himanshu Gupta (2015A3PS339H)
Mihir Kumar (2015B3A3564H)
Salil Jain (2015B5A3578G)

Final Report submitted in partial fulfillment for
Practice School I (BITS F221)

under the guidance of

Mr. V.S. Dewangan

Submitted to

Prof. Ashutosh Bhatia

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Preface

"The trick to having good ideas is not to sit around in glorious isolation and try to think big thoughts. The trick is to get more parts on the table."

-Steven Johnson

If a picture is worth thousand words then a face to reality is priceless.

Project provides an engineer one such opportunity to explore the practical aspects of one's technical knowledge apart from giving a firsthand experience to the professional work environment and opportunity to meet the strong technical work force.

We would like to thank everyone concerned for their time, enthusiasm and effort. Bhilai Steel Plant provided all the data needed for the project.

The project report focuses on the Study of the Electrical system of the new Power and Blowing Station II (PBS-II) and the Emergency calculations for power requirements in case of power failure.

Finally, we regret any inadvertent errors that might have crept in. We hope that reading these proceedings is joie-de-vivre.

Acknowledgement

In preparing these proceedings we have been fortunate to receive valuable guidance, kind support, suggestions, inspiration and assistance from our guide and his colleagues. We greatly appreciate their generosity in devoting their valuable time to help us in pursuing this project.

t is with feelings of profound thankfulness and deep sense of gratitude that we acknowledge the invaluable guidance and consistent encouragement rendered to us by **Mr. V. S. Dewangan (AGM, PP-I)**, Bhilai Steel Plant (SAIL), India. He spared valuable time from his busy schedule for us and helped us by guiding for the project. Our sincere thanks to **Mr. Dewangan** for all the help and resources that were made available to us.

We are deeply indebted to our PS Instructor **Mr. Ashutosh Bhatia** for his constant assistance and help in facilitating and organising the various activities regarding the Summer Internship.

We would also like to thank our Project Mentor **Dr. G.R. Sabareesh** for his valuable input regarding the project.

We are also thankful to **Mr. V.M. Rao, Pankaj Rathore** and all the respected individuals who were directly or indirectly involved in the successful completion of our Technical project.

Declaration

We hereby declare that project work entitled **"Study of the Electrical system of the new Power and Blowing Station II and Emergency calculations for power requirements in case of power failure."** is an authentic record of our own work carried out at the Power and Blowing Station (PBS-2) of Bhilai Steel Plant under the supervision of Mr. V.S. Dewangan and the guidance of Mr. Ashutosh Bhatia, during 22nd May 2017 to 15th July 2017.

Anshul Dubey

Himanshu Gupta

Mihir Kumar

Salil Jain

Date : 7^{th} July 2017

Certificate

सेल SAIL

This is to certify that report entitled **"Study of the Electrical system of the new Power and Blowing Station II and Emergency calculations for power requirements in case of power failure."**, which is submitted by Anshul Dubey, Himanshu Gupta, Mihir Kumar and Salil Jain pursuing B.E. (Hons.) at BITS Pilani University is a record of candidates own work carried out by them under my supervision. The matter embodied in this project is original and has not been submitted for the award of any other degree.

Shri V.S. Dewangan
(Assistant General Manager)
Power and Blowing Station SAIL-BSP

Contents

Chapter 1

Project Overview

1.1 What is the project about?

- To study of all electrical and mechanical system of PBS-2
- Calculation of the emergency power requirement of different units of PBS-2.
- Identification of the source of power in BSP to ensure emergency supply in case of power failure.

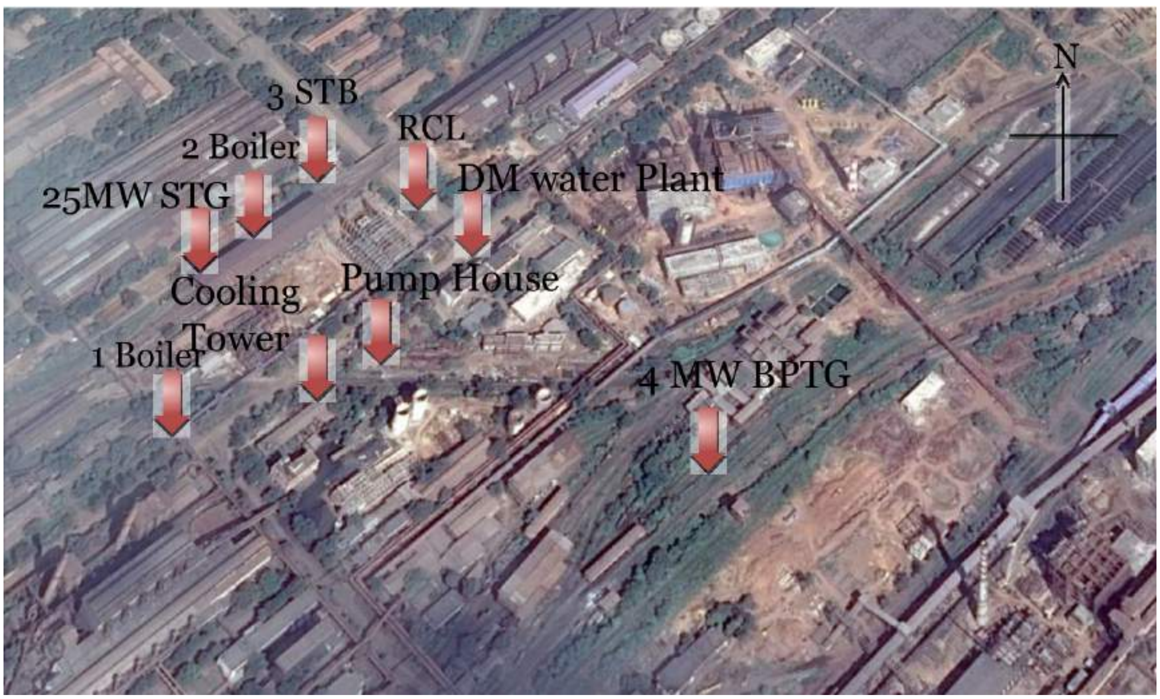
1.2 Objective and Significance of the project

- Detailed exposure of various process involved in power generation system in steel industry.
- Function of boilers , DM water plant ,cooling water pump house , cooling towers , turbine, generator for power requirement in any industry .
- Learning of the various control systems in power plant operations .
- Role of SCADA in electrical control system and communication.
- Calculation of the emergency power requirements of the new Power and Blowing Station II which is being installed in BSP
- Power generation from waste heat of COB-11 is also envisaged in this project and 4 MW along with process steam is being utilized in BSP.
- Total electrical system of BSP are interlinked with PBS-2 for reliable operation of power system in case of power failure

1.3 Learning outcomes and Expected Knowledge gain and Deliverable from the project

- Exposure to all electrical system in power industry like generator reactor HT breaker , LT breaker transformer cable sizing etc.
- Detailed study of SLD for power requirement in any industry
- Project management for execution of any project
- Commissioning methodology of electrical system
- Power calculation of any upcoming unit for reliable operation of plant
- Exposure to power plant operation with detailed knowledge of each equipment
- Introduction to DCS, PLC, SCADA for future references

1.4 Site Map



1.5 Project Packages

Package	Installation	Contractors	Contract signing date
011-01-A	3 Boilers and its auxiliaries. STB Building along with EOT crane	M/s Fujian Longking Corporation Ltd. and M/s Allied Engineering Services Pvt. Ltd.	24.03.12
011-01-B	25 MW STG, 4 MW BPTG, Cooling Tower, Pump House	M/s Triveni Engineering and Industries Ltd.,Banglore	19.01.12
011-01-C	3X 225 M3 /Hr. DM water Plant	M/s TechnoFab Engineering Ltd., New Delhi	25.02.12
12	3 STB's and its auxiliaries.	Bharat Heavy Electricals Ltd.	11.11.10

Chapter 2

Power and Blowing Station-2

Power Blowing Station is a vital installation. It serves the following needs of the Bhilai Steel Plant.

- Supplying air blast to Blast furnaces at requisite parameters.
- Meeting emergency power requirements of the 2.5 MT units of Bhilai Steel Plant in case of any grid power failure and also to generate power to reduce dependency on bought out power and save costs.
- Meeting the process steam needs of various shops for their safe/efficient operation.
- Buffer consumer of available Blast furnace and coke oven gasses to prevent their wastage/high pressure in the gas line network. As such the shop is required to be run at a high level of efficiency and reliability to ensure that working of other shops particularly Blast furnace are not effected.

While PBS 1 doesn't use cooling tower in order to cool the "cooling water" at elevated temperature after absorbing the latent heat of vaporization of steam and works on simple water recycling system PP2 is proposed to have a cooling tower with the following specifications:

- Four pumps of 6.6KV rated voltage and 55Amps. Actual current to be run with a motor of 540KW capacity, the total energy consumption per hour being 1659.82KWhr.
- Five cooling fans of 440V rated voltage and 110 Amps. Actual current to be run with a motor of 74KW capacity
- The total energy consumption per hour being 276.6KWhr
- Thus the total energy consumption increased per hour for installing cooling tower at PP-2 is 1936.45KWhr.
- Though the energy consumption for installing CT at PP-2 would increase in spite of that we would be save a lot of energy as the cooling water avg. temp. would decrease and thus cycle efficiency would increase as per the formula

$$\eta = 1 - T_2/T_2$$

As per our study replacing the CT of PP-2 with Indirect Air cooling with Direct Contact Condenser would save 5.35 million M3 water and 158.30 million rupees per year!!!

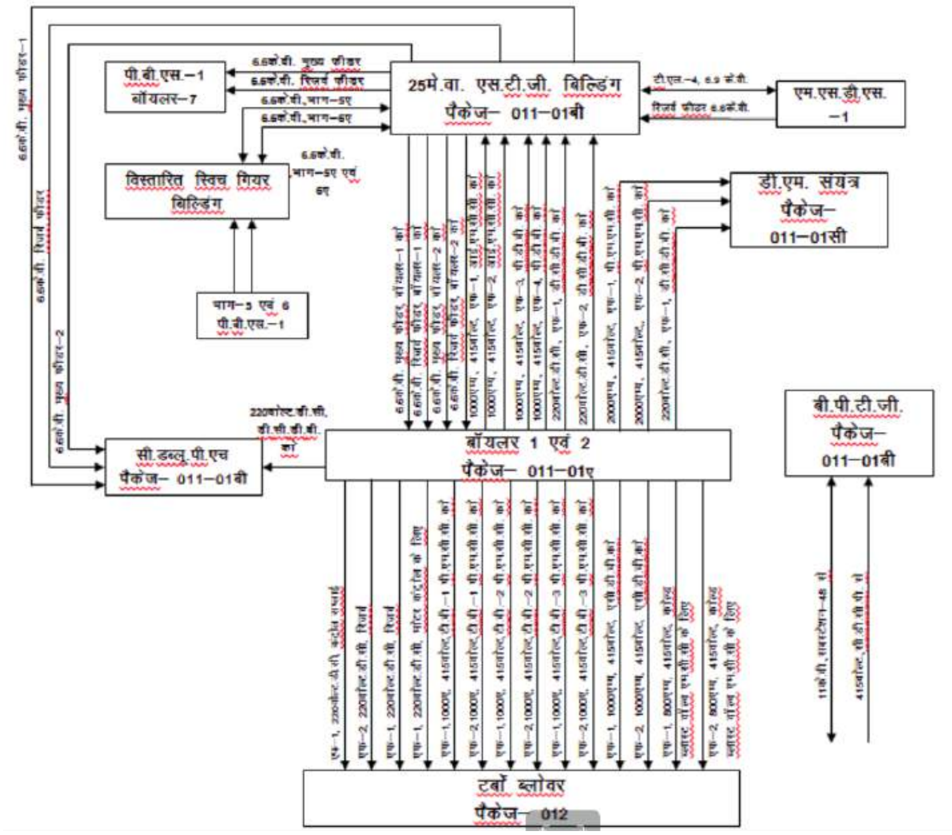
2.1 Need of Steam Turbo Blowers in BSP

Blast Furnaces can be considered as the heart of a Steel Plant. The blast furnace is the first step in producing steel from iron oxides. The purpose of a blast furnace is to chemically reduce and physically convert iron oxides into liquid iron called "hot metal". The raw materials such as iron ore, coke and limestone are dumped into the top and preheated air known as Hot air blast is blown into the bottom. The raw materials undergo numerous chemical reactions and descend to the bottom to become final product of liquid iron and slag. The hot air blast is produced by passing cold air blast trough a stove where residual blast furnace gases are burned. This cold air blast is provided by Turbo blowers form Power and Blowing Station.
Each blower installed on the new Power and Blowing station will provide on average 1500 Nm^3/min of cold air blast. There will be 3 Steam Turbine driven Turbo Blowers (2 working and 1 Standby) each with 50% capacity of maximum air blast requirement.

2.2 Plant Requirement

Requirements	**Emergency Power**	**Air Blast**	**Process Steam**
Facility	STG(25 MW), BPTG (4MW)	STG	Boiler (150TPH), BPTG (4 MW)
Customer	Critical Loads of Plant	Blast Furnace - 8	Plant Stream

2.3 Single Line Diagram of PBS-2



2.4 Overview of PBS-2 Electrical Components

1. Two complete generator sets and their auxiliaries consisting of the following major equipment/systems for the new units.
    - Generator sets.
    - Equipment/systems/mechanisms to meet pollution norms like noise level, vibration level, etc.
    - Generator cooling systems.
    - Generator lubricating oil systems.
    - Complete excitation systems (brushless type), latest digital AVR (thyristor controlled with dual channels and associated electrical equipment having data interface with DDCMIS).

- Generator line side terminal cubicles consisting of Surge Arrestors, PT, CT, Capacitor, Link etc.
- Generator neutral cubicles with neutral side CTs.
- IG-541 extinguishing and automatic injection system for the Generators.
- Any other equipment/systems required for smooth running of generator sets.

2. Transformer -
   - One Generator Transformer of rating 36 MVA, 11/6.9kV, ONAN type.
   - Auxiliary Transformers of rating 2 MVA or 1 MVA, 6.6/0.433 kV, AN type.
3. Two **Interconnections** between MSDS-I and PBS-IIa
   - Tie-line-4- Interconnector between MSDS-I (Sec-IV-Cubicle 36) and PBS-11 sections VII VIII.
   - Reserve supply from MSDS-I (Sec-IV cubicle 66) to the Reserve 6.6kV board at PBS-11.
4. Contractor shall provide one set of Generator Control Desk each with respective MIMICs for controlling all the synchronizing breakers detailed as below:
   - For the 6.9kV switchboard(MSG) Breakers:
     - 2nos. 6.9kV Generator Breakers of TG-4 connected to Section VII section VIII
     - 2 Tie-line-4 feeder breakers of Section VII VIII
     - 2 Sectionaliser breakers connected to Section VII
     - 1 breaker of Section VI(extended) connected to Section VII
     - 2 bus coupler breakers between sections VII VIII and Extended Sections V VI
     - 2 Inter-connector breakers connected to extended sections of Section-V VI located at PBS-11
     - 2 breakers connected to the existing Sections V VI located at the extended switchgear building at PBS-1

     The above Generator control desks shall be placed at PBS-II premises
   - For the 11 kV switchboard at BPTG premises
     - One no. 11 kV Generator Breaker of BPTG connected to the 11 kV Board
     - One no. Tie-line feeder breaker of the 11kV switchboard connected to the 11 kV switchboard at CDCP area

     The above Generator control desks shall be placed at BPTG premises.
5. Relay and Protection Panel for the Generating units, namely
   - 1 x 25 MW STG

- 1 x 4 MW BPTG

6. 6.9kV Switch Boards(sections VII VIII, Extended sections V VI, connecting busduct) including the corresponding reactors, busducts and the isolators. HT busduct shall be provided for 3150A busduct between Generator Transformer and MSG and 2000A busduct for the
   - Incoming Tieline-4
   - Bus coupler between sections VII VIII and
   - Bus coupler between sections (extended)sections V VI
   - Two interconnectors between sections VII V
7. 11 kV Switch Board at the BPTG station.
8. 6.6kV Switch Board at the CWPH area.
9. 415V Power cum Motor Control Centers (PMCCs) for CWPH and BPTG areas.
10. 415V Motor Control Center for the Steam Turbo Generator.
11. 415V Motor Control Center for the BPTG.
12. 415V Motor Control Center for the Cooling Water system.
13. 415V Motor Control Centers for the AC and Ventilation system.
14. 415V Power Distribution Boards.
15. Electrical Auxiliary Control Panel(EACP) for Remote Control, metering annunciation panel for the centralized control, metering and annunciation for all the 11 kV, 6.9kV, 6.6 kV and 415V incomers bus-coupler feeders excluding the feeders mentioned in S.no. 4 above. Separate EACP panels shall be considered for PBS-II
16. Hooking up for control, monitoring and protection of generators and power distribution equipment/systems with DDCMIS. Transducer panels for inputs/outputs from/to electrical equipment to/from DDCMIS. This shall be considered for all the generating sets and its auxiliaries.
17. A dedicated and separate SCADA system shall be provided for Electrical system of PBS II in the Main Control room of the Switchgear Building. The electrical parameters shall be hooked up in this SCADA system for metering , alarm, annunciation and control. The major systems to be covered in the SCADA are as follows:
   - All HT Breaker Status(ON/OFF/TRIP/Ready to Start) and all metering parameters.
   - All the LT switch gear in PMCC, MCC (I/c B/c), all DBs (I/c B/c) and all metering parameters.
   - All intelligent controllers in MCCs.
   - Generator protection and metering parameters.
   - All kinds of Transformer alarm, annunciation and protection.
   - All kinds of alarm and annunciation for batteries, charger and UPS

- All the MFMs.
- Fault annunciation from all the communication type protective relays, meters. From this SCADA, all the relay parameters shall be monitored as well as their settings can be changed/configured.

18. The new SCADA System shall be hooked up with
    - The upcoming SCADA for PBS-11 Boiler pkg-011-A.
    - Existing SCADA system (presently used for existing electrical system for Switch gear and generators).
    - TRT Generator relays (IEC 61850 compliant) located at the TRT building for hooking up all the parameters of TRT Generator at PBS-II.
    - Provision shall also be made for hooking up the entire HT substation with the upcoming centralized SCADA system as well as a separate gateway shall be provided in the relay for interfacing with the instrument SCADA of PBS-11, PBS-I BPTG Station.

    SCADA/PLC interfacing shall be as per TS and all networking equipment required for the completeness of the integration of the proposed SCADA with the above systems shall be in the scope of the Contractor. Separate printers (Laser) shall be provided for both the stations. Wherever signal is to be duplicated for hooking upto two different systems (DDCMIS SCADA) Signal Multiplier (Optical/Galvanic Isolator) may be considered. Furniture required to mount work station for SCADA including provision for operator chairs on the basis of one for each station in the new electrical control room of PBS-II (Six chairs six tables with sufficient drawers for storing documents for MMIs and generator protection Terminal)
19. he entire Contractor's equipment at BPTG station shall be hooked up with their BPTG station PLC/DCS as well as to the PLC / DCS at power and blowing station for complete control, monitoring, sequencing, metering and protections monitoring including alarm and annunciations. The Contractor in all their equipment at BPTG station shall make the necessary arrangement for the same. All cabling including terminations at both ends are included in the scope of the Contractor.
20. Two DCDBs for generator control and protection as well as for HT/LT substation requirement for PBS-2 CWPH areas. These DCDBs shall be fed from the DC system of Boiler Pkg-01A. Necessary cabling from the Employer's switchboard to the DCDB shall be considered in the scope of the Contractor.
21. One set DC System including battery, charger, DCDB, etc for BPTG station.
22. PDBs- Power supply to UPS, Battery chargers, illumination, etc shall be fed from PDB. A separate PDB shall be provided for crane, welding sockets, etc.
23. UPS system complete in all respects individually one set each for TG building, BPTG System and Cooling water control system.

24. UPS Distribution boards.
25. HT LT motors including DC motors and actuators.
26. Motorized control/isolation valves with manual operating handles.
27. HT LT power and control cabling including their termination at both ends and jointing/termination materials.
28. Signal and instrumentation cables, special cables, screened cables, fire optic cables, etc including their termination at both ends (supply as well as laying termination shall be under Contractor's scope).
29. Cable trestle, supporting structures, conduits, prefabricated GI cable trays, cable racks, other associated accessories like cable glands, lugs, termination/jointing kits, ferrules, clamps including trefoil clamps for single core cables, cable markers, cable identification tags, and all other hardware material as per requirement.
30. Supply, laying of cables and termination at both the ends of all interconnecting power, control, signaling and instrumentation cables etc between Contractor's own equipment and between Contractor's equipment and Employer's equipment for all incoming power supplies etc. to make their system complete in all respect along with others
31. Local Push button stations.
32. Islanding and load shedding system shall be provided for grid islanding due to grid disturbances and load shedding shall be planned due to unbalanced of load requirement and generation during generator in islanding mode. Philosophy for the same shall be finalized during detail engineering.
33. Welding sockets, Power receptacles, etc.
34. Monorail arrangement for handling Transformers in Transformer Rooms.
35. Monorail for HT/LT motors and canopy over outdoor HT/LT motors.
36. Complete illumination of Power and Blowing station-TG building, extended Switchgear building, CWPH area and BPTG plant, Plant road and area illumination,etc and all other areas within limit with sufficient numbers of LDBs /SLDBs. Lighting fixtures of electrical rooms shall be industrial, energy efficient fluorescent type with electronic chokes. Control room shall have energy efficient CFL type lamps.
37. All erection materials, required during erection of generator and auxiliaries and all types of electrical equipment under Contractor's scope.
38. DC starter panels for DC motors.
39. HT Soft starters.
40. Complete electrics of material handling equipment like cranes, lifts, hoists, etc.
41. Complete electrics of air-conditioning and ventilation systems in all the premises under battery limit.

42. Water drainage pumps in required numbers with complete electrics including source feeders , pumps/motors, cable laying, etc.
43. Fire protection system including Fire Detection and Alarm System for the complete plant, etc.
44. One unit each of Thermo-vision camera , DC earth fault locator- Model Grouser fault finder, 300V DC.
45. Safety items.
46. Training courses for the Employer's personnel/Engineers to acquire necessary expertise in operation and maintenance of the Plant Equipment of the electrical system for atleast for 120 mandays at works.
47. Complete relay coordination including relay setting calculations for all relays for complete Generation and Power Distribution system at various voltage levels (415V, 6.9kV, 6.6 kV, 11 kV) are under the scope of the Contractor. Necessary system study if required to be conducted by the Contractor.

2.4.1 Standard Voltage Levels

Following power utilization standard voltage levels shall be adopted for various systems

1.	Generation voltage	11 kV, 3 phase, 3 wire, 50 Hz, Un-earthed.
2.	Evacuation & transmission voltage	6.9 kV, 3 phase, 3 wire, 50 Hz, Un-earthed. 11 kV, 3 phase, 3 wire, 50 Hz, Un-earthed.
3.	Auxiliary supply	6600 V, 3 phase, 3 wire, Un- earthed.
		415 V, 3 phase, 4 wire, solidly earthed.
4.	A.C. drive motors	6600 V, 3 phase, 3 wire, non effective earthed.
		415 V, 3 phase, 4 wire, solidly earthed.
5.	DC drive motors	220 V, 2 wire, unearthed D.C.
6.	Instrumentation & control including protection interlocking system	240 V, 1 phase, A.C. (from UPS)
7.	Control and protection of HT and LT switchgears including ACBs of MCCs.	220 V, 2 wire, unearthed D.C.
8.	Control and indication for MCC feeders (other than ACBs)	230 V, 1 phase, line & neutral (through control transformers)
9.	UPS	240 V, 1 phase, 2 wire
10.	Metering	110 V, AC, PT supply
11.	Plant illumination	240 V, 1 phase, line & neutral
12.	Emergency illumination	220 V, 2 wire, unearthed D.C.
13.	Panel lighting and space heaters	240 V, 1 phase, 2 wire, 50 Hz, A.C. with one point earthed
14.	DDCMIS/PLC power supply	240 V, 1 phase, 2 wire, 50 Hz, A.C. (UPS supply)
15.	Welding socket / power receptacles	415 V, 3 phase, 50 Hz, A.C. outlets. 240 V, 1 phase, 2 wire, 50 Hz, A.C. with one point earthed.
16.	Special socket outlets for portable lamps for maintenance	24 V, 1 phase, 2 wire, 50 Hz, A.C. through suitable transformers
17.	Sockets for electrical tools, etc.	240 V, 1 phase, 2 wire, 50 Hz, with one point earthed

2.4.2 Rating

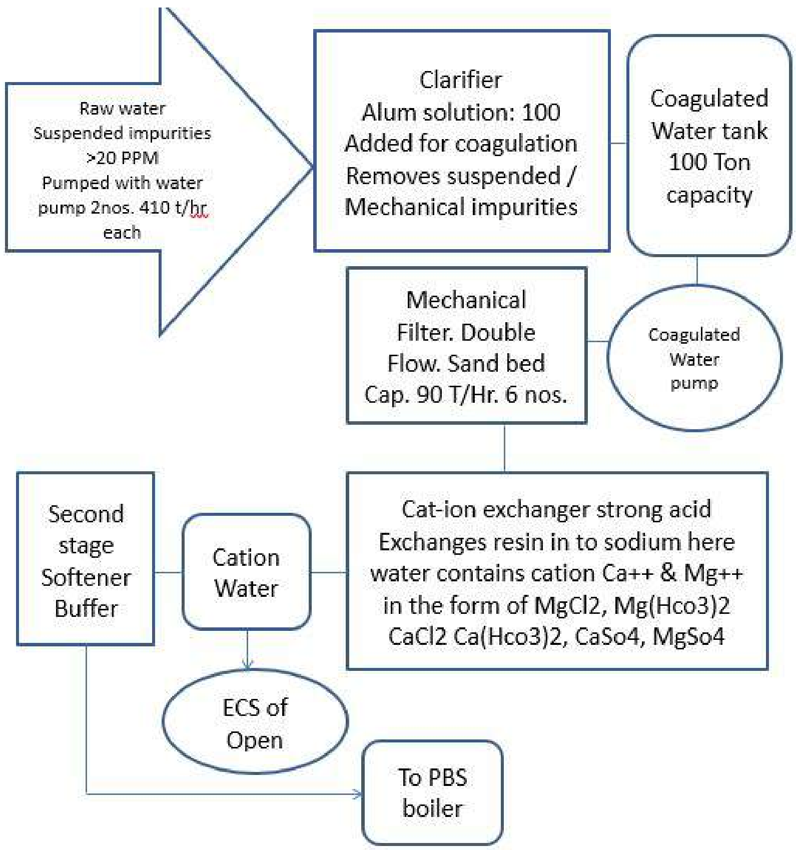
The generator shall have following technical parameters:

			STG	BPTG
1.	Maximum Continuous Rating			
i.	Active output	:	25 MW	4 MW
ii.	Apparent output	:	31.25 MVA	5 MVA
2.	Rated terminal voltage	:	11kV	11 kV
3.	Rated power factor	:	0.8 (Lag)	0.8 (Lag)
4.	Rated frequency	:	50 Hz $\pm$ 6 %	50 Hz $\pm$ 6 %
5.	Phases	:	3	3
6.	Phase connection	:	Star	Star
7.	Line terminals brought out	:	3	3
8.	Neutral terminals brought out	:	3	3
9.	Rated speed	:	1500/3000 RPM	1500/3000 RPM
10.	Short circuit ratio	:	$\geq$0.52	$\geq$0.52
11.	Class of insulation (stator/rotor)	:	F (Temp. rise limited to class B)	F (Temp. rise limited to class B)
12.	Cooling for stator/rotor	:	CACW cooled	CACW cooled
13.	Type of generator earthing	:	Un-Earthed	Un-Earthed

Chapter 3

D.M. Water Plant

Raw water from reservoirs at **Maroda** is required to be treated before it can be used in boilers. The process of softening raw water is shown below.



$$R(\text{Resin}) + Na_2 + Ca \longrightarrow CaR + 2\,NaHCO_3$$

$$R(\text{Resin}) + Na_2 + CaCl_2 \longrightarrow CaR + 2\,NaCl$$

Regeneration is done back to get back Na ions.

3.1 Introduction

Demineralization is the process of removing mineral salts from Water by using the ion exchange process. Demineralised Water is Water completely free (or almost) of dissolved minerals as a result of one of the following processes:

- Distillation
- Deionization
- Membrane filtration (reverse osmosis or nanofiltration)
- Electrodyalisis
- Or other technologies.

Demineralized Water also known as Deionized Water, Water that has had its mineral ions removed. Mineral ions such as cations of sodium, calcium, iron, copper, etc and anions such as chloride, sulphate, nitrate, etc are common ions present in Water. Deionization is a physical process which uses specially-manufactured ion exchange resins which provides ion exchange site for the replacement of the mineral salts in Water with Water forming H+ and OH- ions. Because the majority of Water impurities are dissolved salts, deionization produces a high purity Water that is generally similar to distilled Water, and this process is quick and without scale buildup. De-mineralization technology is the proven process for treatment of Water. A DM Water System produces mineral free Water by operating on the principles of ion exchange, Degasification, and polishing. Demineralized Water System finds wide application in the field of steam, power, process, and cooling.

3.2 Principle

Raw Water is passed via two small polystyrene bead filled (ion exchange resins) beds. While the cations get exchanged with hydrogen ions in first bed, the anions are exchanged with hydroxyl ions, in the second one.

3.3 Process

In the context of Water purification, ion-exchange is a rapid and reversible process in which impurity ions present in the Water are replaced by ions released by an ion-exchange resin. The impurity ions are taken up by the resin, which must be periodically regenerated to

restore it to the original ionic form. (An ion is an atom or group of atoms with an electric charge. Positively-charged ions are called cations and are usually metals; negatively-charged ions are called anions and are usually non-metals).
The following ions are widely found in raw waters :
Cations-

- Calcium (Ca2+)
- Magnesium (Mg2+)
- Sodium (Na+)
- Potassium (K+)

Anions-

- Chloride (Cl-)
- Bicarbonate (HCO3-)
- Nitrate (NO3-)
- Carbonate (CO32-)

3.4 Ion Exchange Resins

There are two basic types of resin - cation-exchange and anion-exchange resins. Cation exchange resins will release Hydrogen (H+) ions or other positively charged ions in exchange for impurity cations present in the Water. Anion exchange resins will release hydroxyl (OH-) ions or other negatively charged ions in exchange for impurity anions present in the Water. The application of ion-exchange to Water treatment and purification.
There are **three ways** in which ion-exchange technology can be used in Water treatment and purification :

- cation-exchange resins alone can be employed to soften Water by base exchange
- anion-exchange resins alone can be used for organic scavenging or nitrate removal
- ombinations of cation-exchange and anion-exchange resins can be used to remove virtually all the ionic impurities present in the feedWater, a process known as **deionization**. Water deionizers purification process results in Water of exceptionally high quality

3.5 Deionization

For many laboratory and industrial applications, high-purity Water which is essentially free from ionic contaminants is required. Water of this quality can be produced by deionization.The two most common types of deionization are :

- Two-bed deionization
- Mixed-bed deionization

3.5.1 Two-bed deionization

The two-bed deionizer consists of two vessels - one containing a cation-exchange resin in the hydrogen (H+) form and the other containing an anion resin in the hydroxyl (OH-) form. Water flows through the cation column, whereupon all the cations are exchanged for hydrogen ions. To keep the Water electrically balanced, for every monovalent cation, e.g. Na+, one hydrogen ion is exchanged and for every divalent cation, e.g. Ca2+, or Mg2+, two hydrogen ions are exchanged. The same principle applies when considering anion-exchange. The decationised Water then flows through the anion column. This time, all the negatively charged ions are exchanged for hydroxide ions which then combine with the hydrogen ions to form Water (H2O).

3.5.2 Mixed-bed deionization

In mixed-bed deionizers the cation-exchange and anion-exchange resins are intimately mixed and contained in a single pressure vessel. The thorough mixture of cation-exchangers and anion-exchangers in a single column makes a mixed-bed deionizer equivalent to a lengthy series of two-bed plants. As a result, the Water quality obtained from a mixed-bed deionizer is appreciably higher than that produced by a two-bed plant. Although more efficient in purifying the incoming feedWater, mixed-bed plants are more sensitive to impurities in the Water supply and involve a more complicated regeneration process. Mixed-bed deionizers are normally used to 'polish' the Water to higher levels of purity after it has been initially treated by either a two-bed deionizer or a reverse osmosis unit.

3.6 Electrodeionization EDI

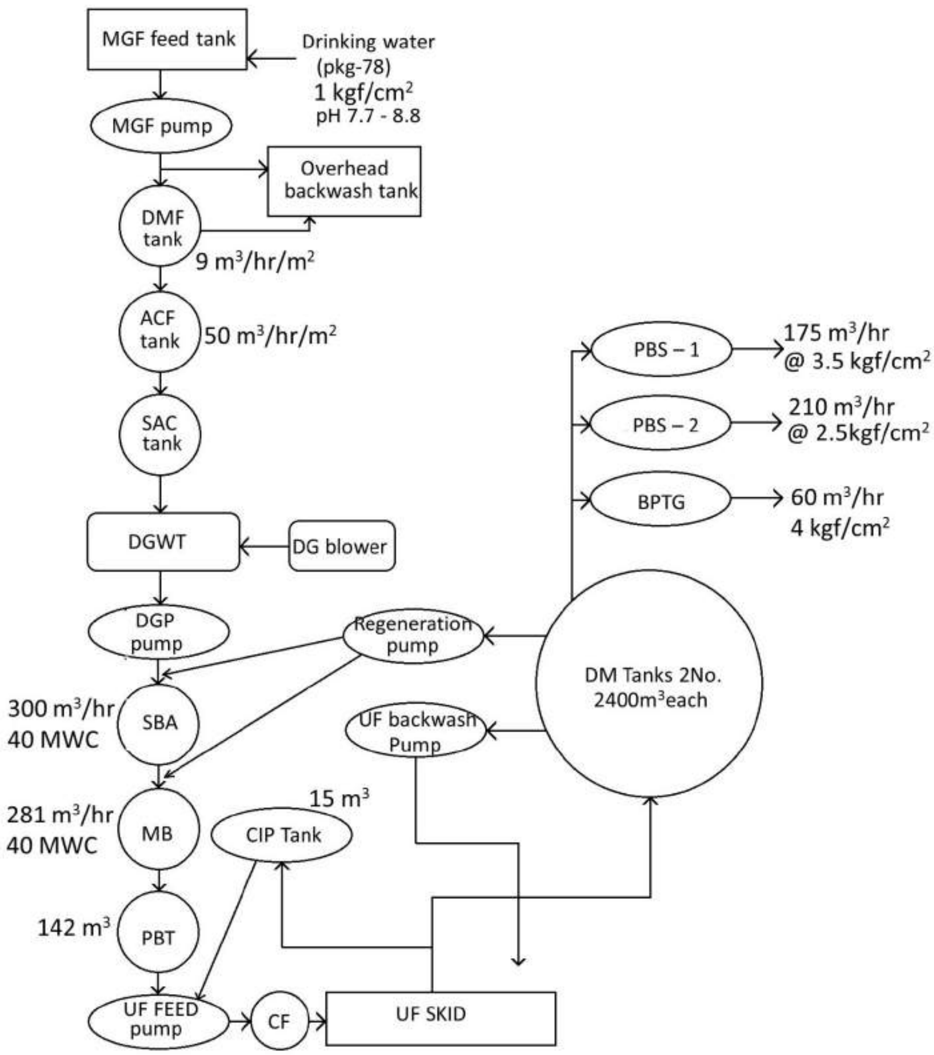
Electrodeionization Systems remove ions from aqueous streams, typically in conjunction with reverse osmosis (RO) and other purification devices. Our high-quality deionization modules continually produce ultrapure Water up to 18.2MW/cm. EDI may be run continuously or intermittently.

3.7 Advantages of DM Water Plant

- Variety of cost effective standard models.
- Improved aesthetics and rugged design.
- User friendly, low maintenance and easy to install.
- Simpler distribution and collection systems.
- Quick availability.
- Pre dispatch assembly check.

- The multiport valves are top mounted as well as side mounted with the necessary high pressure rating PVC piping.
- Single valve operation as compared to the six valves in conventional filters
- Each operating step is clearly marked on the valve, thereby eliminating chances of error in the operating sequence.
- Single valve assembly, with its simplified frontal Piping, simpler distribution collecting systems is Very easy to install.
- Rust free
- Less power consumption
- Durable
- Economical
- High shelf life

3.8 Process Flow Chart



3.9 Plant capacity

1	No. of streams	03 Nos(2W+1R)
2	No of operating streams	01
3	Net capacity of each stream	225 m^3/hr
4	Running cycle for each stream	20 hrs
5	Regeneration cycle time	4 hrs

3.10 Average water quality report of Maroda-2

Sl. No.	parameters	unit	values
1	Physical analysis		
	Temperature	°C	20.5-30.0
	Turbidity	NTU	5
	pH value	-	7.7-8.8
2	solids		
	Total solids	mg/l	70-100
	Dissolved solid	mg/l	66-94
	Suspended solid	mg/l	4-6
3	Chemical analysis		
	As $CaCO_3$	mg/l	-
	Total hardness	mg/l	42-62
	Ca hardness	mg/l	30-42
	Mg hardness	mg/l	12-20
	M Alkalinity	mg/l	50-70
	P Alkalinity	mg/l	0-5
	chloride	mg/l	3-5
	Iron	mg/l	Nil
	NH_3		0.1-0.4
	Ca^{++}		12.0-16.8
4	Special test		
	O.C.P	mg/l	0.2-1.0
	Oil and Grease	mg/l	-
	I.L	mg/l	-0.6-+0.4
5	B.O.D at 37°C	mg/l	0.7-2.1

3.11 Stage wise treated water quality

Sl. No.	Description	Parameters	Values
1	After ACF	Turbidity	<2 ppm
2	After cation exchanger	pH	3-4
		Total cations	Not > 2 ppm as $CaCO_3$
3	After degasser	Free CO_2	<5 ppm as $CaCO_3$
4	After anion exchanger	pH	7.5-9
		TDS	<2mg/l
		Conductivity	<10 micromho/cm at 20°C
		SiO_2	<.2ppm as SiO_2
5	After mixed bed units	pH	6.8-7.2
		conductivity	<.2 micromho/cm at 25°C
		Silica as SiO_2	<.02 ppm
		Fe	<.01 ppm
		Hardness	Nil
		Turbidity	Nil
6	After Ultrafiltration	Silica	Nil
(i)		Reactive Silica	Limited to .02 ppm as SiO_2
(ii)		Colloidal silica	Shall be brought down to 98 % of feed water level

3.12 Regeneration flows for SAC

Sr.No.	Step	Flow(m^3/hr)	Time(m)	Waste water (m^3)	Type of water
1	Back wash	72	10	12	FW
2	Middle collector wash	72	5	6	FW
3	Acid pre injection	45.8	2	1.5	DG
4	Alkali injection				
	@ 1.2%	46	15	11.4	DG
	@ 3%	46	18	13.4	DG
5	Down flow				
	Step 1	46	15	11.5	FW
	Step 2	46	18	13.8	FW
6	Slow rinse	45.3	37	27.9	DG
7	Down flow	45.3	37	27.9	FW
8	Final rinse	281	6	28.1	FW

3.13 Regeneration flows for SBA

Sr.No.	Step	Flow(m^3/hr)	Time(m)	Waste water (m^3)	Type of water
1	Back wash	35	10	5.8	DG
2	Middle collector wash	35	5	2.9	DG
3	Alkali pre injection	10.6	2	0.4	DM
4	Alkali injection @ 3%	12.2	30	5.9	DM
5	Slow rinse	10.6	53	9.4	DM
6	Down flow	12.2	83	16.9	DG
7	Final rinse	281	4	18.7	DG

3.14 Regeneration flows for mixed bed

Sr.No.	Step	Flow(m^3/hr)	Time(m)	Waste water (m^3)	Type of water
1	Back wash	44	10	7.3	SBA
2	Middle collector wash	44	2	1.5	SBA
3	Alkali pre injection	11.1	2	0.4	DM
4	Alkali injection @ 4% NaOH	13.2	20	4.2	DM
5	Slow rinse	11.1	34	6.3	DM
6	Up flow	13.2	54	11.9	SBA
7	Acid pre injection	17	2	0.6	DM
8	Acid injection @ 4%	17.4	20	5.6	DM
9	Slow rinse	17	23	6.5	DM
10	Down flow	17	43	12.2	SBA
11	Drain down	-	5	-	-
12	Air mix	600	10	-	-
13	refil	-	2	5	SBA
14	Final rinse	277	7	32.3	SBA

3.15 Master Equipments List

DESCRIPTION	MOC	QUANTITY
Feed Water Tank (Capacity 580 M3/hr	RCC	1
Dual Media Filter (4700 dia x 4914 ht)	MS, EPOXY	2W + 1S/D
Active Carbon Filter (4900 dia x 5022 ht)	PAINTED MS,	2W + 1S/D
Strong Acid Cation (3200 dia x 5130 ht)	EPOXY PAINTED	2W + 1S/D
Degasser Tower (2400 dia x 2700 ht)	MSRL	2W + 1S/D
Degassed Water Tank (4000 dia x 10460 ht)	MSRL	2W + 1S/D
Strong Base Anion (3000 dia x 3180 ht)	MSRL	2W + 1S/D
Mixed Bed (2500 dia x 3876 ht)	MSRL	2W + 1S/D
Pressure Break Tank (5000 dia x 8000 ht)	MSRL	2W + 1S/D
Cartige Filters for UF Feed (Flow 300 m3/hr x Pr 6 Kg/cm2)	SS	2W + 1 S/D
UF Skids	PVDF MEMBRANE	2W + 1S/D
DM Water Tank (Capacity : 2400 M3)	MSRL	2

3.16 D.M. Water Plant Load Calculations

Raw Water Pump	2 X 75 = 150 kW
Transfer Pumps	30 + 45 + 70 = 145kW
Degasser Pump	2 X 55 = 110 kW
UF Pump	2 X 45 = 90 kW
DG Blower	2 X 3.7 = 7.4 kW
Regeneration Load	150 kW
Aux. Load	80 kW
Total Rated load	737.4 kW
Act. load(80%)	**590 kW**

Chapter 4

Back Pressure Turbo-Generator (BPTG)

4.1 Introduction

Steam is a major energy user and many industrial processes end up wasting some of it; especially if it is produced at higher pressures than what is needed. The conventional approach is to install pressure-reducing valves (PRVs) at various locations to reduce the steam pressure, exhausting the steam to the atmosphere. However, a non-condensing or backpressure turbine, also called a backpressure turbogenerator, can reduce the pressure while simultaneously converting the exhaust steam into electricity.
The steam is expanded until it reaches a pressure that the facility can use. While the steam expands, part of its thermal energy is converted into mechanical energy to be used by pumps, fans, compressors, and other equipment. The steam which has lower pressure is exhausted into the process header from the steam turbine, where a nozzle directs jets of high-pressure steam against the turbine's rotor blades. These blades are attached to a shaft, which rotates to produce power for the electrical generator. Because the exhaust steam temperature is lower compared with a PRV, the boiler steam throughput must be increased by 5% to 7%.
A backpressure steam turbine has a power generation efficiency ranging from 15% to 35% and requires steam of 20 to 100 lb/h per kilowatt (kW). The turbine operates with an exhaust equal to or in excess of atmospheric pressure. In general, installed cost ranges from \$400/kW to \$800/kW. Not all plants are candidates for backpressure turbines, as the following table shows:

Required Conditions for a Backpressure Steam Turbine			
Parameter	Best for Pressure Reducing Valve	Good for Backpressure Turbine	Best for Backpressure Turbine
Steam Flow Rate (lbm/h)	<4,000	<4,000	>10,000
Inlet Pressure (psig)	<125	>125	>150
Pressure Drop (psi)	<100	>100	>150
Cost of Electricity (cents/kWh)	<1.5	>1.5	>6.0
Capacity Factor (%)	<25	>25	>50
Source: TurboSteam. *Note: lbm/h=pound mass per hour, psig=pounds per square inch gauge*			

Maintenance is minimal for these turbines, as long as both the steam and oil are of good quality. Changing the oil and checking the bearings should be done periodically. Service life is typically 20 years, with some turbines lasting as long as 50 years, when properly maintained. At one chemical plant, a 450-kW system using 110-psi steam operates 24 hours a day, five days per week, with few problems.

4.2 Reduce Costs and Lower Emissions

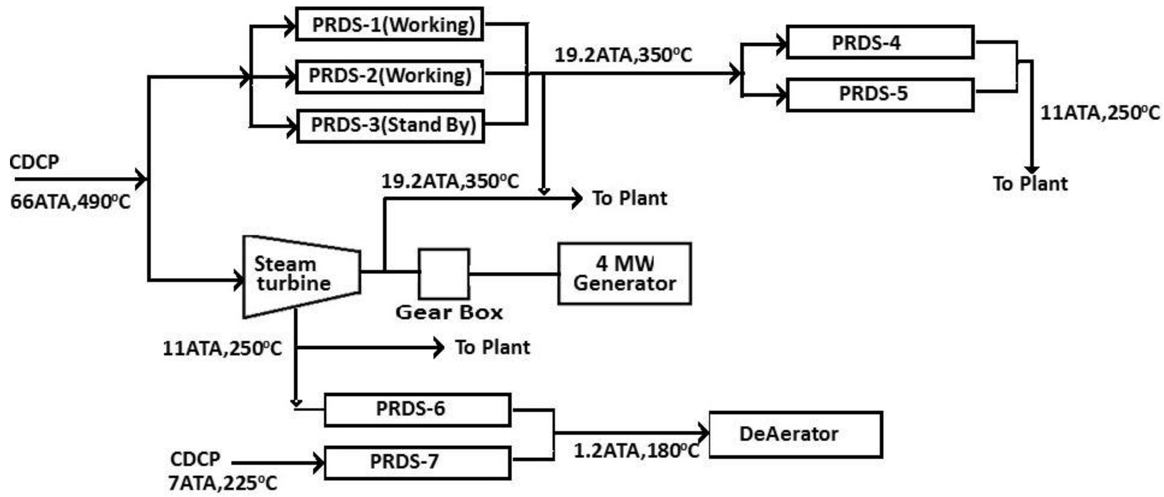
According to the U.S. Department of Energy (DOE), electricity produced by backpressure turbines can cost less than 3 cents/kWh. Payback can be under two years. After a new clinical research center at the National Institutes of Health installed backpressure turbines, the building generated about 5% of its own electricity, saving more than $170,000 annually in electricity costs. When combined with a high-efficiency boiler (80%), effective electrical efficiencies can reach as high as 78%. The following table compares the economics of two different systems:

Economics of Two Backpressure Turbine Systems		
Parameter	240-psig Exhaust, 1,371 kW	150-psig Exhaust, 1,986 kW
Annual Generation, kWh/yr	9,342,349	13,965,000
Electrical Energy Produced, $/yr	355,009	530,670
Increase in Natural Gas Usage, $/yr	209,107	312,580
Estimated Annual Operating and Maintenance Costs, $/yr	16,000	16,000
Net Annual Benefits, $/yr	129,902	202,090
Base Equipment Costs	521,690	568,000
Total Installed Cost	1,258,700	1,380,700
Note: electricity = $0.038/kWh, natural gas = $5.29/MMBtu. *Source: Washington State University*		

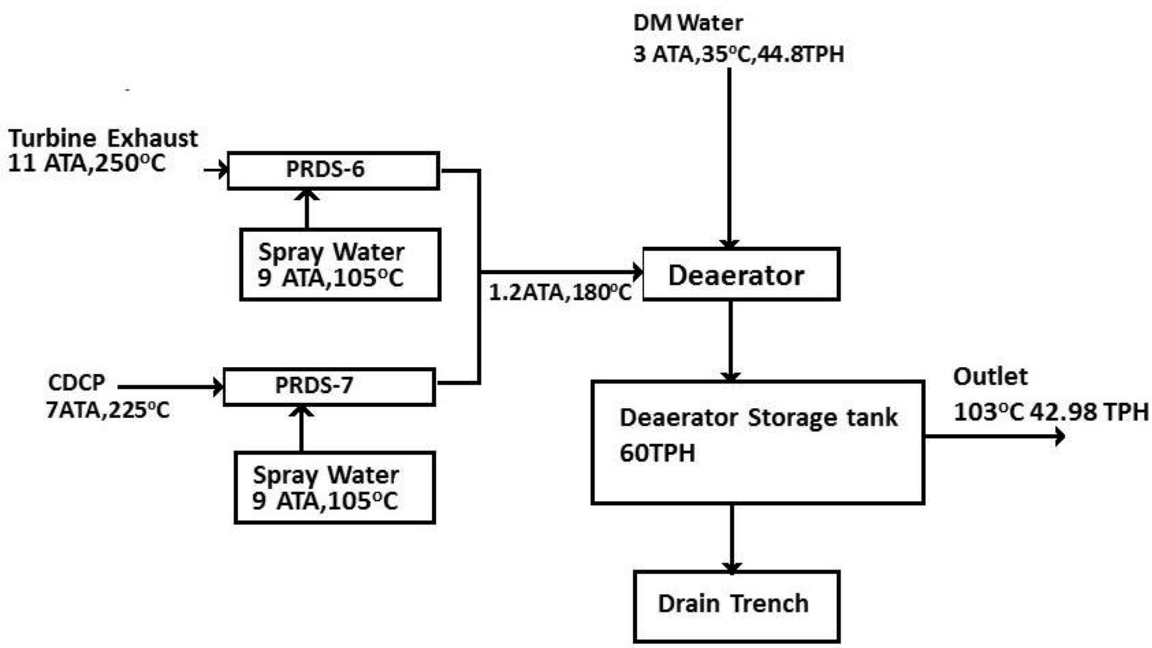
Although backpressure steam turbines do not generate any emissions, the steam generator or boiler does. Emissions will depend on the type of boiler fuel, and as shown in the following table, natural gas generates the fewest total emissions:

Comparison of Boiler Emissions, lbs/MMBtu						
Type of Fuel	500 kW System			3 MW or 15 MW System		
	NOx	CO	PM	NOx	CO	PM
Coal	NA	NA	NA	0.20-1.24	0.02-0.7	<0.30
Wood	0.22-0.49	0.6	0.33-0.56	0.22-0.49	0.06	0.33-0.56
Fuel Oil	0.15-0.37	0.03	0.01-0.08	0.07-0.31	0.03	0.01-0.08
Natural Gas	0.03-0.1	0.08	--	0.1-0.28	0.08	--
Note: All emissions are without post-combustion treatment. Source: U.S. Environmental Protection Agency						

4.3 Flow Diagram of Steam in BPTG



4.4 Deaerator in BPTG



4.5 BPTG Load Calculations

Transfer Pump	30 kW
Spray Water Pump	22 kW
CW Pump	2 X 30 kW = 60 kW
CT Fan	11 kW
Turbine Pumps	15 kW
Aux. load	250 kW
Total Rated Load	388 kW
Act. load	**310 kW**

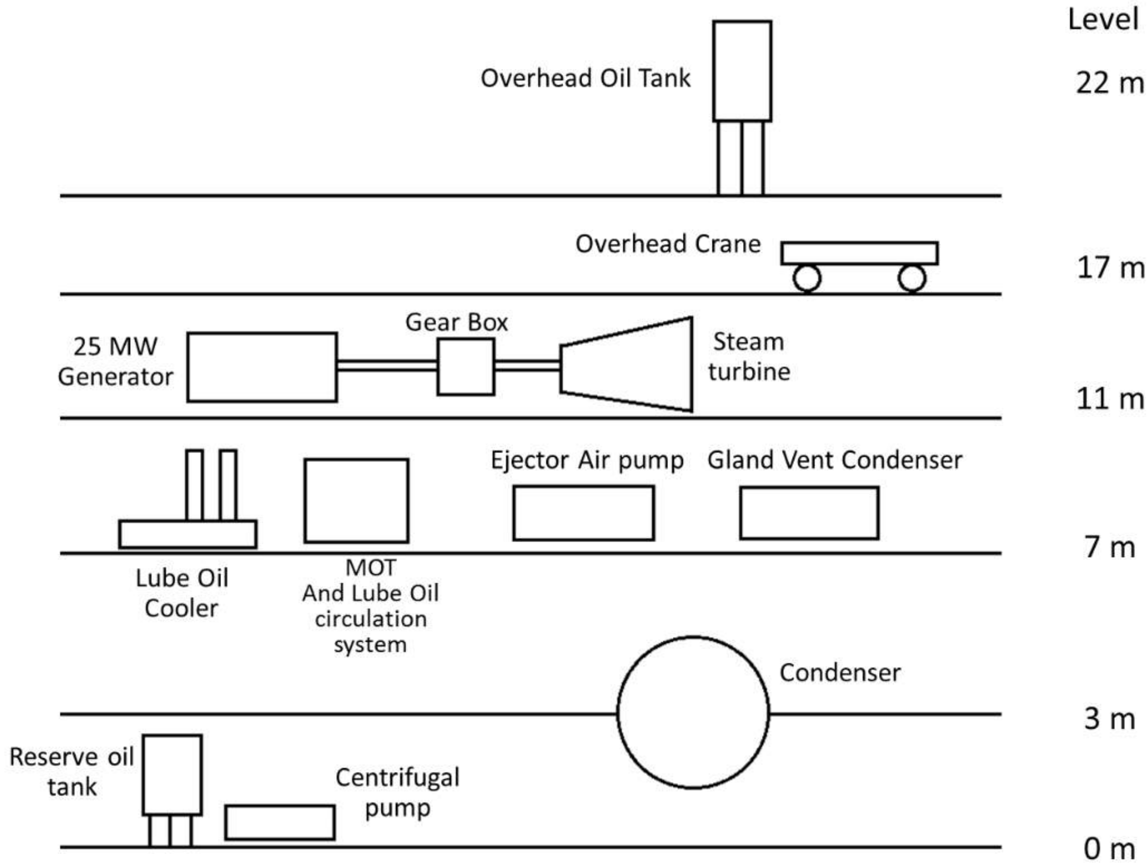
Chapter 5

25 MW Steam Turbo Generator (STG)

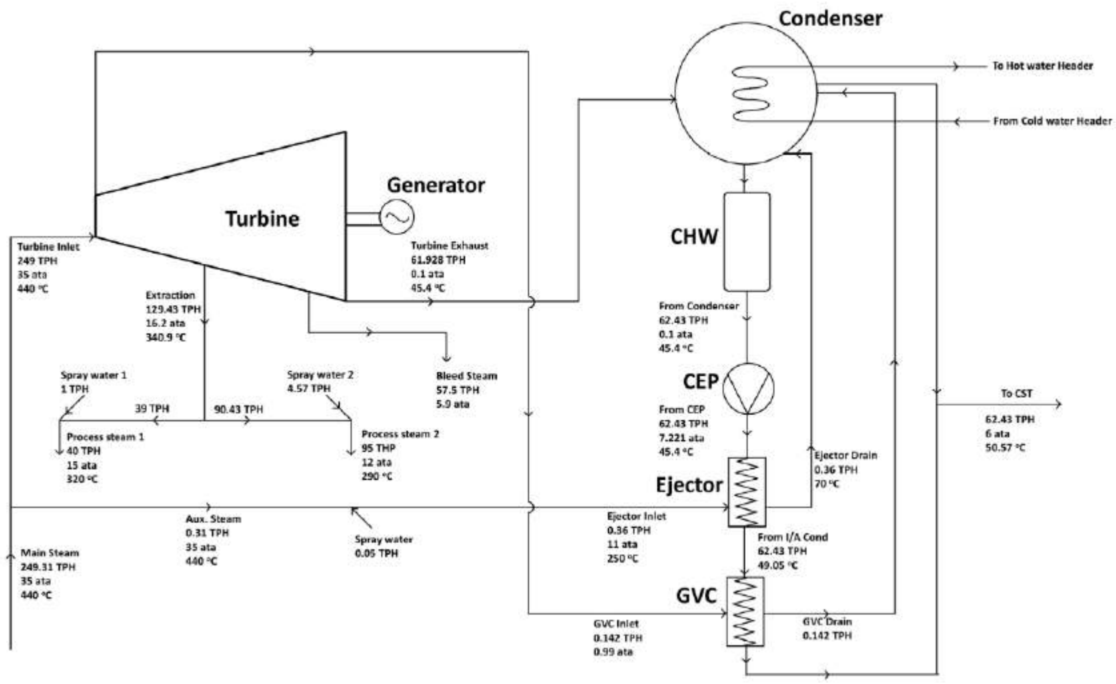
5.1 Introduction

A turbo generator is the combination of a turbine directly connected to an electric generator for the generation of electric power. Large steam-powered turbo generators provide the majority of the world's electricity and are also used by steam-powered turbo-electric ships. Smaller turbo-generators with gas turbines are often used as auxiliary power units. For base loads diesel generators are usually preferred, since they offer better fuel efficiency, but, on the other hand, diesel generators have a lower power density and hence, require more space.
The efficiency of larger gas turbine plants can be enhanced by using a combined cycle, where the hot exhaust gases are used to generate steam which drives another turbo generator.

5.2 Front View



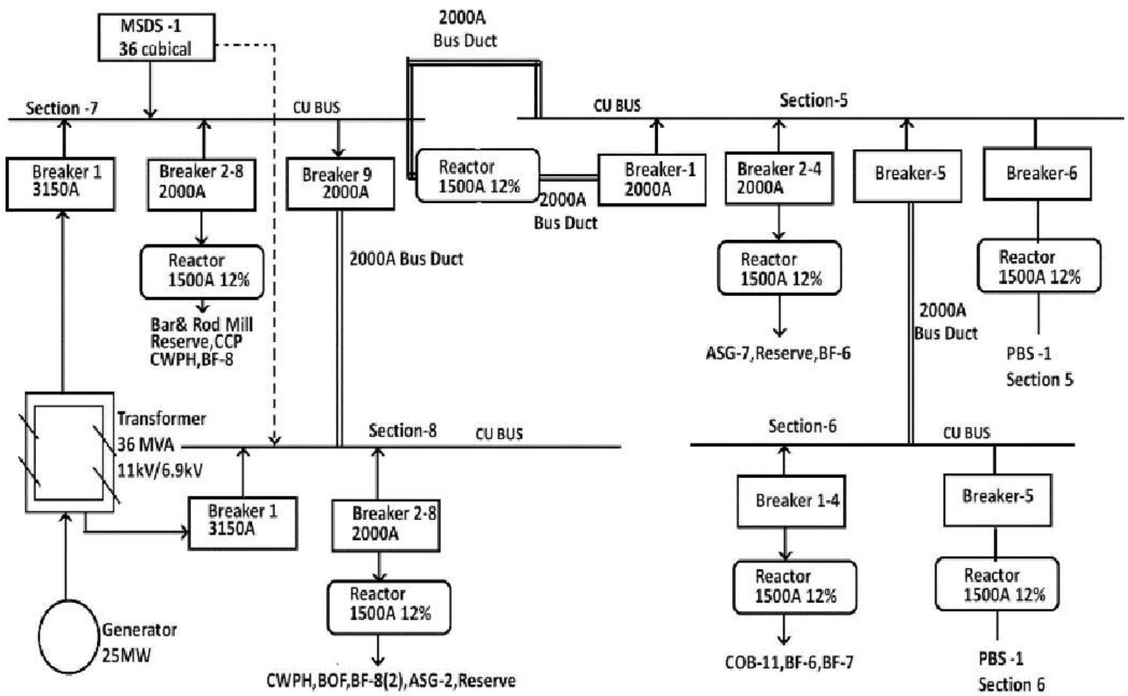
5.3 Process Flow Diagram



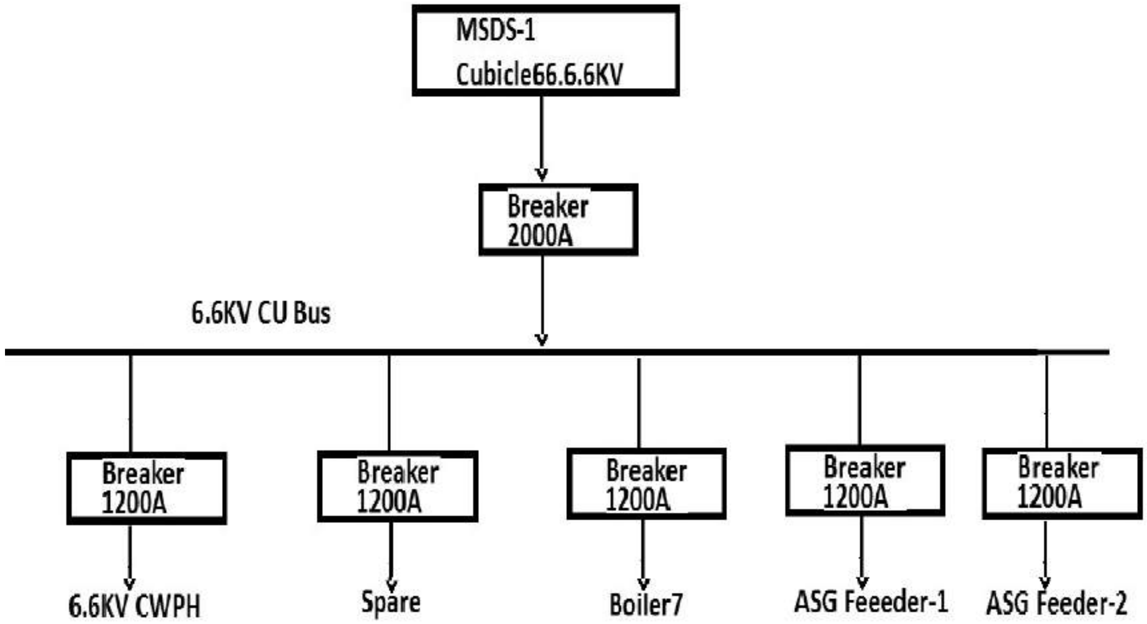
5.4 Mechanical Component

Equipment	Specification			
Main Oil Tank	Fluid – ISO-VG-46 RDL Volume – 16875 lit Design Pressure – Atmospheric			
Lube Oil Cooler	**Shell side** Oil flow 1400LPM 100°C 15 kg/cm^2 G Heat Transfer rate	**Tube side Water flow** 3000LPM 100°C 7 kg/cm^2 G 638 kW		
Oil Circulation System	Lube oil capacity 1150LPM@2.3kg/cm^2	Emergency oil capacity 400LPM@3kg/cm^2	Control oil capacity 200LPM@12kg/cm^2	Jacking oil capacity 7LPM@200kg/cm^2
	Heat transfer capacity		638KW	
Turbine	Power Inlet steam temperature Inlet steam pressure Exhaust pressure Extraction steam pressure Turbine rotor speed	**Extraction mode** 25000KW 440°C 35kg/cm^2 0.1kg/cm^2 15kg/cm^2 5625RPM	**Standard condition** 25000KW 440°C 35kg/cm^2 0.1kg/cm^2 - 5625RPM	
Gear box	Rated power 26035KW Input /output speed 5661/1500 Ratio: 3.774			
Ac generator	Output 31250KVA No. of phases 3 No. of poles 4 Voltage 11000 V Current 1640amp Speed 1500 RPM Limiting speed 1800RPM Power factor 0.8			

5.5 Electrical Component



5.6 Electrical Reserve Supply Switch Board



5.7 Electrical Equipment

Equipment	Specification	Location
Transformers	36MVA, 11kV/6.9kV	0 meters B-C
Breakers	1.3150 Amp, 2.2000 Amp	11 meters A-B
Reactor	1500 Amp, 12%	3 meters A-B
DCS		11 meters
LT Panels		11 meters

5.8 Technical Data Sheet of Auxiliary Transformer

Data Sheet for 01 No. 1000 kVA, 6.6 / 0.433 KV Cast Resin Dry Type Transformer

MAKE	VOLTAMP TRANSFORMERS LTD		
TYPE OF TRANSFORMER	Cast Resin Transformer		
LOCATION OF TRANSFORMER	Indoor		
RATING	1000 kVA		
VOLTAGE RATIO (HV / LV)	6.6	0.433 kV	
VECTOR GROUP	Dyn11		
TAPPING RANGE	+5.0%	-5%	Steps : 2.50%
TAPPING BY	Off Circuit Tap Links		
TAPPINGS ON	On HV side		
CLASS OF INSULATION	" F "		
TEMPERATURE RISE IN WINDING	80 ^{0}C	Over Ambient:	50 ^{0}C
% IMPEDENCE AT 75℃ & PRINCIPAL TAP	5.00 %	(IS Tol.)	
NO LOAD LOSS	1.8 KW	(MAX)	
FULL LOAD LOSS AT 75℃	11.0 KW	(MAX)	
ENCLOSURE PROTECTION	IP 42		

EFFECIENCY *

% LOAD	1 PF	0.8 PF
100	98.74	98.43
75	98.95	98.69
50	99.10	98.88

REGULATIONS *

% LOAD	1 PF	0.8 PF
100	1.219	3.859

PAINT SHADE Epoxy: 632 of IS 5

Data Sheet for 04 Nos. 2000 kVA, 6.6 / 0.433 KV Cast Resin Dry Type Transformer

MAKE	VOLTAMP TRANSFORMERS LTD			
TYPE OF TRANSFORMER	Cast Resin Transformer			
LOCATION OF TRANSFORMER	Indoor			
RATING	2000 kVA			
VOLTAGE RATIO (HV / LV)	6.6	0.433 kV		
VECTOR GROUP	Dyn11			
TAPPING RANGE	+5.0%	-5%	Steps :	2.50%
TAPPING BY	Off Circuit Tap Links			
TAPPINGS ON	On HV side			
CLASS OF INSULATION	" F "			
TEMPERATURE RISE IN WINDING	80 ^{0}C	Over Ambient:	50 ^{0}C	
% IMPEDENCE AT 75℃ & PRINCIPAL TAP	6.25 %	(IS Tol.)		
NO LOAD LOSS	3.5 KW	(MAX)		
FULL LOAD LOSS AT 75℃	18.0 KW	(MAX)		
ENCLOSURE PROTECTION	IP 42			

EFFECIENCY *

% LOAD	1 PF	0.8 PF
100	98.94	98.67
75	99.10	98.88
50	99.21	99.01

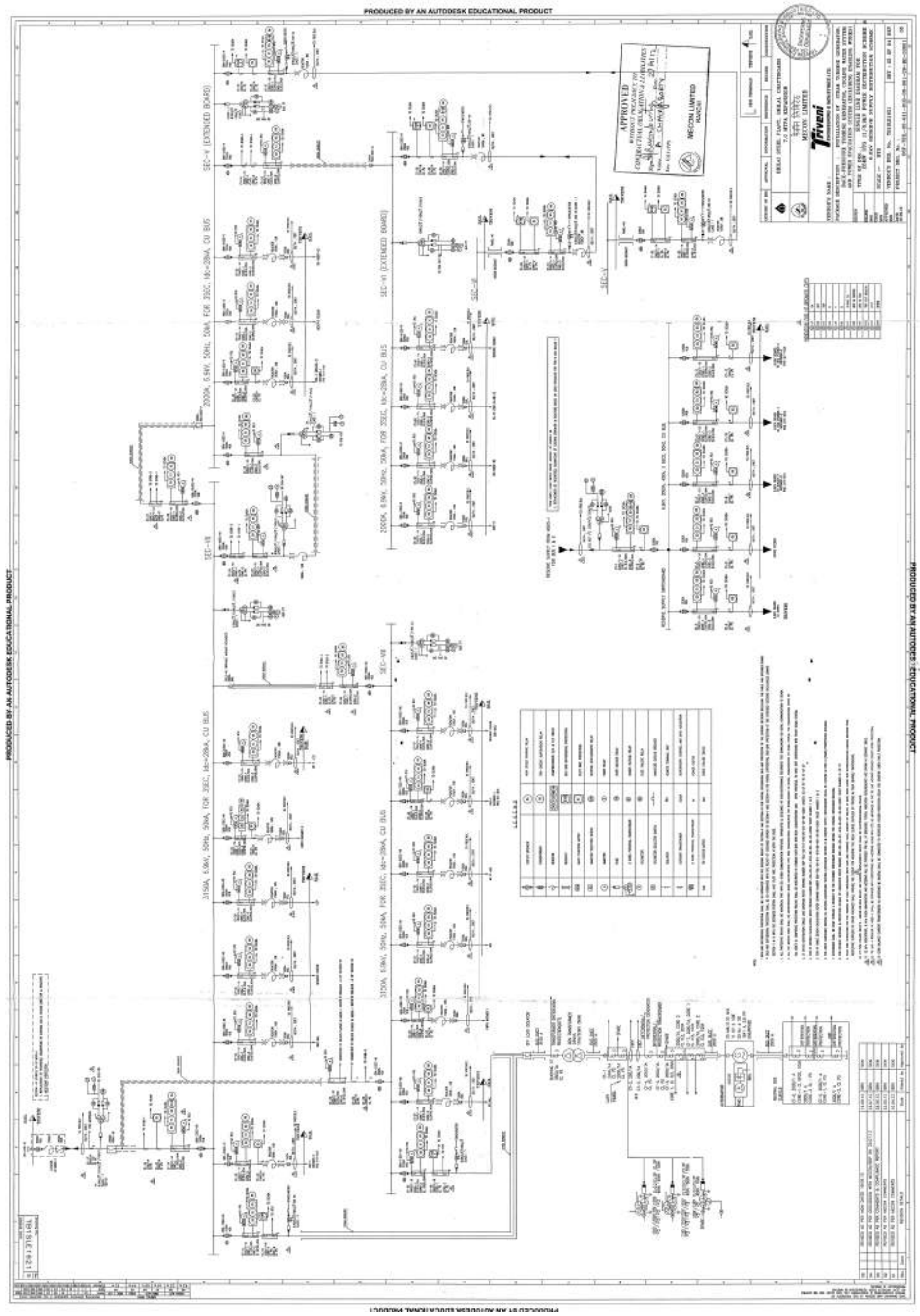
REGULATIONS *

% LOAD	1 PF	0.8 PF
100	1.091	4.528

PAINT SHADE Epoxy: 632 of IS 5

5.9 Approved 25MW STG, ESGB RSSB SLD

Click here for detailed image.



5.10 STG Load Calculation

AOP	55 kW
CEP	45 kW
Aux. Load	300 kW
Total rated load	400 kW
Act. Load	**320 kW**

Chapter 6

Boiler

Boilers or Steam generators are used to generate steam at desired rate and desired pressure and temperature by burning fuel in its furnace. They can be classified as fire tube or water tube boilers depending on whether the hot gas or water is present in the tubes inside the boiler.

6.1 Types of Boilers

Fire Tube Boilers
Earlier designs include fire tube boilers suitable for small steam requirements. They can be externally fired or internally fired. The externally fired is the one in which furnace is outside the boiler shell. The products of combustion flow through the tubes which are immersed in a shell containing water As the flue gases flow through the tubes, heat is transferred from gas to water and water is converted to steam. In internally fired fire tube boiler, the furnace is present inside the shell containing water. Combustion gases flow through the pipes and let out to the atmosphere. These gases exchange the heat with the water present in the shell. The major shortcoming of fire tube boiler is that the pressure limitations are inherent in its basic design. The steam present in the drum exerts hoop stress on the shell and larger the shell, larger is the stresses induced and to increase the pressure carrying capacity, the thickness has to be increased which increases the manufacturing cost.

Water Tube Boilers
Modern boilers are mostly water tube boilers. These were developed to permit increases in boiler capacity with reasonable metal stresses. Since water tube boilers have water flowing in small tubes, the pressure carrying capacity of the tubes being higher, they are used to generate high pressure steam. The water tube boilers can be further divided as straight tube or bent tube boilers.

Modern Boilers Figure shows a typical configuration of a modern boiler. The main parts of a boiler are Economizer, Boiler Drum, Water Walls, Furnace, Convective Superheater, Radiant Superheater, Pendant Superheater, Desuperheater, Reheaters, FD Fan, ID Fan, Electrostatic Precipitator,Air Preheater.

6.2 How does a Boiler work

Economizer is the first step in the steam generation process. The feed water from the boiler feed pump enters the economizer where it is heated by the hot flue gases. The hot flue gases leave burner and travel through the furnace to the chimney and exchanges its heat from different heat ex-changers in its way to the exhaust chimneys.

After getting saturated, the feed water is taken to the **Boiler drum**. The purpose of boiler drum is to evaporate the feed water or provide latent heat. The saturated water from the boiler drum comes down via **Downcommers** and is then passed through **water walls (Risers)** which are number of evaporation tubes spaced all around the walls of the furnace and is used to take away the latent heat using the heat exchange from the hot flue gases. The flow of the feed water can be natural circulation by the density difference between the water in the riser and downcommers or when the pressure is higher, the circulation pump is used to provide the flow as the density difference is not enough to cause natural circulation. The mixture of saturated liquid and steam then enters again to boiler drum where the steam and the liquid are separated and the steam goes to the superheaters.

A **Superheater** is a heat exchanger in which heat is transferred in a saturated steam to increase its temperature to the desired value. In modern boilers, more than 40% of the heat absorption takes place in superheaters. Superheaters are commonly classified as either convective, radiant or pendant supreheaters. The **Convective superheaters** are often termed as primary superheaters where the saturated steam from the drum is admitted. After passing through the convective superheater, the steam proceeds to the Radiant superheaters where the heat exchange between the flue gases and the steam is mostly due to radiation. As the heat exchange is due to radiation, the amount of temperature increase is generally more than what is required so the steam is desuperheated in **Desuperheaters**. The desuperheater is a direct contact type and the tapping from the boiler feed water is taken and sprayed over the steam to desuperheat it. The steam is then passed to **Pendant superheater** where the steam is finally heated to the desired temperature. There heat is transferred partly by convection and partly by radiation.

The flue gases are produced in the burners by burning the mixture of gases and preheated air. The gases contain mixture of BF (Blast Furnace gas), CO (Coke oven) gas, LDO (Light diesel oil) gas. The air is preheated using the **Air Preheater**. The air is sucked through the

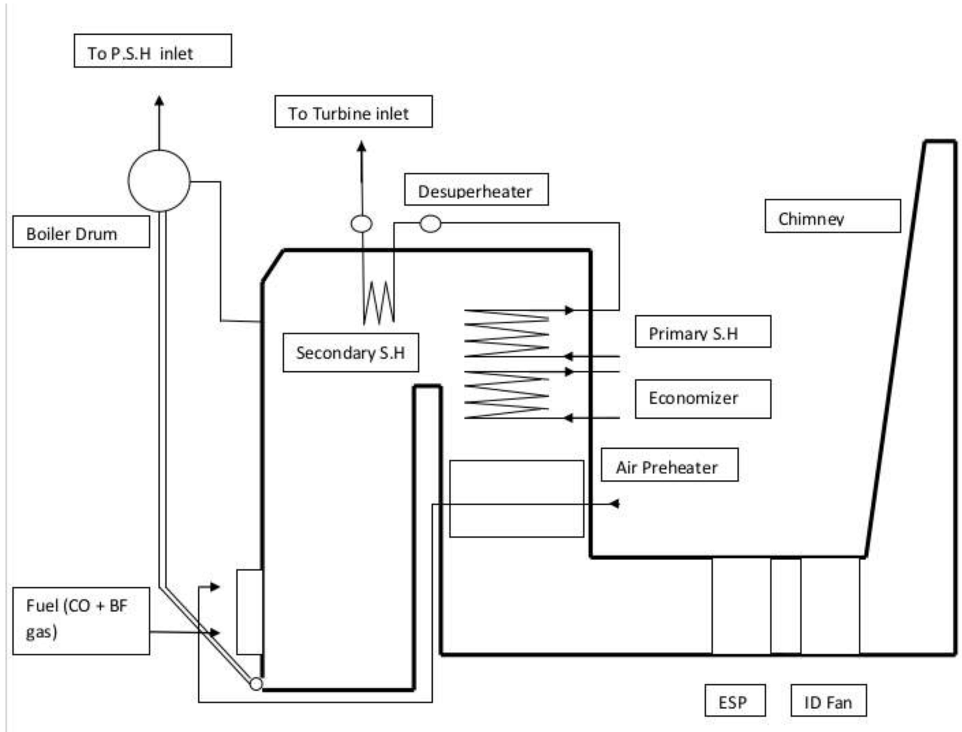
Forced draught fan and then passed through the Air Preheater where the heat exchange takes place between the flue gases and the air.

The flue gases after passing through the air perheater then passes through the **Electrostatic Precipitator** where the dust particles are precipitated and the **Induced Draught**. Fan then takes it to the atmosphere via **chimneys**.

6.3 Specifications of Boiler in PBS – 2

Heating area of Economizer	3100 m^2
Heating area of Superheater	967 m^2
Heating area of Water walls	1005 m^2
Heating area of Evaporators	1240 m^2
Total heating area	6312 m^2
Rated capacity	150 T/hr, 383 Mpa, 450°C
Design Fuel :	
BF Gas	3245KJ/Nm^3
BOF Gas	7531 KJ/Nm^3
CO Gas	16246 KJ/Nm^3

6.4 Flow Diagram of Boiler



	3x150 TPH BOILER PACKAGE ALONG WITH STEAM TURBO-BLOWER BUILDING (EXCLUDING ENABLING WORKS), PKG NO:- 011-01A	ALLIED ENERGY SYSTEM PVT. LTD
	DATA SHEET FOR BOILER FEED WATER PUMP	

DATA SHEET FOR BFW PUMP

REVISION HISTORY					
Rev.	Revision Date	Prepared By	Checked By	Approved By	Description
1	3/9/2013	SUNIL	PRASOON	R.K. SINHA	Issued For Approval

सेल SAIL	**Owner :**
	BHILAI STEEL PLANT, BHILAI, CHATTISGARH
	7.0 MTPA EXPANSION
मेकॉन ISO 9001 Company	**Owner's Consultant:**
	MECON LIMITED, RANCHI
	Contractor: Consortium of
	FUJIAN LONGKING CO., LTD. No. 81, LINGYUAN ROAD, LONGYAN CITY, FUJIAN PROVIANCE, CHINA
ALLIED ENERGY SYSTEM PVT. LTD	**ALLIED ENERY SYSTEMS PVT. LTD.** PLOT NO. 293, KEHAR SINGH ESTATE, WESTEND MARG, SAIDULAJAB, NEW DELHI-110030
PACKAGE DESCRIPTION	**3x150 TPH BOILERS ALONG WITH STEAM TURBO-BLOWER BUILDING (EXCLUDING ENABLING WORK), PKG NO. : 011-01A**

CONTRACTOR DOCUMENT NO.				
Rev. No.	Date	Document No:-	Format	Sheet
1	3/9/2013	BSP-FLCL-05- 011-01A-06-002-01-DE-00108	A4	1

KSB

DATASHEET

Client's enquiry No.	E-MAIL	Date : 25.02.2013	Page No. : 1 of 1
Quotation No.	: 04002720441 R6	Date : 11.03.2013	
Client's LOI / PO No.		Date :	
Indent No.	04002720481	Quantity : 4 Nos.	
SALES ORDER NO.	9972327489	DELIVERY : 07 MONTHS	

Client's Name & Address :	Plant :	Application : Boiler Feed Pump
	Project : 3x150TPH Boiler, BSP project	Item No. : --
	Consultant :	Job No. : --
M/s .Longking Engg. India P Ltd	Inspection By : M/s .Longking Engg. India P Ltd / Consultant / Client	KSB STD QAP QN11042 PART 0
	Witnessing For : Performance test / Strip test / Dimension check	
	G.A.Drg. No. : --	Pr. Testing Drg. No. : --
	Seal arrang. No. : --	C/S Drg. No. : --
	Perfor. Curve No. :	P & I Drg. No. : --
	Design According to KSB Std.	Test Report No. : --

ISP/CC No. : 614301100	PUMP TYPE & SIZE :		Performance Test Std. : HIS
LIQUID HANDLED : Boiler Feed Water	**HDB 125/5**		No. of stages : **5**
LIQUID QUALITY : Ph ≥ 9.0, O2 < 0.02 ppm	**Bearing Housing**	Pr. Stage	**Bearings :** **Pump :-** SLEEVE
Non corrosive to Pump Material	NORMAL	--	**LOD :-** ANITFIRCTION

Rated Temperature	150 °C	Rated Flow	268 m³/Hr	Shut Off Head (+/-5%)	821 mtrs.
Specific Gravity	0.9169	Rated Head	668.6 M	Min. Flow (Thermal)	57 m³/Hr
Kinematic Viscocity	0.202 cSt	Rated Speed	2980 RPM	Min. Flow (Cont.)	130 m³/Hr
Vapour Pressure	4.87 kg/cm²	NPSH Pump/Plant #	6.6 M	Max. BkW @348m3/hr	684.6 KW
Suction Pr.(G)	5.20 kg/cm²	Efficiency (Hot) $	74 %	Driver Make	Client to specify
Discharge Pressure (G)	66.5 kg/cm²	Rated Power	607 Kw	Frame Size	
Differential Pressure	61.3 kg/cm²	Rated Driver Rating	700 / 720 kW		

DESIGN PARAMETERS: Q: 295m3/hr; H: 634m; EFF:73.3; BKW:636.5 KW; NPSHR: 7.4m; SPEED: 2980rpm

Casing : Ring Section		Flanges : ASME B16.5		Stuffing Box : HWD	
Nozzle Orientation	Size	Rating	Hyd.Test Pr.	Feet : CF	Conn. : G
Suction : V. Up	150 mm	B 16.5 # 150	15 Kg/cm²	Std.Curve NO. :	
Discharge: V. Up	125 mm	B 16.5 # 600	120 Kg/cm²	**1820.452/449**	
Balancing Line Back to : DEAERATOR		Stage Hyd.Test Pr.	120 Kg/cm²	Impeller Dia. : 340X17 mm	

	API Plan No.		Medium	Pr. (kg/cm²)	Temp(oC)	Flow (lpm)
Seal Make : MECH. SEAL						
Mech.Seal Type:	Sealing :		--	--	--	--
Size :	Flushing :	23	SELF	--	--	--
Material :	Quenching :	61	Plugged	--	--	--
Control Drg. No :	Cooling: K1+LOD		Water	3 - 5	30 - 35	60-70

Sr.No.	Part Name	Material	Sr.No.	Part Name	Material	Sr.No.	Part Name	Material
1	Barrel	--	11	Shaft	AISI 410 Cr.Plt.	21	Spacer Sleeve	AISI 410 (A)
2	Suction Casing	CA6NM	12	Impeller	1.4008.09	22	Stage Bush	AISI 410 (H)
3	Disch. Casing	CA6NM	13	Suc. Impeller	--	23	Throttle Bush	--
4	Stage Casing	CA6NM	14	St.box	CA 6NM	24	Balancing Disc	A 182 GR F6A cond.B
5	Stage Casing	----	15	Gland Packing	MECH. SEAL	25	Coun.Bal. Disc	A 182 GR F6A cond.C
6	Casing Part	--	16	Seal Cover	--	26	Bal. Piston	--
7	Inlet Ring	--	17	Wearing Ring	CR.HARD 400	27	Casing Studs	--
8	Cover	--	18	Impeller Ring	--	28	Tie Rod	817 M40 (EN 24) V
9	Diffuser	1.4008.09	19	Stage Sleeve	AISI 410 (A)	29	Distributer casing	--
10	Suc. Diffuser	--	20	S. P. Sleeve	AISI 316	30	Column Pipe	--

Driver : MOTOR	Coupling Type & Size :	Coupling Guard : Normal
Procurement : CLIENT	Gear type with spacer	Base Frame : With drain collector
Not to be received at works	Rathi / Equi. Make	Motor Side to be drilled & tapped
Bearing Lubrication : Ring Oil		Paint : WI 0014010-3BK2
Execution : OUTDOOR	Direction of pump rotation as seen from drive end : **CW**	KSB Standard

Remarks :

CLIENT TO ENSURE THAT NPSH(A)- NPSH(R) >= 1.5m AT SUCTION NOZZLE AFTER STRAINER LOSSES

$ HOT EFFICIENCY CALCULATIONS ACCORDING TO HIS

PERFORMANCE TESTING SHALL BE CONDUCTED AT NORMAL PARAMETERS WITH COLD WATER AT KSB TEST BED, WITH TEST BED MOTOR AND TEST BED CONNECTING COUPLING AND AT REDUCED / RATED SPEED. RESULTS OBTAINED WILL BE EXTRAPOLTED FOR RATED TEMPERATURE, SPEED & OTHER DESIGN PARAMETERS. DETAILS OF TEST ARE AS PER ATTACHED QAP.

GUARANTEE IS FOR RATED CONDITION ONLY AT KSB TEST BED WITH KSB TEST BED MOTOR

WE HAVE SELECTED MOTOR WITH 15% MARGIN ON PUMP RATED POWER.
MOTOR RATING WILL BE SUITABLE FOR RUN OUT FLOW OF 348 M3/HR (130% OF NORMAL).

SHUT OFF TO RATED RATIO:

NOISE LEVEL: 88 DBA AT 1M DISTANCE IN ANY DIRECTION ONLY FOR PUMP

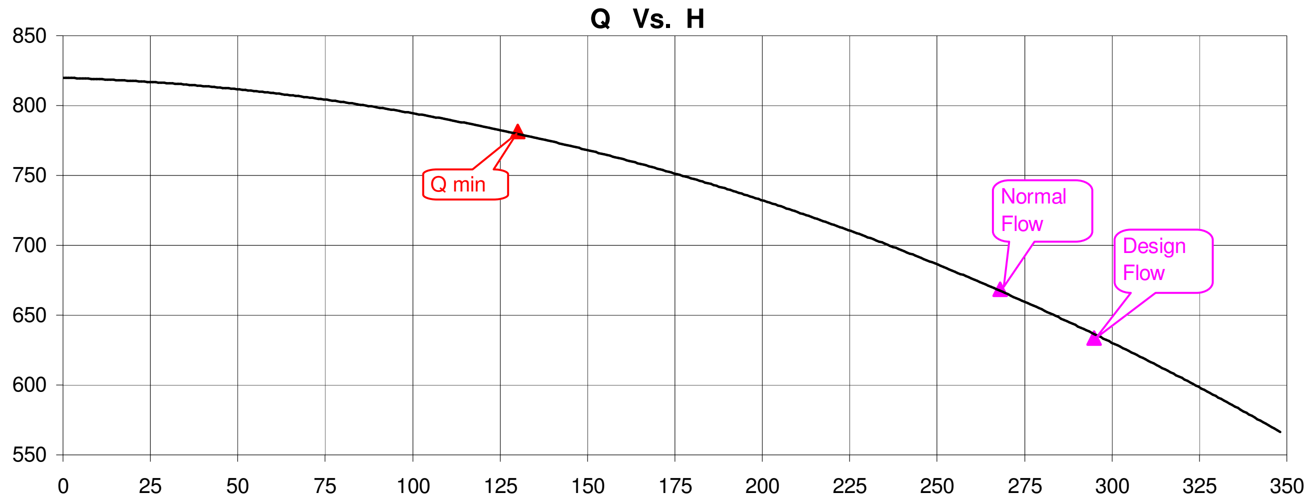
MECHANICAL DESIGN TEMPERATURE = 160 DEG. CEL.

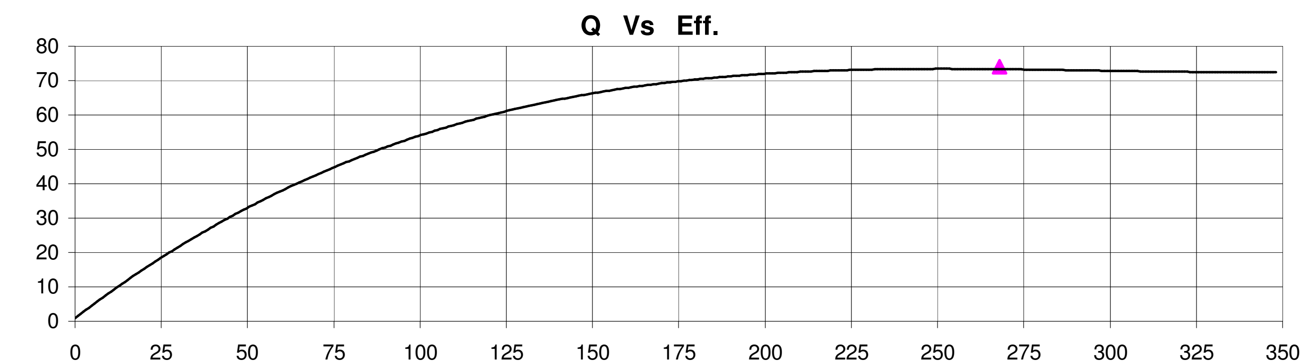
PART LIST NO.: **AGGREGATE NO. :**

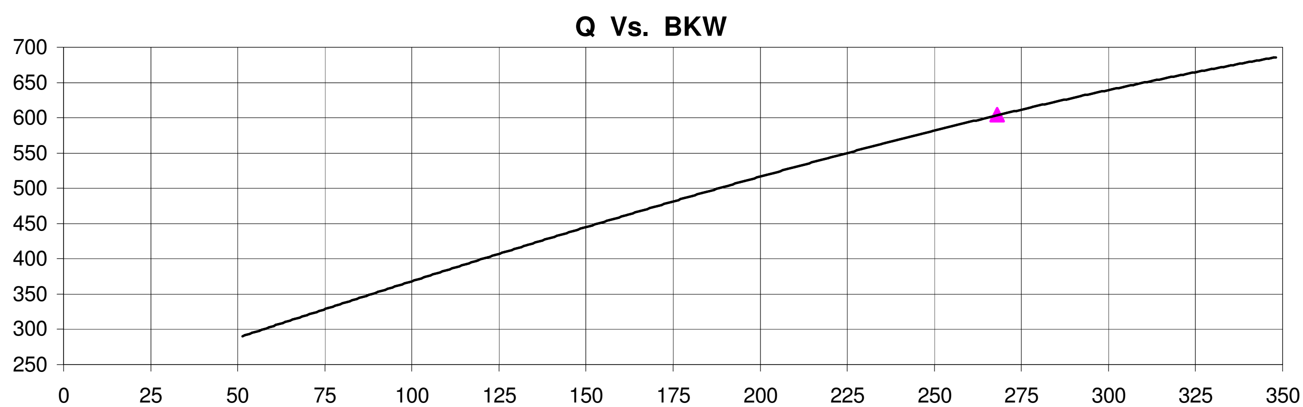
	Prepared	Checked	Part list booked	Part list released	Aggregate released
Sign & Date	ATG				
Revision	R6		3	4	5
Sign Date	11.03.2013				

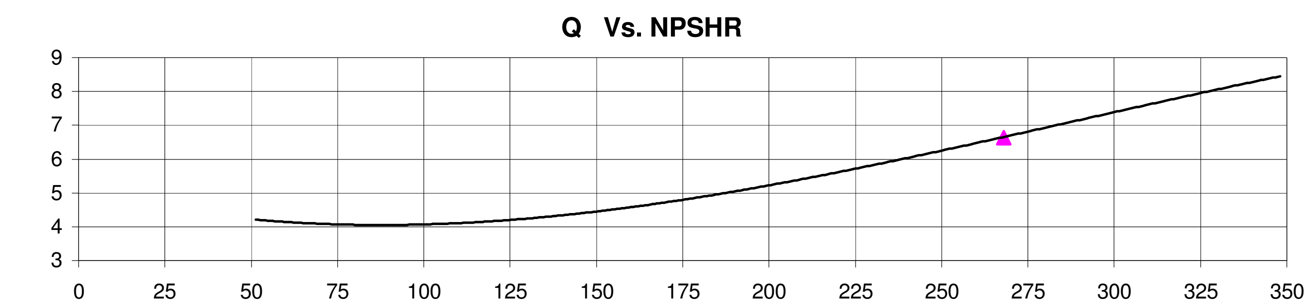
Pump Performance Curve

Client	M/s .Longking Engg. India P Ltd		SO NO	9972288496		
Project	3x150TPH Boiler, BSP project		Pump Type	HDB 125/5		
Design Points	Flow m3/hr.	268	Speed (rpm)	2980	Eff. % (Hot)	74
	Head m	668.6	Temp. °C	150	NPSH R (m)	6.6
	Shut off Head	821	Sp. Gr.	0.9169	BKW (Hot)	607









Prepared by	Sales Order No		Curve ref.	1820.452/449	
ATG	9972327489		Rev.0	Dated	11.03.2013

	3x150 TPH BOILER PACKAGE ALONG WITH STEAM TURBO-BLOWER BUILDING (EXCLUDING ENABLING WORKS), PKG NO:- 011-01A				
	DATA SHEET FOR CONDENSATE TRANSFER PUMP				

DATA SHEET FOR CONDENSATE TRANSFER PUMP

REVISION HISTORY					
Rev.	**Revision Date**	**Prepared By**	**Checked By**	**Approved By**	**Description**
0	1/19/2013	SUNIL	PRASOON	R.K. SINHA	Issued For Approval

Owner :

BHILAI STEEL PLANT, BHILAI, CHATTISGARH

7.0 MTPA EXPANSION

Owner's Consultant:

MECON LIMITED, RANCHI

Contractor: Consortium of

FUJIAN LONGKING CO., LTD.

No. 81, LINGYUAN ROAD, LONGYAN CITY,

FUJIAN PROVIANCE, CHINA

ALLIED ENERY SYSTEMS PVT. LTD.

PLOT NO. 293, KEHAR SINGH ESTATE,

WESTEND MARG, SAIDULAJAB, NEW DELHI-110030

PACKAGE DESCRIPTION	**3x150 TPH BOILERS ALONG WITH STEAM TURBO-BLOWER BUILDING (EXCLUDING ENABLING WORK), PKG NO. : 011-01A**

CONTRACTOR DOCUMENT NO.				
Rev. No.	**Date**	**Document No:-**	**Format**	**Sheet**
0	1/19/2013	BSP-FLCL-05- 011-01A-06-002-01-DE-00109	A4	1

SINTECH PUMPS
www.sintechpumps.com

Sintech Precision Products Limited
C-189/190, Bulandshahar Road Industrial Area,
Site No. 1, Ghaziabad – 201001 (U.P.), INDIA.
Ph.: +91-120-4176000, 3290637/38, 2866320/21
Fax: +91-120-2867715
Email: marketing@sintechpumps.com

O.A.000141/2515

January 15, 2013

TECHNICAL SPECIFICATIONS

Item No.	**1**
Quantity	2
Application	**Condensate Transfer Pump**
Type of Pump	Horizontal split casing pump
Model No.	**SCS 200X630**
Stages	Single
Liquid	Water
Specific Gravity	0.99
Temperature ° C	50
Flow (m³/hour)	500
Differential Head at Casing Flange (mwc.)	133.5
Efficiency %	77
BKW Water	236.1
BKW Liquid	233.7
Pump RPM	1450
Motor KW/RPM	260/1450
Suction Size (mm)	300
Dis. Size (mm)	200
Impeller Type	Closed
NPSHR, m	2.8
Shaft Sealing / Flushing Plan	Mechanical Seal
MATERIAL OF CONSTRUCTION	
Casing	WCB
Impeller	WCB
Stuffing Box	WCB
Shaft	AISI 410
Shaft Sleeve	AISI 410-Hardened 12% Chrome Steel (ground smooth)
Coupling	Flexible Pin & Bush/Spacer Type
Wear Ring	WCB
Shaft Seal	Mechanical Seal
Base Frame	Mild Steel
Bearing	Deep Groove Ball Bearing/Anti Friction
other material	Manufacturer's Standard

Sintech Precision Products Limited Ghaziabad

SINTECH PRECISION PRODUCTS LIMITED, GHAZIABAD

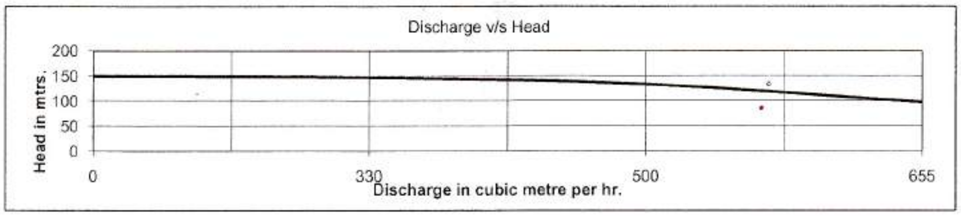
Pump Characteristic Curves

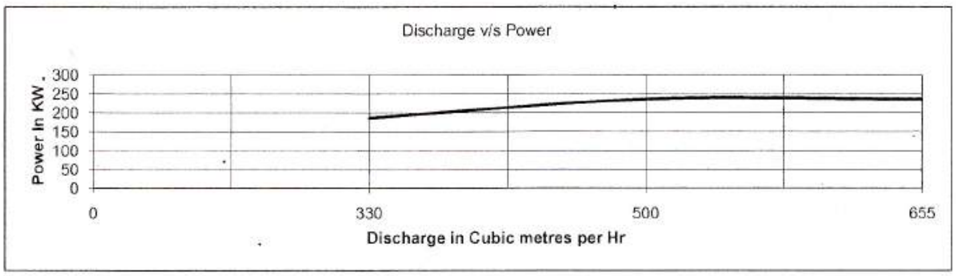
O.A.000141/2515 January 15,2013

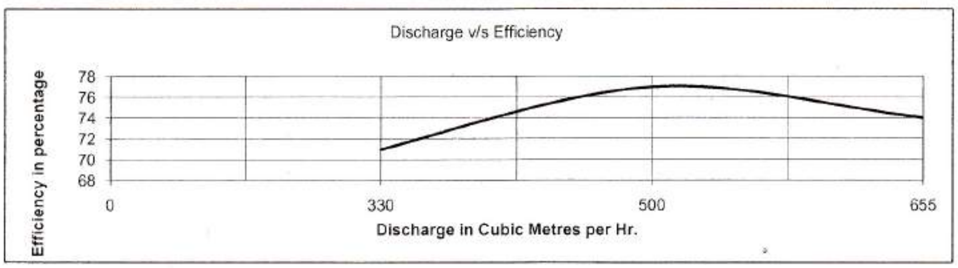
Pump Model : SCS 200X630
CAPACITY [m^3/hr] 500
Motor Rating [KW / RPM] 260/1450
Application :- Condensate Transfer Pump

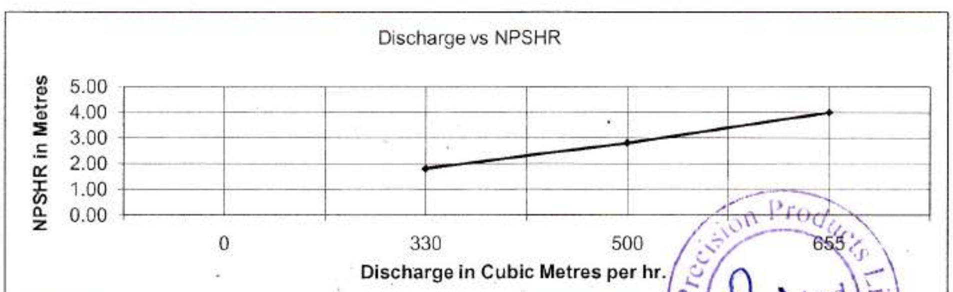
RPM - 1450
Head - 133.5 MLC
S.O.H- 150 Mtrs.

Client:	Allied Energy Systems Pvt. Ltd. A/C 3X150 TPH Boiler's,Auxiliaries&Steam Turbo Blower at Bhilai Steel Plant

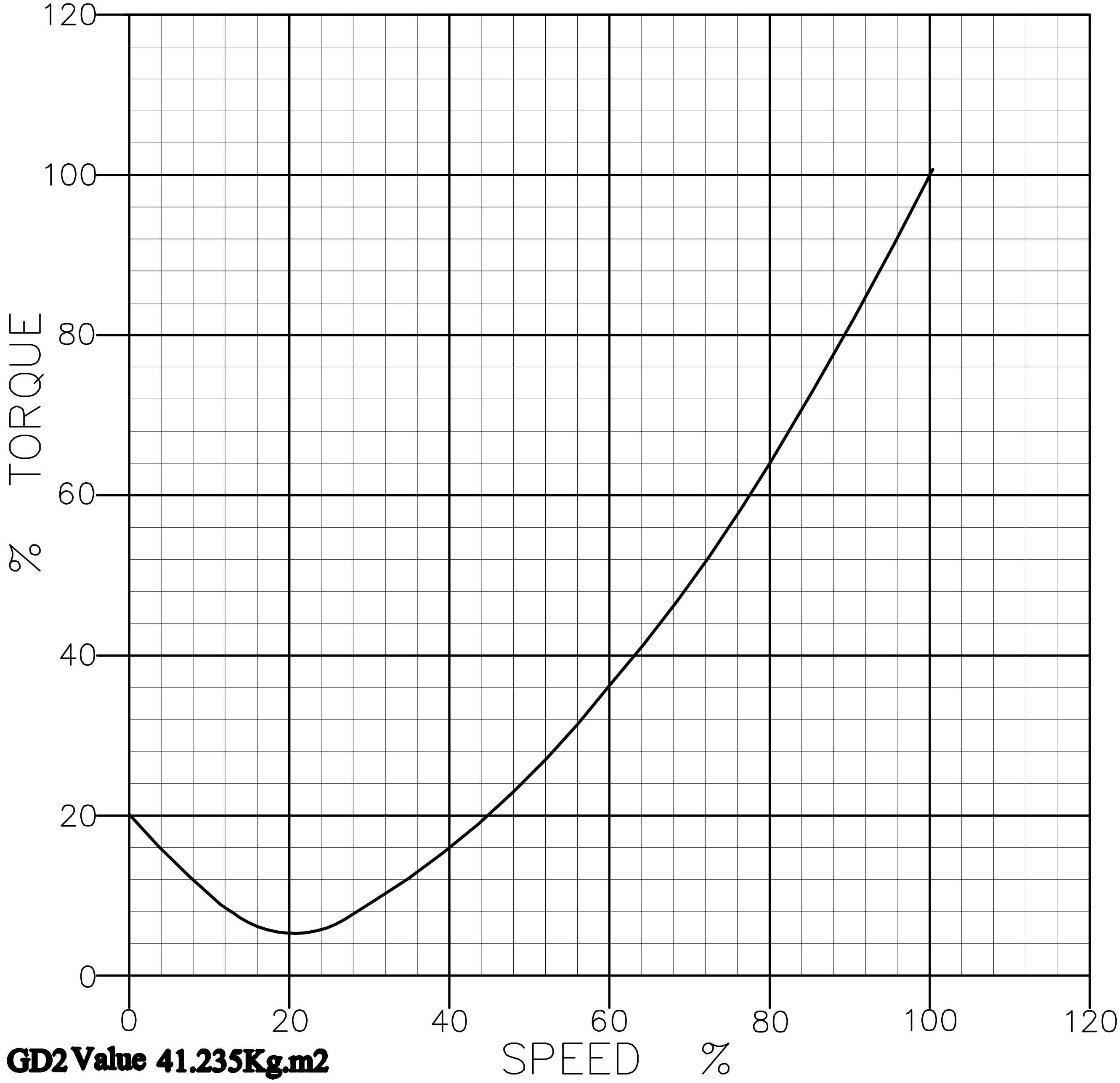








Sintech Precision Products Limited Ghaziabad



GD2 Value 41.235Kg.m2

RATED POWER 236 K.W.

MOTOR RATED POWER 260 K.W.

RATING TORQUE 1712 N-m

STARTING TORQUE 1860 N-m

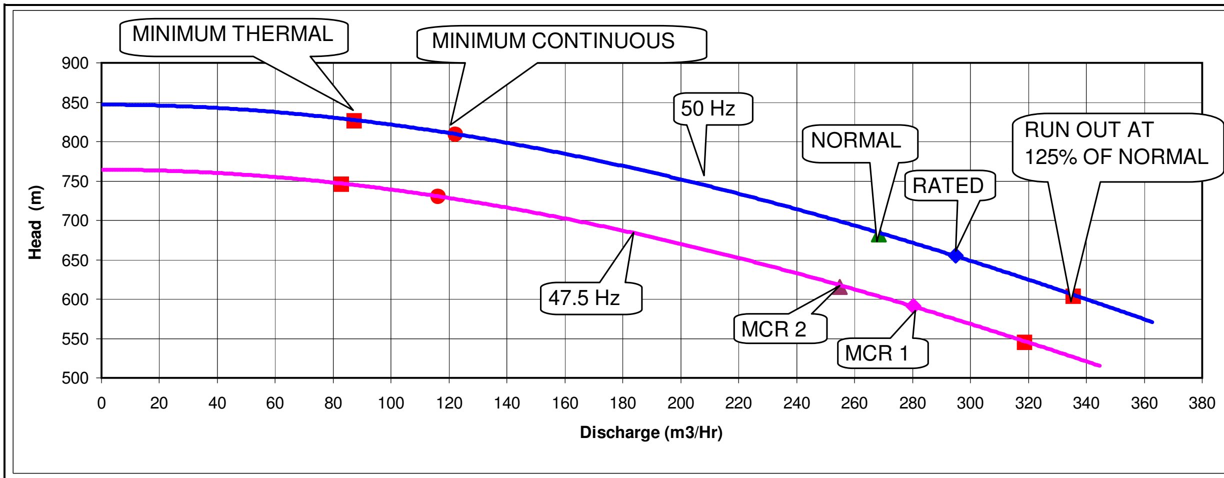
SINTECH	SINTECH PRECISION PRODUCTS LTD. B.S. Road Industrial Area GHAZIABAD (U.P.)

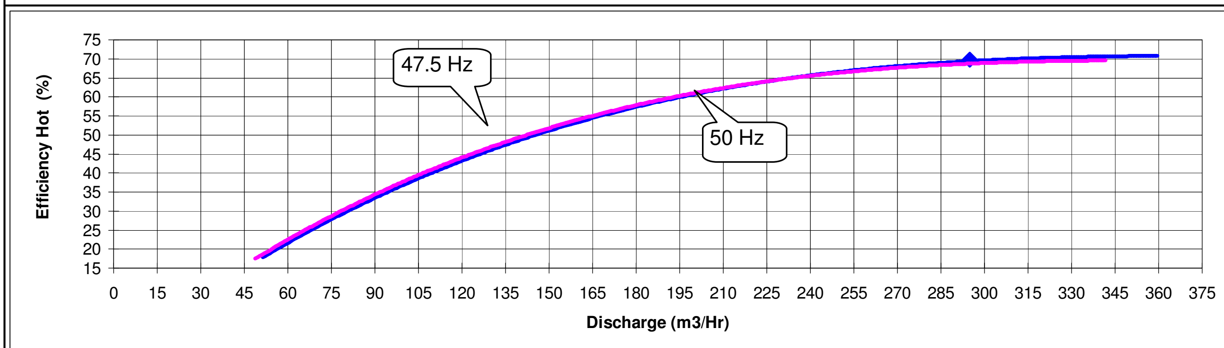
DRN. BY	INDER	MODEL SCS 200x630-1450rpm
CHD. BY		
APPD. BY		PART NAME TORQUE SPEED CURVE
DATE	16.01.2013	
SCALE	NTS	
REF.	-	
REF. DRG. No. -		Curve No. 7-00-2063-00-TSC-00-0
		REV. No. 0

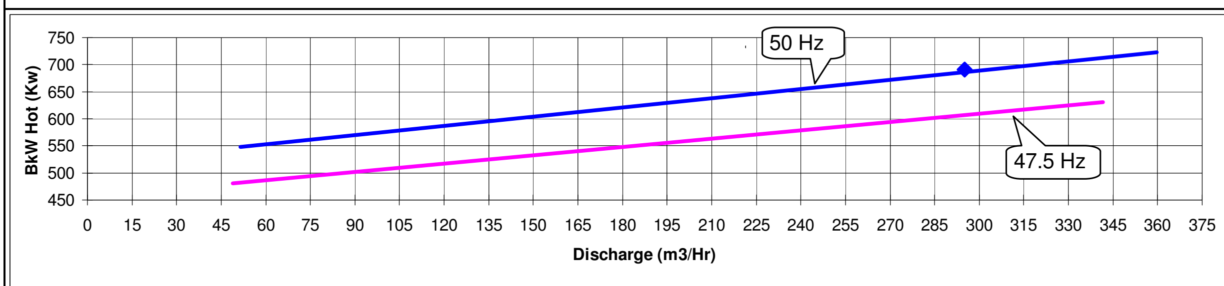
PERFORMANCE CURVE

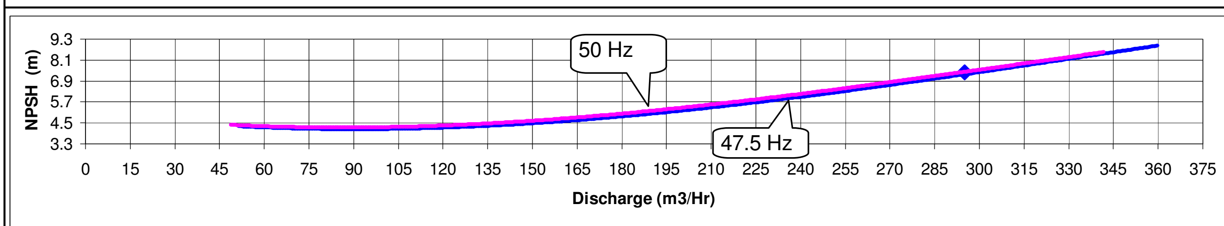
Client	ALLIED ENERGY SYSTEMS PVT. LTD.	**Pump Type**	HDB 125 / 5	KSB
Project	3 X 150 TPH BOILER, AUXILIARIES & TURBO BLOWER SYSTEM	**Sq. No.**	04002711662 R6	
Plant	M/S. BHILAI STEEL PLANT (BSP)	**Ind No.**	OFFER STAGE	
Consultant	MECON	**So No.**	OFFER STAGE	

PARAMETERS	Q Suction / Discharge	H at Discharge	EFF	NPSH R	BKW	SPEED	REMARK
RATED	295.0	655	69.8	7.4	691.5	2980	50 HZ
NORMAL	268.3	682	66.7	6.7	685.5	2980	50 HZ
MCR 1 / DESIGN	280.3	591	68.6	7.2	603.7	2831	47.5 HZ
MCR 2	254.9	616	65.8	6.5	596.0	2831	47.5 HZ









9) PUMP IS SELECTED FOR 50 HZ FREQUENCY. AT 47.5 HZ FREQUENCY Q, H, EFFI, BKW IS AS PER MCR 1 & MCR 2 CONDITION.

Prepared by:	**RSI**	Checked By:	**SSP**	Revision :	**R 6**
Curve No :	LATER	Ref Curve	LATER		

3x150 TPH BOILER PACKAGE ALONG WITH STEAM TURBO-BLOWER BUILDING (EXCLUDING ENABLING WORKS), PKG NO:-011-01A
SIZING CALCULATION FOR CONDENSATE WATER TRANSFER PUMPS

SIZING CALCULATION
FOR
CONDENSATE WATER TRANSFER PUMPS

REVISION HISTORY

Rev.	Revision Date	Prepared By	Checked By	Approved By	Description
0	23/06/2012	K.PASUPATHI	K.A.GANESH	RKS	Issued For Approval
1	9/9/2012	K.PASUPATHI	K.A.GANESH	RKS	Issued For Approval

Owner :

BHILAI STEEL PLANT, BHILAI, CHATTISGARH

7.0 MTPA EXPANSION

Owner's Consultant:

MECON LIMITED, RANCHI

Contractor: Consortium of

FUJIAN LONGKING CO., LTD.

No. 81, LINGYUAN ROAD, LONGYAN CITY,

FUJIAN PROVIANCE, CHINA

ALLIED ENERY SYSTEMS PVT. LTD.

PLOT NO. 293, KEHAR SINGH ESTATE,

WESTEND MARG, SAIDULAJAB, NEW DELHI-110030

PACKAGE DESCRIPTION	3x150 TPH BOILERS ALONG WITH STEAM TURBO-BLOWER BUILDING (EXCLUDING ENABLING WORK), PKG NO. 011-01A

Rev. No.	Date	Document No:-	Format	Sheet
1	9/9/2012	BSP-FSCL-05-011-01A-06-001-01-BE-00053	A4	2

Project	3X150TPH Boiler, Auxiliaries & Turbo Blower System.
Client	M/S. Bhilai Steel Plant
EPC Contractor	M/s Fujian Longking Co. Ltd., / M/s Allied Energy Systems Pvt. Ltd.,
Document Title	Sizing Calculation for Condensate Transfer Pumps
Document Number	BSP-FSCL-05-011-01A-06-001-01-BE-00053

Description	Units	Parameter	Remarks
Flow Calcualtions:			
Maximum flow required from condensate tank to deaerator when all the three boilers are working	tph	411	From Deaerator Sizing Calculation
Maximum temperature of condensate	°C	45.05	From condensate tank sizing Calculation
Margin on flow	%	20%	As per contract
Density of water	Kg/m³	990.099	
Design discharge flow	tph	493.2	
Selected capacity of pump	**tph**	**495**	
Head calculations:			
Deaerator safety valve set presssure	Kg/cm² a	6	
Deaerator nozzle pressure drop	Kg/cm²	0.25	
Pressure drop in control valve	Kg/cm²	2	
Static head	Kg/cm²	2.65	
Pressure drop in flow measuring orifice	Kg/cm²	0.2	
Pressure drop in line	Kg/cm²	0.5	
Total pressure drop	Kg/cm²	5.60	
Margin on pressure drop	%	10%	
Discharge pressure required	Kg/cm² a	12.16	
Selected Discharge Pressure	Kg/cm² a	13	
Suction pressure	Kg/cm² a	1.3	

Project	3X150TPH Boiler, Auxiliaries & Turbo Blower System.		
Client	M/S. Bhilai Steel Plant		
EPC Contractor	M/s Fujian Longking Co. Ltd., / M/s Allied Energy Systems Pvt. Ltd.,		
Document Title	Sizing Calculation for Condensate Transfer Pumps		
Document Number	BSP-FSCL-05-011-01A-06-001-01-BE-00053		
Description	**Units**	**Parameter**	**Remarks**
Differential pressure	Kg/cm²	11.7	
Design conditions for the pump:			
Rated flow in terms of TPH	tph	495	
Rated flow in terms of m³/hr	m³/hr	500	
Temperature of medium	°C	50	
Differential pressure at rated flow	MLC	131.3	Suction pressure neglected
Suction pressure	MLC	flooded	

6.5 Boiler and BOP Load Calculation

BFP	2 X 720 = 1440 kW
ID Fan	9 X 110 = 2 X 55 110 kW
FD Fan	6 X 200 = 1200 kW
CTP	2 X 150 = 300 kW
Aux. Load	700 kW
Total Rated Load	6340 kW
Act. Load(80%)	**5072 kW**

Chapter 7

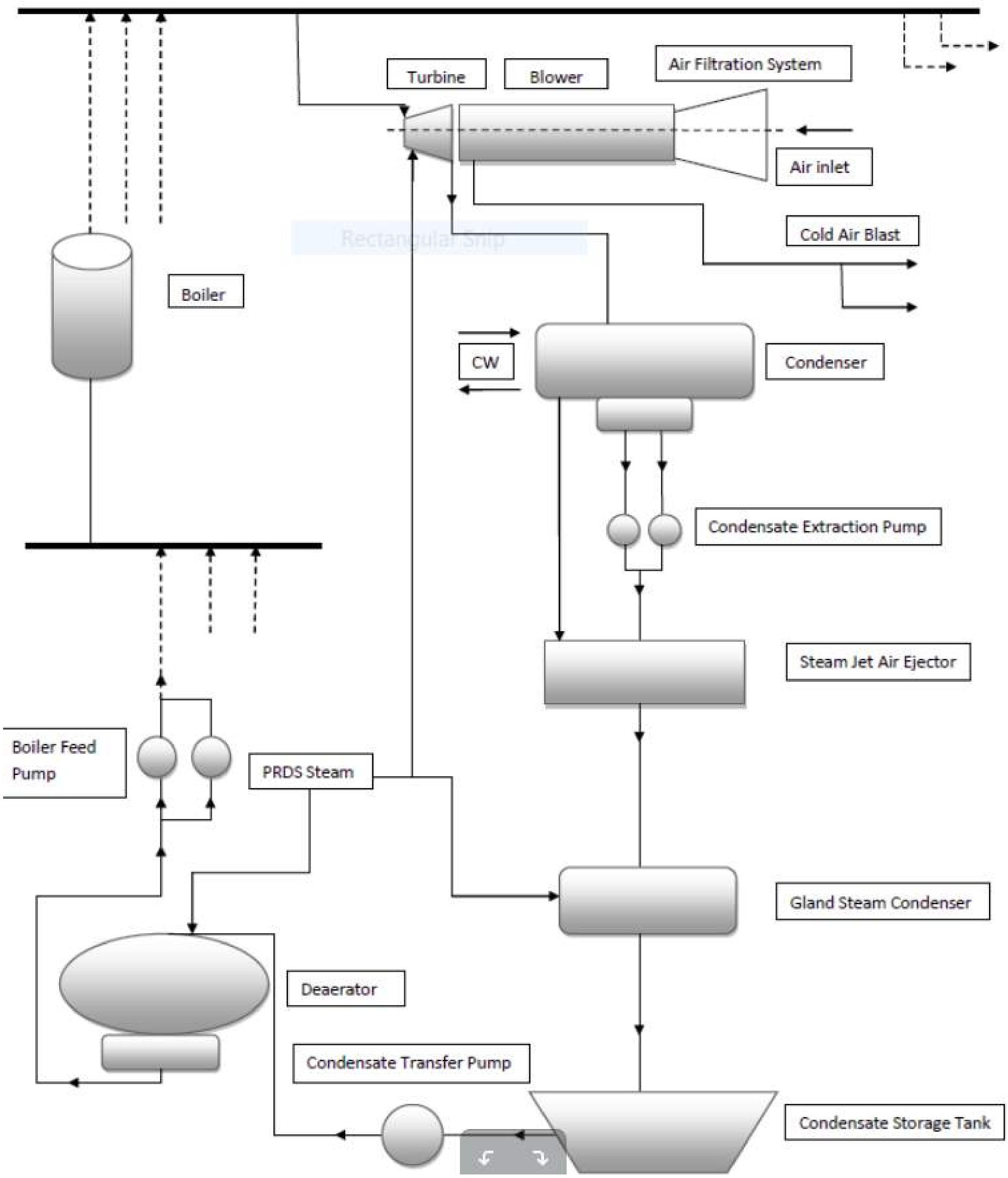
Steam Turbo Blowers(STB)

7.1 Need of STB in BSP

Blast Furnaces can be considered as the heart of a Steel Plant. The blast furnace is the first step in producing steel from iron oxides. The purpose of a blast furnace is to chemically reduce and physically convert iron oxides into liquid iron called "hot metal". The raw materials such as iron ore, coke and limestone are dumped into the top and preheated air known as Hot air blast is blown into the bottom. The raw materials undergo numerous chemical reactions and descend to the bottom to become final product of liquid iron and slag. The hot air blast is produced by passing cold air blast trough a stove where residual blast furnace gases are burned. This cold air blast is provided by Turbo blowers form Power and Blowing Station.

Each blower installed on the new Power and Blowing station will provide on average 1500 Nm^3/min of cold air blast. There will be 3 Steam Turbine driven Turbo Blowers (2 working and 1 Standby) each with 50% capacity of maximum air blast requirement.

7.2 Flow Diagram of STB and Auxiliaries



7.3 Process Overview of STB and Auxiliaries

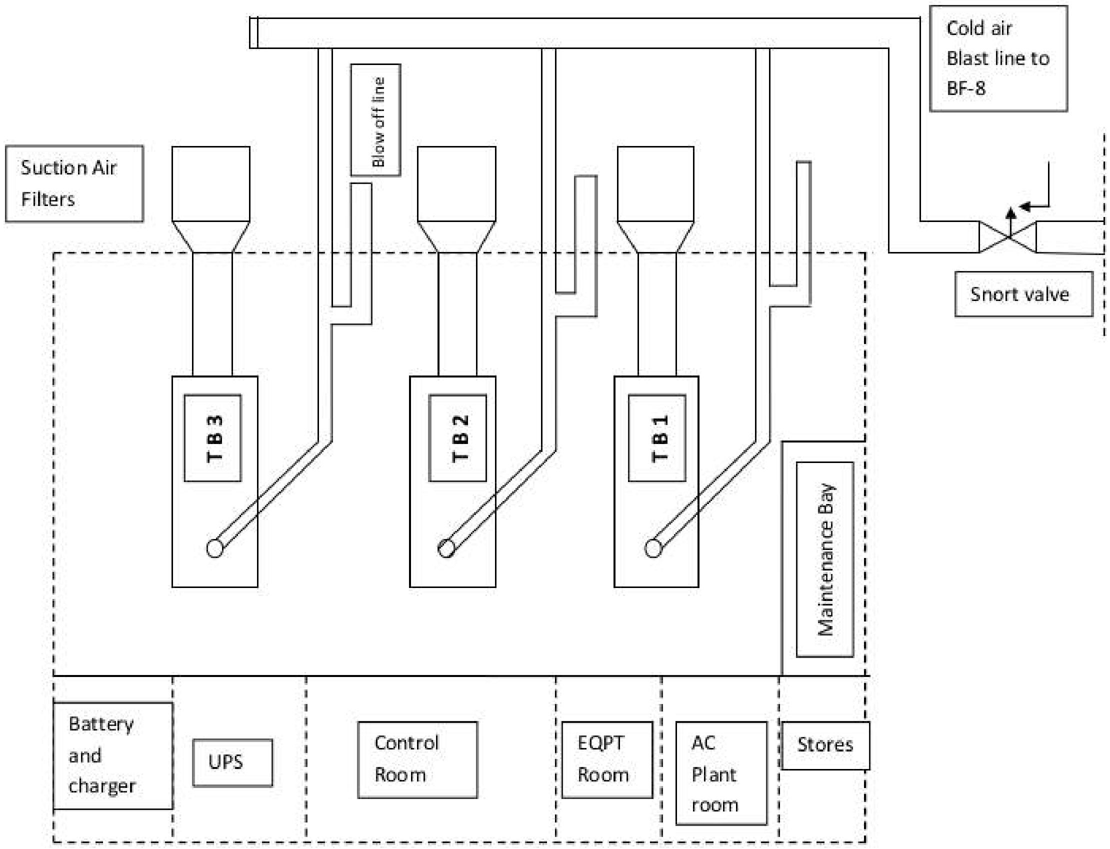
The steam used to drive the blowers is produced in **3 Boilers** at 40 ata, 450 degree Celsius. Waste gases from blast furnace and coke oven mainly BF gas and CO gas are used to fire the burners in boiler to produce steam. The steam so produced is sent to main steam header from where tapings are taken for different stations mainly **Turbo blowers, Turbo generators and Pressure Reducing and De superheating Station**.

Steam enters the **Turbine** at around 36 ata, 440 degree Celsius. The steam in turbine passes through different stages where its enthalpy is converted into rotational energy to drive the turbine shaft which in turn drives the **Blower** attached. The blower thus sucks the air passing through air filtration system and delivers the high pressure air to the blower outlet. The steam from turbine outlet goes through **Condenser** where it is condensed by cooling water to liquid condensate which is collected in hotwell.

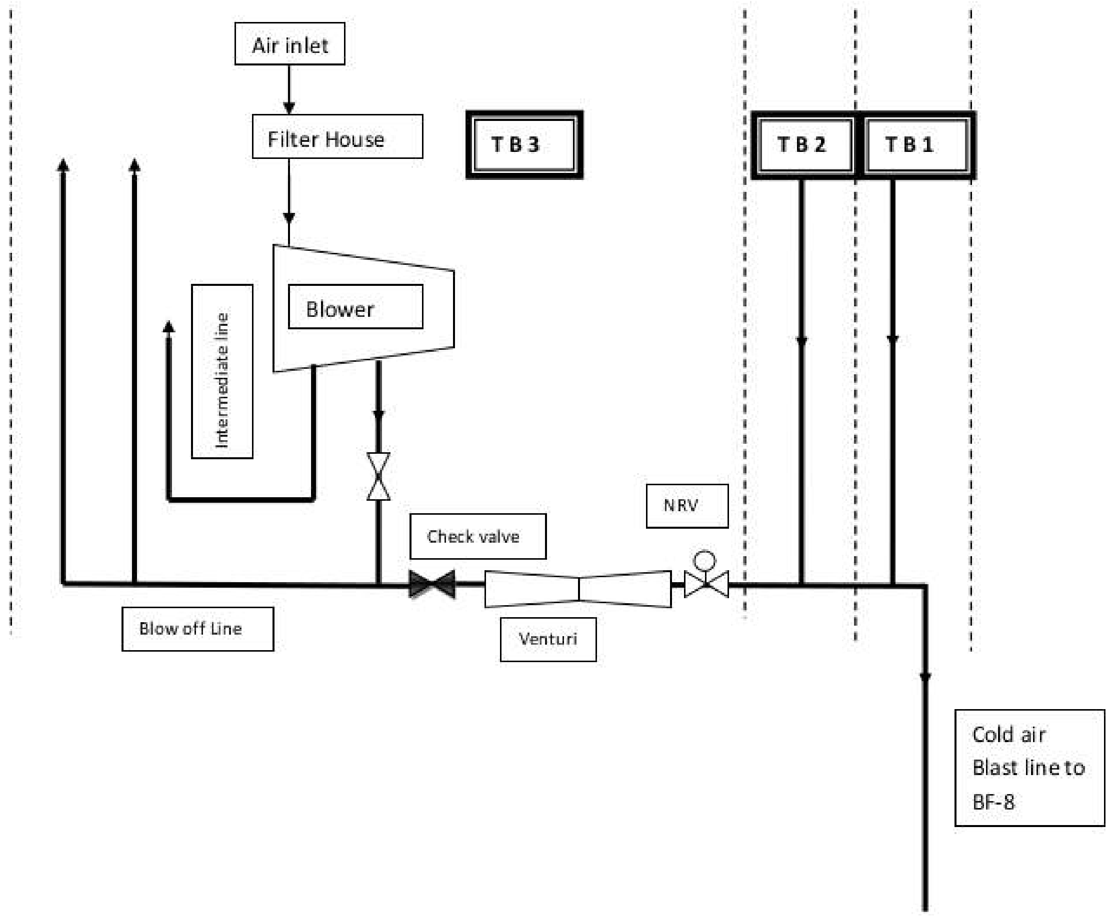
The liquid condensate from the hotwell is then pumped using **Condensate Extraction Pump**. The condensate is then passed through the **Steam Jet Air Ejector** where the condensate is heated and the air in the condenser is simultaneously ejected using the steam from **PRDS**. The condensate is then passed through the **Gland Steam Condenser** where it is heated using the PRDS steam.

The condensate is then stored in the **Condensate Storage Tank**. The condensate is then transferred to the **Dearator** using the **Condensate Transfer Pump**. The condensate is sprayed from the top in the dearator and PRDS steam is used to heat the condensate and remove the impurities. The feed water so formed is collected and then pumped to the Boiler using the **Boiler Feed Pump**. The feedwater in boiler is first converted to saturated liquid by economizer and then it goes to the boiler drum where it is evaporated and then passes through superheater before reaching its final state and transferred to main steam header.

7.4 Layout of STB PBS-2



7.5 Air Distribution system STB PBS-2



7.6 Turbo Blowers

Turbo-blower is a combination of two turbo machines - Turbine and Blower. A turbo machine is a device that exchanges energy with a fluid using continuously flowing fluid and rotating blades The turbine is a work producing device which is run using the steam from the boilers. This turbine thus rotates the shaft attached to the blower. Blower is a work consuming device and is used to transfer energy to the fluids. Thus the turbine takes the energy from one fluid (steam) and the blower then transfers this energy to other fluid (air, in our case).

There are 3 ways of classifying turbo machines

1. Type of fluid they work on – Compressible or Incompressible

Figure 7.1: 219000 Nm /hr BLOWER AT PBS-2 STB

2. Direction of flow in the machines – Radial, Axial or Centrifugal
3. Whether they deliver or extract power – Turbine or Blower

A steam turbine is a prime mover which continuously converts high pressure high temperature steam supplied by steam generator into shaft work with low temperature steam exhausted to the condenser. This energy conversion takes place in 2 steps.
High pressure high temperature steam expands in nozzle and comes out at a high velocity. The high velocity jet of steam coming out of nozzles impinge on the blades mounted on the wheel, get deflected by an angle and suffers a loss of momentum which produces torque.

Figure 7.2: Turbine at PBS-2 STB

7.6.1 Conservation of Mass

Conservation of mass in simple language states that the total mass flow into the turbine equals the total mass flow out of the turbine.

$$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$$

7.6.2 Conservation of Momentum

Newton's second law applied to the rotational motion states that "Rate of change of angular momentum of a system equals the total external torque applied to the system".

$$T = \frac{dL}{dt}$$

Also, the angular moment is given by moment of momentum

$$L = mv_\theta r$$

So the change in the angular momentum can be given as

$$mv_{2\theta}$$

and

$$T = m(v_{2\theta}r_2 - v_{1\theta}r_1)$$

And the power produced is given by

$$P = T\omega = m\omega(v_{2\theta}r_2 - v_{1\theta}r_1)$$

This is known as Euler Turbomachinery equation. This is the basic equation and applies to all types of turbomachinery.

7.7 Nozzle

A nozzle is a duct by flowing through which the velocity of a fluid increases at the expense of pressure drop. A duct which decreases the velocity of fluid and causes a corresponding increase in pressure is called a diffuser. The shape of the nozzle depends on the mach number of a flowing fluid. If the fluid is subsonic, the nozzle will be convergent and if the flow is supersonic, the nozzle will be divergent in shape.

7.7.1 Nozzle efficiency

Due to friction between the expansion process is irreversible, although still approximately adiabatic. In nozzle design, it is the usual practice to base all calculation on isentropic flow and then to make an allowance for friction using a coefficient or efficiency.
The nozzle efficiency is defined as the ratio of actual enthalpy drop to the ideal enthalpy drop.

$$\eta_n = \frac{h_0 - h_1}{h_0 - h_{1s}}$$

7.8 Blading

Depending on the types of blade used and the method of energy transfer from the fluid to the rotor wheel, the turbine may be of two types

- Impulse turbine
- Reaction turbine

In Impulse turbine, the pressure drop occurs in nozzle and no pressure drop occurs in rotors. The pressure energy is first converted to kinetic energy in nozzles and the kinetic energy is used to turn the rotor blades. These are called impulse turbines as the power is produced using the impulse of the high velocity fluid exiting the nozzles.
Generally, single stage turbines are not used as the enthalpy drop occurs only on one stage and the increase is velocity is very large and this results in higher blade velocity which is not desired. Hence compounding of steam turbines is necessary. The compounding is done in two ways

- Pressure compounding or Rateau staging
- Velocity compounding or Curtius staging

Pressure compounding corresponds to putting a number of simple impulse stages in series. The total enthalpy drop is divided equally among the stages. **Velocity compounding** or curtis staging, all the pressure drop and hence enthalpy drop occurs on the single row of nozzles and the resultant kinetic energy of the steam is absorbed by the wheel in a number of rows of moving blades with stator in between the two such rows. The purpose of stator or guide blade is to guide the fluid without changing the velocity so that the fluid enters the next stage similar to the previous stage. In curtis satging as the number of rows of moving blades increases, the effectiveness of moving rows decreases.

7.9 Reaction turbines

In these turbines, the pressure drop occurs both in nozzles or fixed row of blades as well as the moving row of blades. Blades rotates both due to both the impulse effects of the jets and the reaction forces from the exiting jets on the blades and this is why they are called as reaction turbines.
The degree of reaction is defined as

$$R = \frac{\Delta h_{rotor}}{\Delta h_{stage}}$$

The general arrangement of consist of initial two-row Curtis stage initially which involves large enthalpy drop and then remaining stages can either be of impulse type or reaction type.

7.10 Blower Specification in STB PBS-2

Identification	**An Air Blower**
Serial Number	6612
Vendor's Name	Man Diesel and Turbo SE
Gas Handled	Air
Rated Capacity	219000 Nm$^3/hr$
Rated Power	22836 kW
Hydrostatic Test Pressure	10.7 kg/cm^2g
Casing Design Pressure	7.1 kg/cm^2g
Casing Design Temperature	340°
Purchaser Item Number	TBB 01
Year of Fabrication	2012
Type + Size	AG080/16RB
Min. Operating Speed	3964 rpm
Max. Constant Speed	5814 rpm
Trip Speed	6104 rpm
First Critical Speed	2663 rpm
Max. allow work pressure	7.0 kg/cm^2abs
Min/Max allow temp	9/337°C

7.11 Turbine Lubrication System at STB PBS-2

The modern steam turbine and generator are carefully designed pieces of equipment constructed of well selected materials. Its satisfactory performance and useful life in service depend, among other things, on the maintenance of proper lubrication. This is one of the best insurances against turbine outage. The Lubricating oil system performs three basic functions: It reduces friction between rotating and fixed elements, It removes heat from the bearings and In mechanical hydraulic governing systems, it is used as a hydraulic pressure fluid. Figure shows a typical turbine lubrication system. Majority of oil is stored in a Lube oil tank. Different pumps as described below take suction from pump and discharge oil for bearings.

Main oil pump

The main oil pump is the one that delivers all the oil requirements for the turbine-generator at high pressure during normal operation. It is direct-driven from the turbine shaft and may be located at either the turbine or generator end of the shaft. Because the main oil pump is and attached pump, it runs at turbine shaft speed. During startup and shutdown, the main oil pump is not turning fast enough to deliver the required flow so auxiliary pumps are used.

Auxiliary oil pump

The auxiliary oil pump has two functions. The first is to operate during the startup and shutdown when the main oil pump is not running and second is to act as a standby during the main oil pump failure.

Emergency oil pump

The time required for a turbine to run down from operating speed to a stop is typically from 20 to 45 minutes. If the bearings did not receive lubrication during this period, they would rapidly overheat and be destroyed. The only method of protection is to provide a sufficient number of alternate power supply lube oil pumps to insure all lube oil flow is not lost. The auxiliary lube oil pump is normally backed up with ac and dc emergency lube oil pump. This pump is automatically started from a pressure switch in the lube oil supply header to the bearings.

Jacking oil pump

When the heavy turbine-generator shaft is at rest, It will squeeze the oil film from under the shaft at the bearings. If the shaft is then rotated, there will be metal-to-metal rubbing until the oil can work its way underneath. To avoid this situation, the jacking oil pump injects oil at high pressure into the bearing at the bottom of the shaft. This tends to lift or jack the shaft a few hundredths of a millimeter off the bearing so that there will be no metal-to-metal contact.

Equipments used in Turbine lubrication system

Type	AOP
Pump Sr. No.	110588
Pumping Head	102.30 m
Rate of flow	105 m^3/hr
Radial SKF	6311
Thrust SKF	2 X 7312
Casing Hyd.Tst	63 Kg/cm^2
Speed	2955 rpm

Auxiliary Oil Pump at P&BS 2 STB

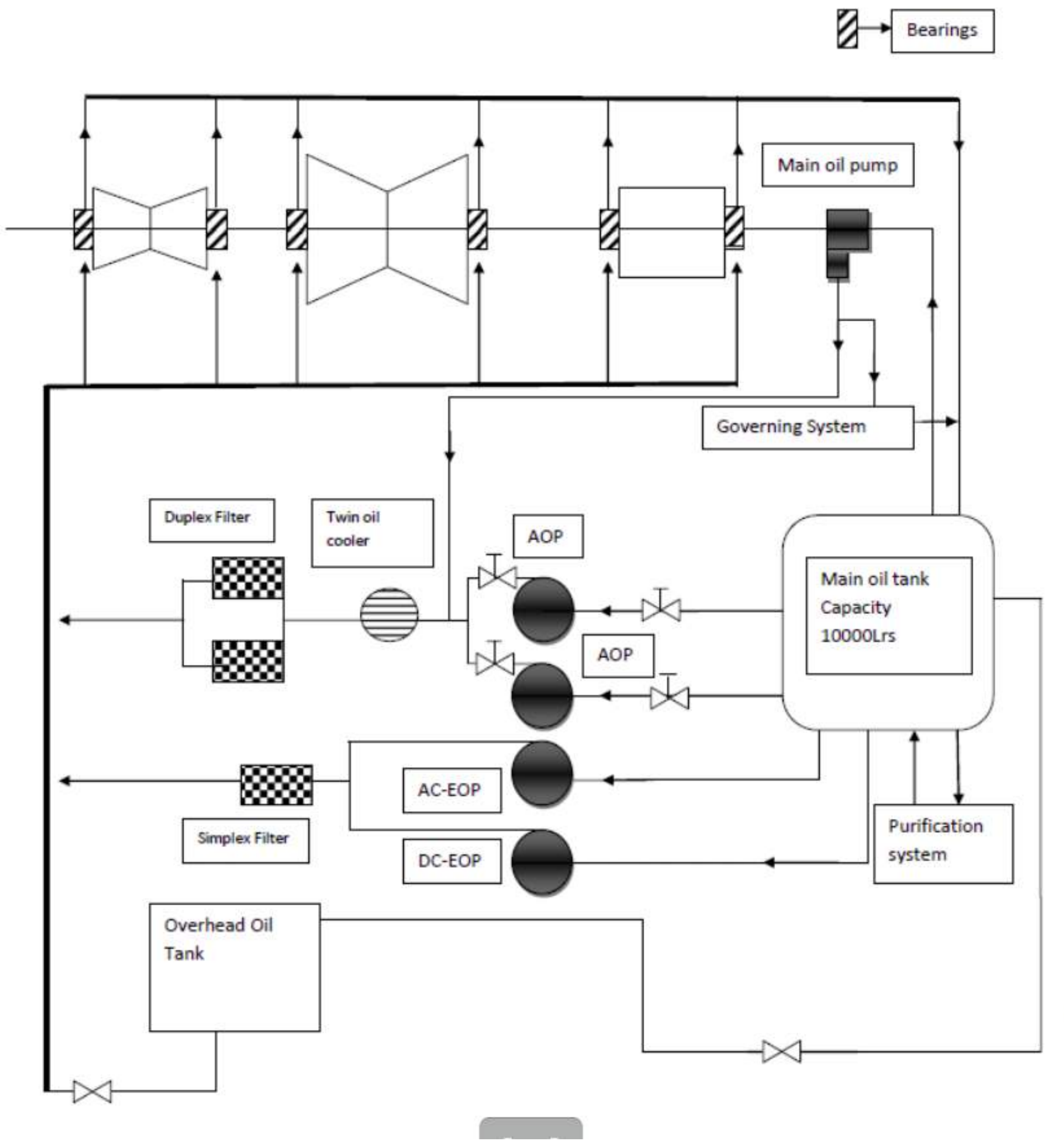
Type	DC-EOP
Pump Sr. No.	110582
Pumping Head	45.45 m
Rate of flow	30 m^3/hr
Radial SKF	6309
Thrust SKF	2 X 7310
Casing Hyd. Tst	29 Kg/cm^2
Speed	3000 rpm

DC Emergency Oil Pump at P&BS 2 STB

Type	AC-EOP
Pump Sr. No.	110581
Pumping Head	45.45 m
Rate of flow	30 m^3/hr
Radial SKF	6309
Thrust SKF	2 X 7310
Casing Hyd. Tst	29 Kg/cm^2
Speed	2920 rpm

AC Emergency Oil Pump at P&BS 2 STB

7.12 Single Line Diagram



7.13 STB Load Calculation

AOP	3 X 1680 = 2 X 55 110 kW
CEP	9 X 110 = 2 X 55 110 kW
Aux. Load	400 kW
Total Rated Load	620 kW
Act. Load(80%)	**496 kW**

Chapter 8

Circulating Water and Pump House

8.1 Overview

Circulating towers are the devices that take heat from the cooling water to cool them for condenser heat removal. The heat is rejected to the atmosphere. The cooling towers can be further divided as Wet type and Dry type.

8.1.1 Wet Cooling towers

Wet cooling tower have showers that sprays hot water over horizontal packing. The outside air enters the tower through louvers on the side of the tower. The water evaporated is directly proportional to cooling. Cold water is collected in a concrete basin and is pumped again to the condensers.

The minimum temperature to which water can be cooled is the adiabatic saturation or wet bulb temperature of the ambient air. At this temperature, the air is 100 cannot absorb more moisture.

A Cooling tower is specified by

$$Approach(A) = (Exit\,Temperature\,of\,C.W.) - (WBT\,of\,ambient\,air)$$

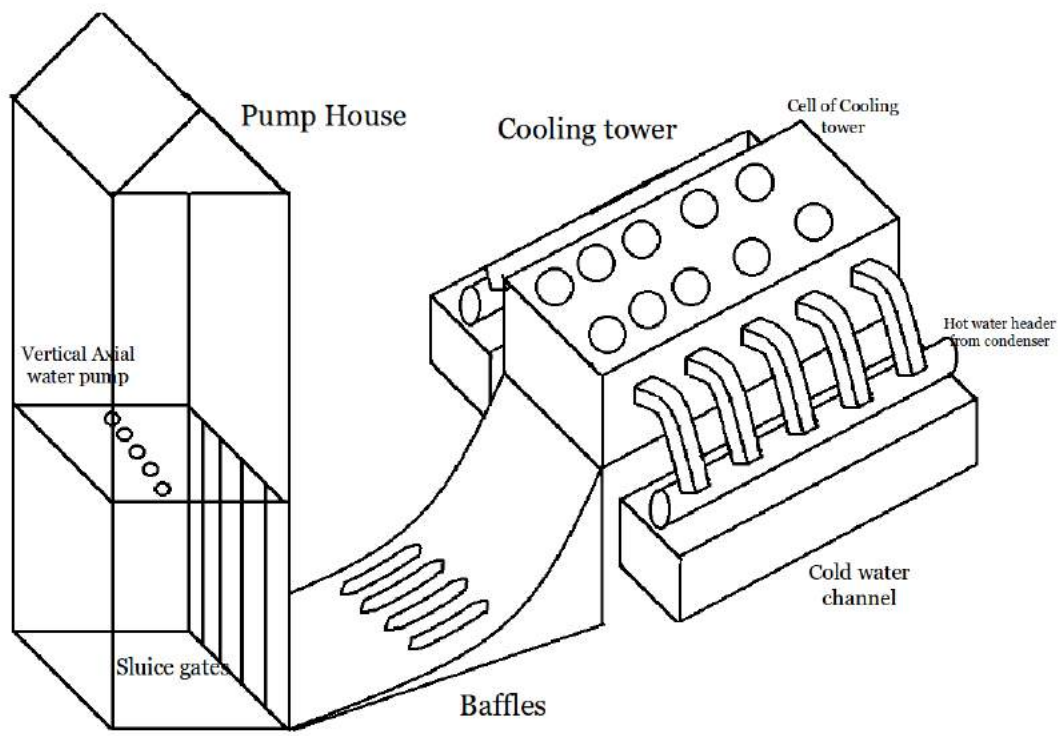
where WBT stands for Wet Bulb temperatue which is the temperature a parcel of air would have if it were cooled to saturation (100% relative humidity) by the evaporation of water into it, with the latent heat being supplied by the parcel.

Also the cooling efficiency is defined as

$$\eta = \frac{Actual\,Cooling}{Maximum\,possible\,Cooling}$$

We have 10 cooling cells with 9 working and 1 standby. Temperature reduces from 42° to 34° at supplied to STG and STB condensor. Its cooling capacity is 19655 m^3/hr. It has 5 vertical axial flow pumps with 3 working and 2 for standby. Water sump in pump house is 8.5 m deep.

8.2 Diagram



8.3 CWPH Load Calculation

CW Pump	3 X 1680 = 5040 kW
CT Fans	9 X 110 = 990 kW
Aux. Load	70 kW
Total Rated Load	6100 kW
Act. Load(80%)	**4880 kW**

8.4 Single Line Diagram

Click here for detailed image.

Chapter 9

Conclusion

The Power and Blowing Station is one of the most important station of Bhilai Steel Plant. The production of cold air blast is carried out in STB unit and is taken to the various blast furnaces for further conversion to the hot air blast. The waste gases from the blast furnaces and other units mainly coke oven are used as fuel to produce the cold air blast thereby reducing the fuel requirement and hence the overall efficiency of the plant. The project tries to explain various processes and equipments used in the production of cold air blast for the blast furnace. The various equipments for example Boiler, Condenser, Turbo-Blowers, Deaerator, Steam jet air ejector, lubrication system etc. have been studied.
From our calculations we concluded that total PBS-2 actual load is approximately **11678kW**
Usually there is the aim to minimize the friction losses, heat losses and drain leakage in steam lines of any power plant. Often, this is the primary goal and proper utilization of pipe length (shortest route to carry steam), proper insulation and installation of well working drain valve are favorable solution. However, in Bhilai steel plant, most of the plants use old technology, therefore only a very small proportions of waste steam is utilize including turbo blower and turbo generator condensate (initially exhauster steam also feeds back to boiler but not now).
At present all the consumers of PBS don't feed condensate back to the boiler this is the biggest loss because we demineralized water for water this require a lot of input. So utilization of used steam by condensing might reduce the steam losses and will increase power plant efficiency to a remarkable extent. Insulation is the main factor in heat losses, glass wool (or mineral wool) with aluminum coating is commonly used, according to diameter of standard value of insulation is provided. But provided insulation should be repaired within a time interval but as it is seen in BSP many steam pipe lines not having proper insulation which are leading huge heat losses. Friction losses can be minimized by avoiding unnecessary bend, trap (for drain), reducer and expander in steam line.
This study will result in a net return to any integrated steel plant by the recovery of steam losses. Recovery of steam losses will result reduced specific fuel consumption and which lead

reduced cost of fuel and substantial reduction in steam generation cost through this work i.e. proper insulation, proper trap for drain. Implementation of this solution will definitely increase overall efficiency of power plant. BSP is not too far to recover all their pipe line insulation and proper maintenance of steam line.

All materials related to our project can be found on this GitHub repository.

https://github.com/him1411/ps-project-eee

The end