Draft Report on

Environmental Impact Assessment Study

5x660MW (Super-critical) Thermal Power Project

Village -Bhadreswar
Taluka -Mundra
District - Kutch
State -Gujarat

Project by

Kutch Power Generation Limited

Prepared by

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TABLE OF CONTENT

List of Figures

Abbreviation

KPGL	:	Kutch Power Generation Limited
EC	:	Environmental Clearance
MoEF	:	Ministry of Environment and Forest
GETCO	:	Gujarat Energy Transmission Corporation Limited
PGCIL	:	Power Grid Corporation of India Limited
MPSEZ	:	Mundra Port and Special Economic Zone
EIA	:	Environment Impact Assessment
TOR	:	Terms of reference
PLF	:	Plant Load Factor
ODC	:	Over Dimension Consignment
ESPs	:	Electrostatic Precipitators
PPA	:	Power Purchase Agreements
MCR	:	Maximum Continuous Rating
IDF	:	Induced Draft Fan
PA	:	Project Authority
LDO	:	Light Diesel Oil
MVA	:	Million Volt Ampere
NIO	:	National Institute of Oceanography
IDCT	:	Induced draft counter flow cooling tower
RO	:	Reverse Osmosis
MMT\	:	Million Metric Tone
HCSD	:	High Concentration Slurry Disposal
HFO	:	Heavy Fuel Oil
EPC	:	Engineering, Procurement and Construction
DCS	:	Digital Control System
AAQ	:	Ambient Air Quality
RSPM	:	Respirable Suspended Particulate Matter
SPM	:	Suspended Particulate Matter
AAQM	:	Ambient Air Quality Monitoring

USEPA	:	US Environmental Protection Agency
GLCs	:	Ground level concentration
OSHA	:	Occupational Safety and Health Administration
CHP	:	Coal Handling Plant
CEA	:	Central Electricity Authority
EAC	:	Expert Appraisal Committee
GPCB	:	Gujarat Pollution Control Board
R&R	:	Resettlement and Rehabilitation
MSIHC	:	Manufacture, Storage & Import of Hazardous Chemicals Rules
SMPV	:	Static & Mobile Pressure Vessels
EOT	:	Electrically Operated Cranes
MCB	:	Miniature Circuit Breaker
MCC	:	Motor Control Centers
PCCs	:	Power Control Centers
DBs	:	Distribution Boards
PFEs	:	Portable Fire Extinguishers
ECC	:	Emergency Control Center
SE	:	Superintending Engineer
ICC	:	Incident Control Coordinator
EMP	:	Environment Management Plan
CDM	:	Clean Development Mechanism
UNFCCC	:	United Nations Framework Convention on Climate Change

1. INTRODUCTION

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1.1 INTRODUCTION

The Adani Group, an emerging conglomerate has decided to enhance the power generation capacity and has floated a special purpose vehicle Kutch Power Generation Limited" (KPGL), which is planning to set up 5X660 MW Coal Based Thermal Power Plant at village Bhadreswar Taluka- Mundra, District- Kutch, Gujarat.

1.2 BACKGROUND OF THE STUDY

As per Environment Impact Assessment Notification dated 14th September 2006, operation of power plants above 500MW requires Environmental Clearance (EC) from MoEF as category 'A' project before the commencement of ground activity.

Kutch Power Generation Ltd has appointed GIS Enabled Environment and Neo-graphic Centre in association with Envirotech East Private Limited to prepare the Environment Impact Assessment report for the 5x660 MW coal-based Thermal Power Plant at village Bhadreswar of Taluka-Mundra, District-Kutch, Gujarat to facilitate environment clearance for the same from Ministry of Environment and Forest (MoEF), Govt. of India.

1.3 PURPOSE OF THE REPORT

The purpose of the report is to integrate different environmental factors into project planning and decision making by studying probable changes in the various socio-economic and bio-physical characteristics, which will result from the proposed project, so as to achieve ecologically sustainable development. The purpose of the study is to identify Environmental risks, reduce conflicts by promoting community participation, minimize adverse Environmental Impacts and keep decision makers informed thus laying base for Environmentally sound Project, such that the benefits shall be observed at all the stages of the Project starting from conceptualization to planning, design, construction, operation, decommissioning and site closure.

The process of EIA has been developed with the prevalent laws and local practices by understanding the interlinkages and dynamics between various activities in order to assess direct, indirect and cumulative impacts on physical and social environments for evaluating the nature of impacts and provide suitable mitigation measures.

Demand for electrical energy in Gujrat has been steadily increasing with the progressive expansion of the electrical supply system covering larger areas population and industries. The task of economic development is very closely linked with uninterrupted and adequate supply of power. Most of the activities leading to income generation as well as the general improvement of the infrastructure facilities require a reliable source of power. Since, power is the wheel for any development, the surrounding villages, neighboring states & particularly Gujrat state would get maximum benefits out of this project. The benefits would be realized by upcoming of industries and its allied ancillary units. Other benefits would be generation of either direct or indirect employment to the local community. The ensured and reliable supply of power to upcoming industries and surrounding region would be a boon for development.

1.4 PROJECT JUSTIFICATION

The station is planned as an Independent Power Producer which will sell power to Gujarat state, other state distribution companies and other identified consumers through the GUVINL, GETCO and PGCIL system. Since the project shall supply to more than one state, efforts will be initiated to obtain Mega Power status from MoP.

Govt. of India has envisaged capacity addition of 1,00,000 MW by 2012 to meet its mission of Power to All. Achievement of this target also requires large capacity projects at private level to meet the requirements of number of states. It has been seen that gap between peak demand & availability for Western region states is to the tune of 26.5 % & it can be further reduced in near future in Western region unless all out efforts are made to add capacity considering fuel availability & evacuation system.

The nearby area of the project site is under development by the Mundra Port and Special Economic Zone (MPSEZ) along with Port and Other upcoming Industries. Mundra Port and the nearby SEZ area are fast emerging as a gateway port for the productive, landlocked Northwestern hinterland of the country. Reliable availability of power is one of the crucial considerations for any such development.

1.5 LOCATION AND NATURE OF THE PROJECT

The site is located near Village Bhadreswar, Mundra, Kutchh District of Gujarat State. The details of the location are given in Table1.1 & figure 1.1.

Table-1.1: Location & Nature

Project Site	**Village:** Bhadreswar **Taluka:** Mundra **District:** Kutch **State:** Gujarat
Habitat in Vicinity	Households (within 10 km): 3246 Population (within 10 km): 15952
Total no of villages in Impact Zone	15
Source of water	• Water will be sourced from Gulf of Kutch. • The total requirement of water will be 5,25,000m^3/hr
Nearest Railway Station	Anjar (20 kms) & Gandhidham (35 kms)
Road Connectivity	8 km from NH-8A
Nearest Water Body	2.0 Km (Mithi River)
Nearest Sea Coast	0.7 Km (Gulf of Kutchh)
Site Contour	15 – 22m
Land-use	About 30% Agriculture Land
Source of Water	Sea water(3.5 kms)
Source of coal	Blended coal (imported and Indian) will be used for the project Indian Coal will be sourced through long-term linkages Annual Coal Requirement: 13.98 MTPA

Figure 1.1 Location of the Project Site

The general Conditions applicable to set up a Thermal Power Plant (TPP) have been adhered to while selecting the present site. The location of the proposed TPP is not within 10 km radius from the outer periphery of the following:

- Metropolitan Cities.
- National Park and wildlife sanctuaries.
- Ecologically sensitive areas like tropical forests, important lakes, coastal areas rich in coral formation, etc.
- The chimney does not fall in the landing funnel of nearest airport.
- No forestland or prime agricultural land is being taken for setting up the plant.
- The site is not in the vicinity (10 km) of places of archaeological importance.
- Places of religious importance within 10 KM are Chowkhanda Mahadev Temple and Bhadreswar Jain Temple.

1.6 SCOPE OF THE STUDY

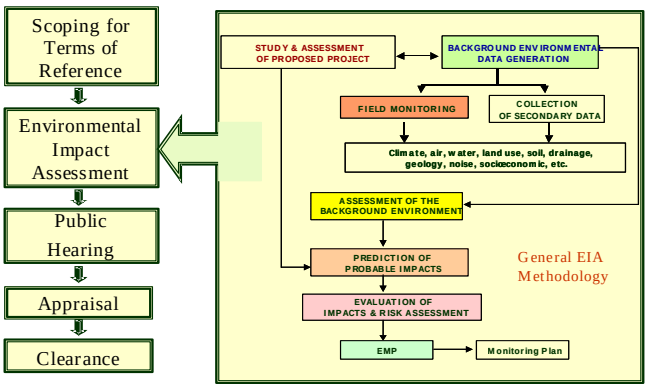
- To conduct literature review and collect the data relevant to study area.
- To undertake environmental monitoring so as to establish the baseline environmental status of the study area.
- To identify existing pollution load due to various activities in the ambient levels.
- To identify the basic environmental status including the meteorological parameters and socio-economic environment of the proposed study area.

- To predict incremental levels of pollutants in the study area due to the proposed plant activities.
- To evaluate the predicted impact on the various environmental attributes in the study area by using scientifically developed and widely accepted environmental impact methodologies.
- To prepare an environmental management and monitoring plan outlining the measures for improving the environmental quality for environmentally sustainable development.
- To prepare Risk Assessment and Disaster Management Plan and undertake Additional studies if required.

1.7 PROCESS FOR OBTAINING ENVIRONMENT CLEARANCE

The projects are classified into Category A or Category B projects based on spatial extent of potential impacts on human health and natural and man-made resources. The Category A projects require prior clearance by the MoEF, Govt. of India while the Category B projects have to get clearance from the state government for this purpose. The environmental clearance process for new projects will comprise of a maximum of four stages these four stages in sequential order are:-

Figure 1-2: Steps of Environmental Clearance for Category 'A' Projec



- Stage (1) Screening (only for Category 'B' projects and activities)
- Stage (2) Scoping
- Stage (3) Public Consultation
- Stage (4) Appraisal

Stage (1) Screening: It refers to the definite assignment of environmental category to projects or activities where the same is not completely specified. In case of Category 'B' projects scrutiny of application at State level to categorize project in 'B1' or 'B2' is done. The B2 projects do not require EIA Reports. Since this project comes under category 'A' so it doesn't need screening.

Stage (2) Scoping: It refers to the process by which the Expert Appraisal Committee in the case of Category 'A' projects or activities, and State level Expert Appraisal Committee in the case of Category 'B1' projects or activities, including applications for expansion and modernization or change in product mix of existing projects or activities, determine detailed and comprehensive terms of reference (TOR) addressing all relevant environmental concerns for the preparation of an Environment Impact Assessment (EIA) report in respect of the project or activity for which prior environmental clearance is sought.

Stage (3) Public Consultation: It refers to the process by which the concerns of local affected persons and others who have plausible stake in the environmental impacts of the project or activity are ascertained with a view to taking into account all the material concerns in the project or activity design as appropriate. The public consultation takes part in two steps: Pubic Hearing and written responses.

Stage (4) Appraisal: means the detailed scrutiny by the expert appraisal committee or state level expert appraisal committee of the application and other documents like the final EIA report.

1.8 STRUCTURE OF THE REPORT

The overall contents of the EIA report follow the list of contents prescribed in the Gazette Notification on Environmental Clearance" issued by Ministry of Environment & Forests, Govt. of India vide no. SO 1533 dated 14th September 2006. The report consists of ten chapters and the contents there in is briefly described in this section.

Chapter 1: Introduction

The present chapter 1 gives brief outline of the project and its Proponent, brief description of the nature, size, and location of the project and its importance, extent of the EIA study, including the scope of the study.

Chapter 2: Project Description

The description of the power generation process and the various features of the proposed power plant incorporating utilities, water, fuel requirements are described in this chapter.

Chapter 3: Description of the Environment

This chapter presents the methodology and finding of the field studies covering physical, biological and socio-economic environments, carried out to ascertain the

baseline environmental condition of the study area. It includes the information regarding physical environment, water environment, air environment, soil environment, noise environment, ecological environment, & the socio economic baseline settings of the area.

Chapter 4: Anticipated Environmental Impacts & Mitigation Measures

This chapter provides details of the environmental impact assessment of the project during construction and operational phase. It expresses the impacts of the proposed project on the various components of environment. The mathematical modeling exercise pertaining to prediction of ground level concentration of air pollutants have also been dealt in this chapter. Mitigation measures are suggested along with the impact prediction.

Chapter 5: Analysis of Alternatives

This chapter describes systematic comparisons of feasible alternatives for the proposed project site, technology, and operational alternatives. Alternatives have been compared in terms of their potential environmental impacts, suitability under local conditions, and institutional training and monitoring requirements. For each alternative, the environmental costs and benefits have been quantified to the extent possible. Economic values have been attached wherever feasible and the basis for the selected alternative has been stated.

Chapter 6: Environmental Monitoring Program

The monitoring of environmental parameters in construction as well as operation phase of the project for assessing the impact and the organization structure, which will be responsible for environment monitoring have been detailed in this chapter.

Chapter 7: Additional Studies

This chapter provides details of the public consultation, risk assessment and social impact assessment. It includes information regarding the activities associated with the project likely to pose a risk to man, environment or property. Such activities include transport, storage, handling and usage of fuels (Coal and LDO), hazardous Chemicals, Acids and Alkali. Computation of risk assessment has been covered in this chapter. It also provides details regarding precautionary measure to be taken. This section presents a brief outline of impact and respective management plan to address socio-economic conditions.

Chapter 8: Project Benefits

This chapter includes the benefits likely to accrue and improve the physical & social infrastructures for the local community in particular and region in general.

Chapter 9: Environment Management Plan

This chapter deals with the management plan incorporating recommendations to mitigate the adverse impact likely to occur on environmental parameters during construction and operation phase of the proposed power plant. Post project monitoring & organization structure for environment management have been provided in the chapter.

Chapter 10: Clean Development Mechanism

This chapter deals the Kyoto Protocol allowing industrialized countries with a greenhouse gas reduction commitment to invest in emission reducing projects in developing countries as an alternative to what is generally considered more costly emission reductions in their own countries.

Chapter 11: Disclosure of Consultants Engaged

The detailed profile of the consultants along with their capabilities and experience are highlighted in this chapter.

2. PROJECT DESCRIPTION

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2.1 INTRODUCTION

Kutch Power Generation Limited is proposing to set up 3300 (5X660) MW Coal-based Super-critical (Open Cycle) Thermal Power Plant at Village-Bhadreswar, Taluka-Mundra, Kutch District, Gujarat. Because of high generation capacity, the proposed project will meet the power demand of a number of states through transmission of power on regional and national basis.

2.2 PROJECT LOCATION

The site is located at Latitude 22° 53' 18.4" North and Longitude 69° 52' 01.6" East Coordinates in Village-Bhadreswar, Taluka-Mundra, Kutch District, Gujarat. The details of the location are given in **Table 2.1**. The project area has been shifted further by 50 mtr. away from 500m. setback line.

Table 2.1 Location of the Project Site

Location	**Village:** Bhadreswar **Taluka:** Mundra **District:** Kutch **State:** Gujarat
Latitude	22°53'18.4"N
Longitude	69°52'01.6"E
Nearest Railway Station	Anjar (20 kms) & Gandhidham (35 kms)
Road Connectivity	8 km from NH-8A
Nearest Water Body	2.0 Km (Mithi River)
Site Contour	15 – 22m
Land-use	About 30% Agriculture Land
Source of Water	Sea water(3.5 kms)
Nearest Sea Coast	0.7 Km (Gulf of Kutchh)

2.3 BASIC REQUIREMENT

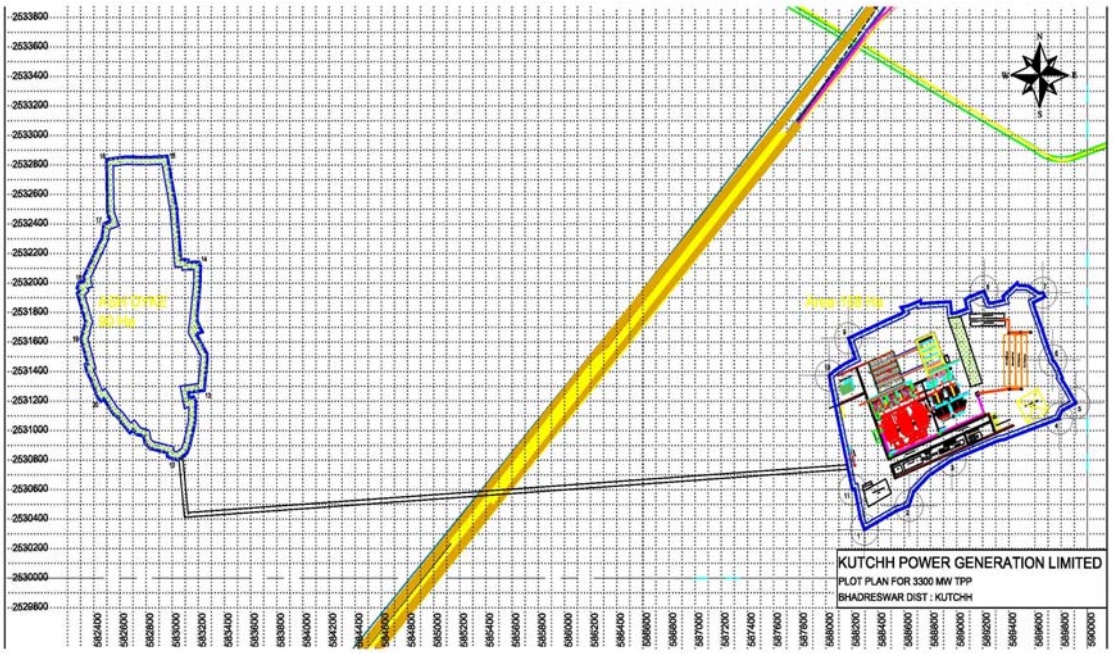
2.3.1 Land Requirement

The total land requirement is estimated at 315 Ha. The above estimate considers space requirement for main plant as per configuration discussed which also includes railway line, coal storage, ash handling system with storage and dispatch unit, transformer and switchyard, ash dyke, waste

Table2.2 Land details of Plant area

Plant Details	Total 3300 MW (5x660 MW)
Plant Area	130.00 Ha
Green Belt	95.00 Ha
Ash Pond	90.00 Ha
TOTAL	**315.00 Ha**

water treatment facility including guard pond, green verge as per the MoEF norms. Details of the proposed plant layout are shown in **Figure 2.1** and **Table 2.2.**



LOCATION	COORDINATES		8	22⁰53'40.1"N	69⁰52'12.3"E
1	22⁰52'47.7"N	69⁰51'39.8"E	9	22⁰53'29.8"N	69⁰51'35.9"E
2	22⁰52'52.8"N	69⁰51'51.9"E	10	22⁰53'21.7"N	69⁰51'30.6"E
3	22⁰53'02.8"N	69⁰52'03.5"E	11	22⁰53'4.15"N	69⁰48'35.37"E
4	22⁰53'11.8"N	69⁰52'32.2"E	12	22⁰53'47.64"N	69⁰48'47.64"E
5	22⁰53'18.2"N	69⁰52'36.8"E	13	22⁰54'11.12"N	69⁰48'33.17"E
6	22⁰53'24.8"N	69⁰52'30.7"E	14	22⁰54'10.27"N	69⁰48'16.97"E
7	22⁰53'39.6"N	69⁰52'28.1"E	15	22⁰53'42.19"N	69⁰48'8.86"E

Figure 2.1 Plant Layout with co-ordinates & Ash dyke location

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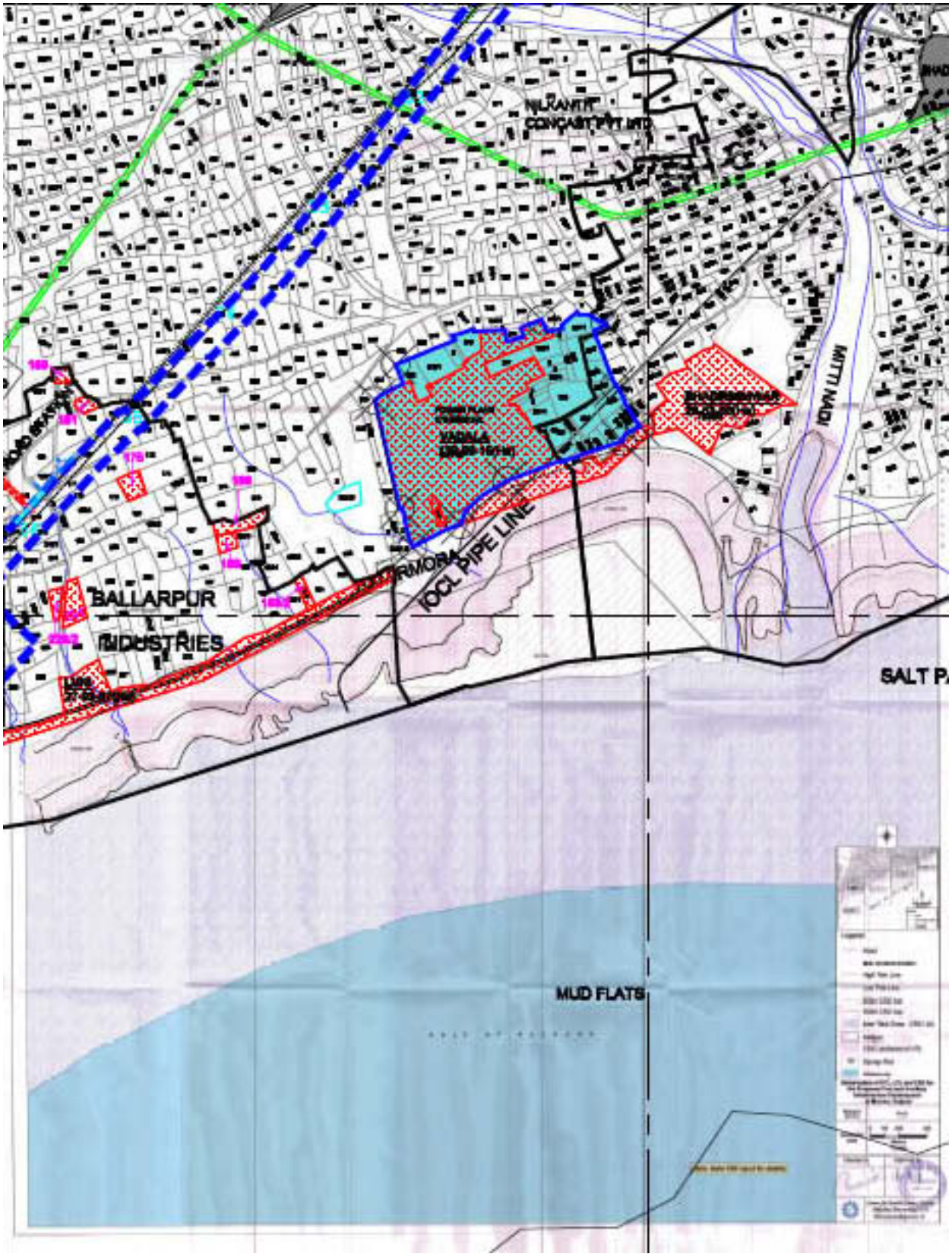

BALLARPUR
INDUSTRIES
IOCL PIPE LINE
MUD FLATS

2.3.2 Water Requirement

The power station has to depend on seawater to meet both consumptive and cooling water requirements due to non-availability of sweet water either from the surface water sources or underground sources on a sustained basis. Accordingly seawater will be drawn from Gulf of Kutchh as per recommendation given by NIO. The total sea water requirement for both consumptive and cooling water along with Desalination Plant for the power plant will be 5,25,000 m^3/hr.

2.3.3 Fuel Requirement

Main Fuel – Coal

The fuel used for Thermal Power Plant will be Blended Coal (Imported / Indian in the ratio of 70:30). The average calorific value of washed Indian coal will be 4000 kcal/kg, while the average calorific value of imported coal will be 5200 kcal/kg. The coal will be imported from the countries like Indonesia, China and Australia through Adani Port. The coal will be transported from Adani Port to the proposed site by dedicated railway line and the Indian coal will be transported through railway to the proposed site from the coal linkages source.

The estimated coal requirements for 5x660 MW as planned follows:

Station Heat Rate for 660 MW set	:	*2150 KCal/kWh*
Average GCV of Indian Coal	:	*4000 KCal/kg*
Average GCV of Imported Coal	:	*5200 Kcal/kg*
Daily Coal Requirement for 3300 MW	:	
i.e. 5x660 MW Station@ 90% PLF	:	*38301 TPD*
Annul Coal Requirement for 3300MW	:	
i.e. 5x660 MW Station@ 90% PLF	:	*13.98 MMT / Annum*
Auxillary Fuel:	:	
Light Diesel Oil	:	26,017 KL/annum

FUEL ANALYSIS:

Parameters	**Domestic coal**	***Imported coal***
G.C.V. (Kcal/Kg)	4000	5200
Sulphur (%)	0.4	0.5

Ash (%)	< 34	<25
Pb (mg/Kg.)	< 5	< 5
Cr (mg/Kg.)	< 5 - 10	< 5 – 10
As (mg/Kg.)	< 0.02	< 0.02
Hg (mg/Kg.)	< 0.02	< 0.02

2.4 INFRASTRUCTURE FACILITIES

The infrastructural facilities, which are considered essential during early stage i.e. construction stage are:

- Access roads and rail network
- Water supply
- Power grid
- Communications (internet, phone lines and public address system etc)
- Housing facility for the construction staff
- Local availability of skilled and unskilled manpower

With existing infrastructural facilities, the site is near the Mujndra-Gandhidham Railway line. Approach road needs to be developed to ensure movement of heavy equipments/Over Dimension Consignment (ODC) for the plant. Amenities like market, hospital, schools, college, small scale industries to support the local community during the initial phase of construction of the new power plant are available.

2.5 THE PROCESS

In a Thermal Power Plant, the chemical energy of the fuel (coal) is first converted into thermal energy (during combustion), which is then converted into mechanical energy (through a turbine) and finally into electrical energy (through a generator). The schematic diagram of the process of power generation from a coal based thermal power plant is shown in the **Figure 2.2**. The main steps in the process of power generation are briefly given below.

- The coal is transferred from the coal handling plant to the coalbunker through the conveyor belt, from where it is fed to the pulverizing mills, which grinds it to fine powder, which is then mixed with air and blown into the boiler by a fan where it burns like a gas.

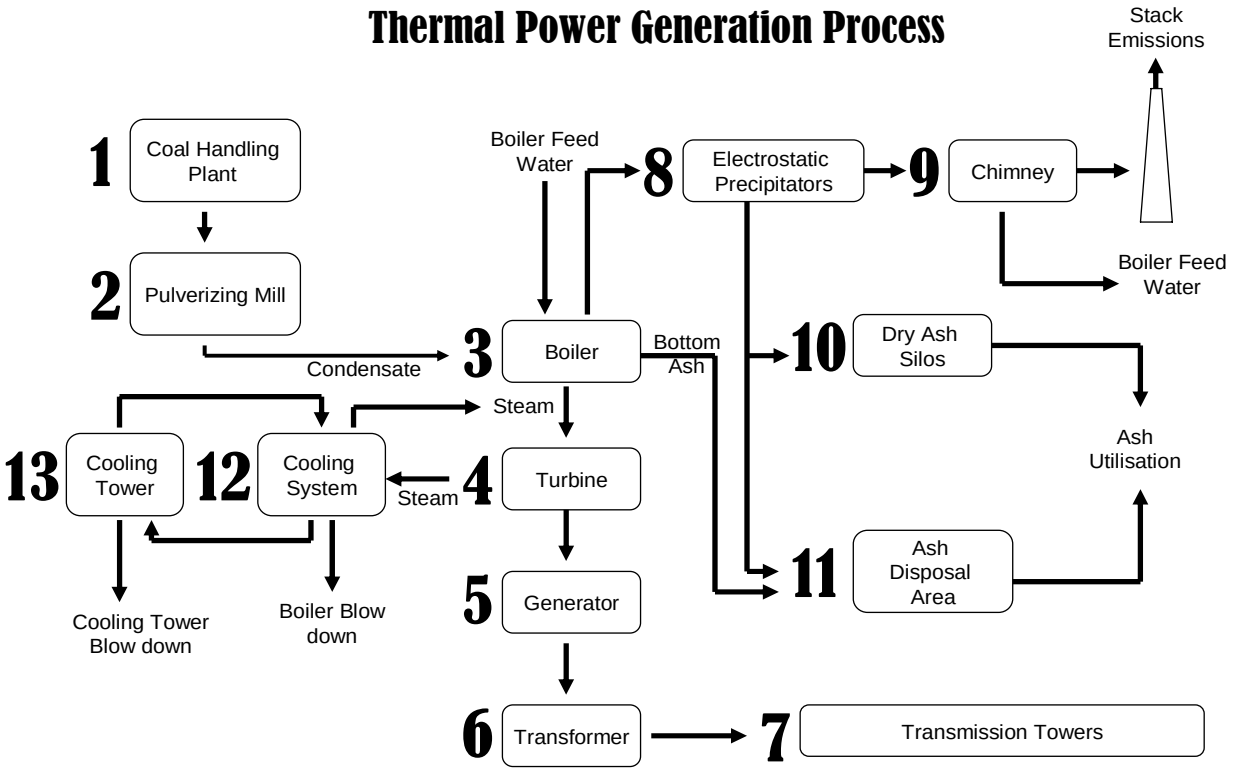


Figure 2.2 Process of Thermal Power Plant

- The process of combustion releases heat energy from coal. The boiler walls are lined with boiler tubes containing high quality de-mineralized water (known as boiler feed water). The boiler tubes absorb the combustion heat and the heat converts the boiler feed water into steam at high pressure and temperature. The steam, discharged through nozzles on the turbine blades, makes the turbine to rotate, which in turn rotates the generator coupled to the end of the turbine. Rotation of generator produces electricity, which is passed to the step-up transformer to increase its voltage so that it can be transmitted efficiently. The power is evacuated via switchyard through a Transmission System.
- During combustion, the non-combustible part of coal is converted into ash. A small part of ash (about 20%) binds together to form small clinker/particulates, which fall into the ash pits at the bottom of the furnace. This part of ash, known as bottom ash is water quenched and then conveyed to pits for subsequent disposal to ash disposal area or sale.
- Major part of the ash (about 80%) is in fine powder form, known as Fly Ash, and is carried out of the boiler along with the flue gas. The flue gas, after

heat recovery, is passed through the electrostatic precipitators, where electrodes charged with high voltage electricity trap the ash.

- The flue gases exiting from the Electrostatic Precipitators (ESPs) are discharged through a tall chimney for wider dispersal of remaining ash particles and gases. The ash collected in the ESP hoppers is extracted in dry form and conveyed to dry ash storage silos from where it is supplied to user industries.
- It is proposed to utilize power plant ash to maximum extent.
- The Steam, after passing through the turbines, is condensed back into water in condensers and it is re-used as a boiler feed water for making steam. The reasons for condensing and reusing the steam are following:

➢ The cost of Boiler feed water is very high as it is very pure de-mineralized water hence reuse is economical.
➢ The use of condenser lowers the temperature at the exit end, and hence increases the efficiency of the turbine.
➢ The condenser contains tubes through which cold water is constantly pumped. The steam passing around the tubes of condenser looses heat and condenses as water. During this process, the steam gets cooled while cooling water gets heated up and system adopted is once through cooling.

2.6 POWER EVACUATION

The total power generated from the station will be 3300 MW. After meeting the power requirement of the station auxiliaries, rest of the Power will be available for evacuation. The generator will be connected to the switchyard through the generator transformer. Start up power will be derived from the switchyard through the Station transformers.

It is proposed to off take/sell power generated from the station at 400 KV / 500 KV level to Gujarat or other states utilities through existing / proposed Gujarat Energy Transmission Corporation Limited (GETCO) & Power Grid Corporation of India Limited (PGCIL) system to other deficit states. Study for grant of open access to the project through PGCIL shall also be initiated. Accordingly suitable Power Purchase Agreements (PPA) shall be drawn with both PTC and DISCOM of the state.

2.7 TECHNOLOGY

The proposed plant will be using super-critical technology. The thermal efficiency of the power plant can be improved by using the steam at super critical condition. The

improvement in overall efficiency of the plant compared to sub critical parameters will be at least 2% if the super critical parameters are implemented. The "efficiency" of the thermodynamic process of a coal-fired power describes how much of the energy that is fed into the cycle is converted into electrical energy. The greater the output of electrical energy for a given amount of energy input, the higher the efficiency. A thermal power plant based on supercritical technology is more efficient than a subcritical plant, producing more power from less coal and with lower emissions.

Importance of Efficiency: Since the time thermal power stations have been engineered, there is a quest for efficiency improvement. One such effort in that direction is supercritical parameters (i.e.) the pressure above 225kg/cm^2 and temperature above 374.15ºC. The supercritical parameters for Kutuch 5x660 MW boilers are: 258kg/cm^2 of pressure and 540ºC SH and 568ºC RH of temperature.

Methods of Increasing Rankine Cycle Efficiency: The steam power cycle efficiency can be improved by the following methods:

- **Raising supply temperature by super heating:** Increasing the turbine inlet temperature of steam will raise the heat supply to the boiler more than the heat rejection.
- **Raising inlet pressure of steam:** Increasing the pressure will mean increase in saturation temperature at which steam evaporates thus increasing the average inlet temperature (T_1).
- Efficiency can be improved by dropping the final pressure (or temperature) at which heat is rejected.
- **Regenerative heating:** Heating the feed water pumped to the boiler by bleeding steam from turbine.
- **Reheat cycle:** Reheating of steam in boiler after it has already expanded in high pressure (HP) turbine will avoid moisture formation in low pressure (LP) Turbine. Also more heat content of steam before LP turbine will improve efficiency.

Supercritical Conditions

The critical condition of water: Critical pressure = 225 Kg/cm^2

Critical temperature = 374.15º C

At most elevated condition the steam is supercritical. Thus, if water is at a supercritical pressure and is heated the temperature will increase continuously. At a particular value the water will flash instantaneously into steam and super heating will

commence. There is no change of specific volume from the liquid to the dry steam state.

Supercritical Boiler

Supercritical boilers are used for the generation of electric power. They operate at "supercritical pressure". In contrast to a "subcritical boiler", a supercritical boiler has no water - steam separation. Thus, the fluid generated is called "supercritical fluid". It passes below the critical point as it does work in the high pressure turbine and enters the generator's condensor. This is more efficient resulting in slightly less fuel use and therefore less greenhouse gas production.

Benefits of Supercritical thermal cycle technology

- Reduced fuel costs due to improved plant efficiency.
- Significant reduction in CO_2 emissions.
- Excellent availability, compared to conventional sub-critical plant.
- Plant costs comparable with sub-critical technology and less than other clean coal technologies
- Much reduced NOx, SOx and particulate emissions
- Overall reduction in Auxiliary Power Consumption
- Reduction in requirement of ash dyke land and consumptive water.
- Sliding pressure operation due to once through system.
- Uniform distribution of heat due to spiral wall arrangement leading to less Boiler tube failure, thereby improving system continuity and availability of the station.
- Low thermal stress in turbine.
- Less start up time of the boiler.
- Compatible with biomass co-firing
- Can be fully integrated with appropriate CO_2 capture technology.
- In summary, highly efficient plants with best available pollution control technology will reduce existing pollution levels by burning less coal per megawatt-hour produced, capturing the vast majority of the pollutants, while allowing additional capacity to be added in a timely manner.

2.8 PLANT CONFIGURATION

2.8.1 Thermodynamic cycle

The thermodynamic cycle for 660 MW units will consider super-critical steam parameters comprising the boiler, the steam turbine generator, the condenser, the condensate extraction and boiler feed systems along with all other necessary equipment for single/double reheat-regenerative cycle. For the purpose of the study, the steam parameters at the outlet of the boiler have been considered to be

255 Kg/Cm^2 (abs.), 571 °C with steaming capacity of about 2115 TPH as per the established practice of the manufacturers of units of 660 MW configuration. Corresponding steam parameters at the turbine inlet would be 246 Kg/Cm^2 (abs.) at 566 °C and reheated steam parameters would be about 55 Kg/Cm^2 (abs.) and 566 °C. The HP-IP cylinders may be of single/double casing design as per manufacturers' standard. The exhaust from HP-IP turbine will expand further in the double flow LP Turbines.

The exhaust steam from the LP turbine will be cooled in the main steam condenser by circulation of required quantity of cooling water and its vacuum will be maintained by two of the three (3) 50% capacity vacuum pumps maintaining a backpressure of 76 mm Hg (abs.). The condenser would be twin flow, double pass, horizontal, surface type cooled by circulation of cooling water (inlet water temp. 33 °C max.) in a re-circulating cooling water circuit using wet type cooling tower.

The regenerative feed heating system will consist of four stages of low pressure heaters, one gland steam condenser, one spray-cum-tray type deaerator, 3 high pressure heaters. The condensate drawn from condenser hot well by 2x100% capacity condensate extraction pumps will be pumped to the deaerator through condensate polishing unit, gland steam condenser and the LP heaters. The feed water after being deaerated in the deaerator would be drawn by the boiler feed pumps and pumped to the respective boiler to three (3) higher pressure heaters. Two (2) nos. 50% capacity [two (2) nos. turbine driven and one (1) no. motor driven] boiler feed pumps have been envisaged for each unit.

2.8.2 Steam generator set

The steam generator for super- critical unit consists of a number of parallel circuits connected by inlet & outlet headers. Pressurized water enters the circuit at one end and leaves as supercritical steam at other end. Thus boiler is of "Once-through type". Once-through boiler may be Designed in both two-pass & tower type design. Since flow is once-through furnace wall tube temperature tends to increase at low load. Assisted circulation mode is super imposed to overcome this problem. The volume of the evaporator system is much smaller compared to a Natural circulation boiler. Due to smaller inventory of stored water & steam, theoretical rate of response is much faster than drum unit at base load. Super heater section would be divided in

convection and radiant zones and Designed so as to maintain rated steam temperature of 571 ^{0}C at the outlet over a control range of 50% to 100% of MCR load. The units would be complete with coal preparations and firing system, fuel oil firing system, draft plants comprising FD, ID and PA fans, electrostatic precipitators with required number of fields in series and 275 m high chimney. Light Diesel Oil (Calorific value around 10,300 KCal/Kg) would be used as start-up and stabilization fuel. To limit the dust load at the inlet to the chimney to a value of 100 mg/ Nm^3, as prescribed by MoEF, adequately sized electrostatic precipitators would be provided.

2.8.3 Turbine generator set

The steam turbines would be standard multi-stage, 3000 rpm, tandem compound, single reheat, regenerative, condensing, multi-cylinder unit with eight (8) uncontrolled extractions for regenerative feed water heating. The LP turbine will exhaust against a condenser pressure of 76 mm Hg (abs) and maximum cooling water temperature of 33 °C. A quick acting "HP and LP turbine bypass Station" would be provided as a part of turbine package. The unit will be equipped with all auxiliaries as per good engineering practice.

The steam turbines will be directly coupled to the horizontally mounted, three phase, two-pole, cylindrical rotor type electric generators and will have a nominal rating of 660 MW at generator terminal after meeting power requirement for excitation system. The generation would be of 0.85 power factor and thus the MVA rating works out to be about 776 MVA. The generators will deliver power at the standard voltage of the manufacturer between 20-24 kV, 3 phase, 50 Hz. The generators would have Class-F insulation but rated for Class-B temperature rise. The TG sets would be capable of delivering continuously the rated power at rated power factor when the voltage variation is within ±5% of rated value and also when frequency variation is within 47.5 Hz and 51.5 Hz. The units would be complete with twin flow, double-pass, horizontal, surface type, water cooled condensers, 2 x 100% vacuum pumps, horizontal shell and tube type high pressure feed water heaters with individual bypass arrangement, 4-stage horizontal U-tube type low pressure heaters, gland steam condenser, horizontal two spray-cum-tray type deaerator with integral vent condenser etc. The units would be equipped with two (2) nos. 50% capacity

[two(2) turbine driven and one(1) motor driven] centrifugal, multistage, horizontal, barrel casing construction boiler feed pumps.

2.9 PLANT WATER SYSTEM

The power station has to depend on seawater to meet both consumptive and cooling water requirements due to non-availability of sweet water either from the surface water sources or underground sources on a sustained basis. Water is proposed to be drawn from the Gulf of Kutchh and will be disposed to sea as per the recommendation of National Institute of Oceanography (NIO) along with the necessary approvals from the competent authorities.

Total estimated seawater requirement for the power plant shall be around 5,25,000 m3/hr for all the units. Seawater cooling is proposed for condenser cooling. The "Once through system" for the project is proposed. Water shall be drawn from the sea. Open cycle condenser cooling will be provided for cooling water system.

Adequate capacity of CW Sump shall be provided for pumping cooling water to the condenser and thereafter will be discharged into the sea. Once through cooling by using sea water is proposed for the project.

RO plant

For meeting the requirement of fresh water to the various services, seawater will be passed through Desalination plant comprising of Pretreatment Plant (stilling chamber, flash mixer, high rate clarifier), RO System, Chemical dosing system (coagulant dosing, acid dosing and dosing by SHMP and SMBS), Chlorination System (pre and post) and Post Treatment System (de-carbonization and pH control). The desalinated water will be stored in a storage tank from where it would be distributed for the use. Desalination water available from desalination plant shall be used as drinking water. A pipe network for distribution of potable water for plant will be provided from the overhead storage tanks. Required number of potable water pumps for plant area will be provided. A service water pipe network spread over the entire plant area would be provided for cleaning of main plant area and other buildings.

Adequate measures would be provided to limit the cooling water return temperature as per the guidelines laid down by MoEF.

Since, once through cooling system using sea water is proposed, zero discharge from the project is not feasible. The water balance diagrams for 5x660 MW are enclosed at **Figure – 2.3**

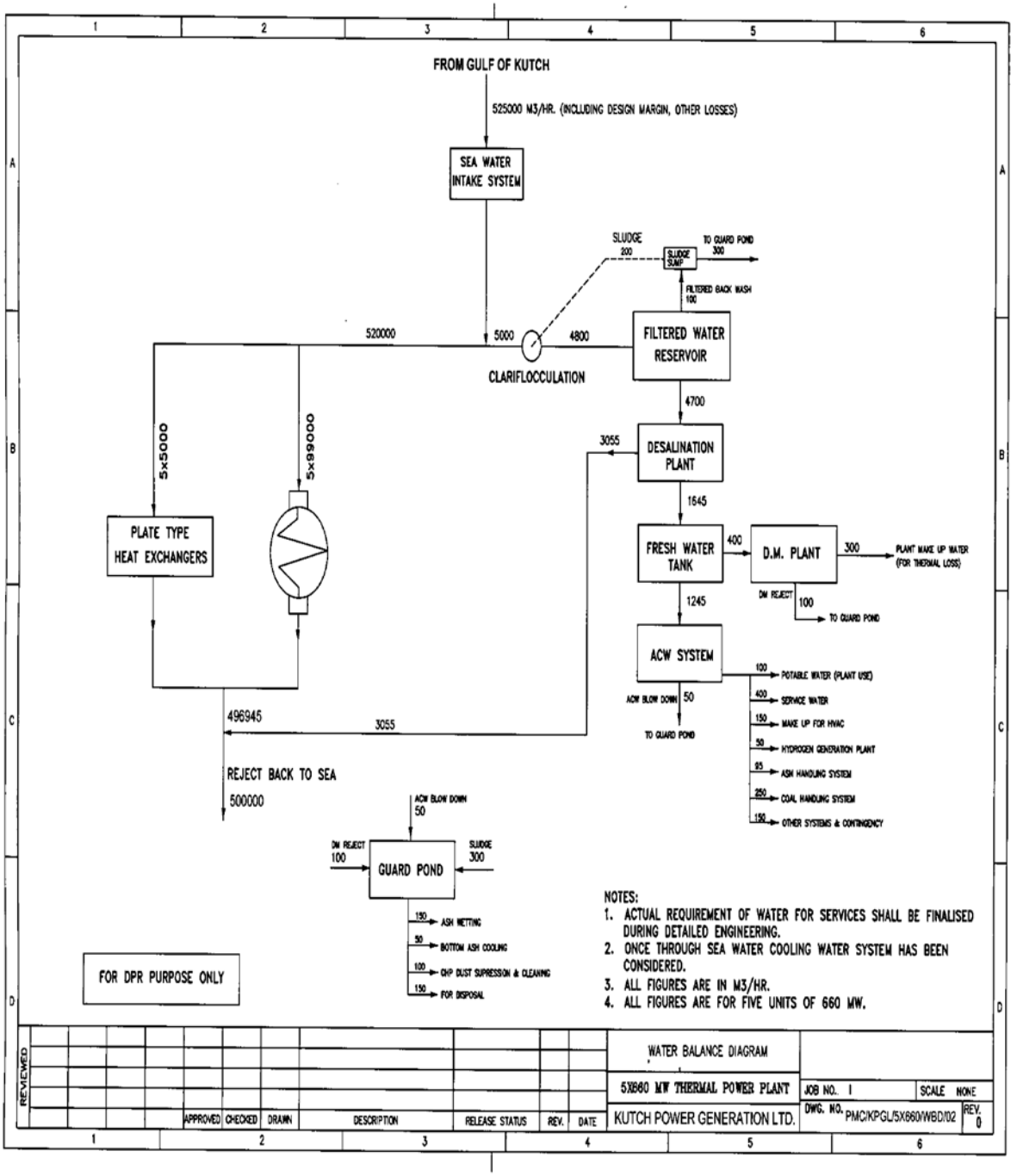


Figure: 2.3 Water Balance Diagram

Effluent Disposal System

3. DESCRIPTION OF THE ENVIORNMENT

3. DESCRIPTION OF THE ENVIRONMENT

3.1 BACKGROUND OF THE STUDY

To assess environmental impacts from proposed project at a specific location, it is essential to monitor the environmental quality prevailing in the surrounding area prior to implementation of the project. The environmental status within the impact zone could be used for identification of significant environmental issues to be addressed in the impact assessment study.

For base-line data collection, an area covering 10 km radius from the proposed project site as the centre has been considered as per EIA guidelines published by the MoEF, Govt. of India. Base line data was collected for various environmental parameters including Air, Water, Land, Flora-Fauna and Socio-economic status to determine quality of the prevailing environmental settings. The study was conducted during post monsoon season (October 2009 to December 2009), and data has been presented in this report.

3.2 METHODOLOGY ADOPTED

For collecting the base line data during the study period, a temporary field office was established at Bhadreswar village. The study team operated from this field station and carried out sampling of soil and water, monitoring of air quality and noise level and other secondary data.

- A meteorological station was setup on the rooftop of a house in Bhadreswar village. Wind speed, wind direction, dry and wet bulb temperature, relative humidity and general weather conditions were recorded throughout the study period in an automated data logger.
- In order to assess the Ambient Air Quality (AAQ), samples of ambient air were collected by installation of High Volume Sampler (with RSPM facility) at different locations within the study area and analyzed for primary air pollutants to work out the existing status of air quality.
- Ground water samples were collected from the existing tube wells, while samples for surface water were collected from steams and ponds. The samples were analyzed for parameters necessary to determine water quality (based on IS: 10500 criteria)

and those, which are relevant from the point of view of environmental impact of the proposed thermal power plant.

- Soil samples were collected and analyzed for relevant physical and chemical characteristics in order to assess the impact of the proposed plant on soil.
- The noise level measurements were also made at various locations at different intervals of time with the help of sound level meter in the study area to establish the baseline noise levels in the impact zone.
- Socio-economic data was collected from field studies and secondary sources like Census of India 2001.
- Inventory of flora and fauna species were collected through field visits and data available with the Forest Office.

3.3 MICRO METEOROLOGICAL ENVIRONMENT

Meteorological aspects consist of the climatic factors, which are prevailing in the area, including temperature, humidity, rainfall, wind speed and direction, etc. The weather prevailing in the study area was studied during the post monsoon season (October 2009 to December 2009).

3.3.1 Meteorological Condition (IMD)

The summary of the 30 year data as recorded by Indian Meteorological Department station at Bhuj is given in **Table 3.1** below:

Table 3.1: Micro-meteorological Data (30Year IMD Data of post monsoon season)

Parameter	Average Maximum	Average Minimum
Temperature (°C)	32.13	15.33
Relative Humidity (%)	67.66	32
Average Wind Speed (kmph)	7.36	
Wind Direction	Predominant wind direction is from NE, N	
Source: IMD Meteorological Station Bhuj		

From the table, it can be observed that during the post monsoon season, the temperature varied between 32.13ºC to 15.33ºC. The average Relative Humidity of the area was found to be 67.66% to 31% and the mean wind speed was 7.36 kmph. The predominant wind direction was NE, & N.

3.3.2 Meteorological Condition On site

The meteorological conditions at the project site will regulate the transport and diffusion of air pollutants released into the atmosphere. Therefore, meteorology is considered as an

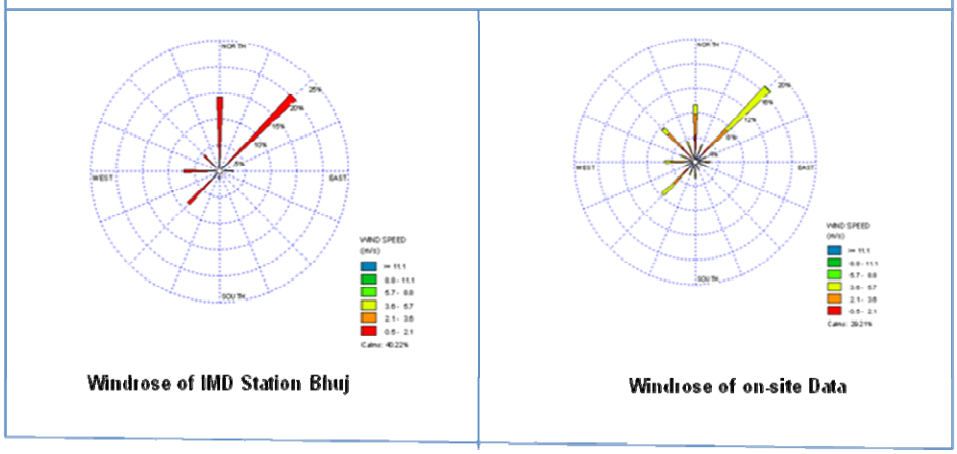
important tool for air pollution assessment. The principal meteorological variables are horizontal convective transport (average wind speed and direction), vertical convective transport (atmospheric stability, mixing height) and topography of the area. The climatology details of the site are given in **Table 3.2**.

Table 3.2: Micro-meteorological Data (on site Data of post monsoon season)

Parameter	Maximum	Minimum
Temperature (°C)	36.2	6.8
Relative Humidity (%)	82.0	42.0
Average Wind Speed (m/s)	6.5	Calm
Wind Direction	Predominant wind direction is from NE & NNE	

Source: GreenC Survey

Figure 3.1 Windrose Diagram



It can be seen from the above table that the temperature recorded during the study period had a minimum reading of 6.8°C and a maximum of 36.2°C. The relative humidity showed a minimum of 42% and maximum of 82% during the monitoring period. The wind varied between calm to 6.5 m/sec with a mean of 2.10 m/s. The predominant wind direction was observed from NE, NNE & NW. The 16 direction wind-rose diagram for the on-site data is depicted in **Figure 3.1.**

Table 3.3 Air Monitoring Location

Location Name	Code	Dis. (km)
Plant Site	AQ1	0.0
Luni Village	AQ2	4.5
Bhadreswar Village	AQ3	2.5
Wadala	AQ4	2.5
Mokha	AQ5	7.0
Bhadreswar	AQ6	4.5
Vovar Satt	AQ7	7.0
Ash Pond Site	AQ8	5.0

3.4 AIR ENVIRONMENT

Kukadsar	AQ9	8.0
Bhadreshwar (Near SH)	AQ10	1.5

The Respirable Suspended Particulate Matter (RSPM), Suspended Particulate Matter (SPM), Sulphur Dioxide (SO_2) and Oxides of Nitrogen (NO_x), Ozone were monitored as significant parameters for ambient air quality as these will be emitted from the plant and for which ambient air quality standards are prescribed. Ten Ambient Air Quality Monitoring (AAQM) Stations were selected based on the criteria used for designing the network. The location (relative direction and distance) of these stations with respect to the project site is given in **Table 3.3 and Figure 3.2.**

3.4.1 Ambient Air Quality

Ambient air quality at ten different locations was monitored during the post monsoon seasons for the period from October, 2009 to December 2009. The analysis was carried out as per the method described in the applicable IS codes. The result of the analysis has been summarized in **Table 3.4** to **Table 3.8.**

Table 3.4 Suspended Particulates Matter (SPM µg/mg3)

S.No	Station Code	Min	Max	Standard Deviation	Average	98 Percentile
1	AQ1	146.0	160.2	4.4	160.1	154.7
2	AQ2	136.4	161.2	6.6	160.7	151.5
3	AQ3	140.3	160.2	5.6	160.1	152.7
4	AQ4	129.8	153.8	7.0	152.6	141.9
5	AQ5	126.4	147.9	5.9	147.0	138.8
6	AQ6	124.3	146.2	5.2	143.4	133.5
7	AQ7	120.5	139.2	5.4	138.6	129.4
8	AQ8	119.5	139.7	5.1	138.1	128.1
9	AQ9	132.4	147.9	4.9	147	139.8
10	AQ10	135.6	153.7	5.2	153.5	143.0

Table 3.5 Respirable Suspended Particulates Matter (RSPM µg/mg3)

S.No	Station Code	Min	Max	Standard Deviation	Average	98 Percentile
1	AQ1	51.4	68.3	5.4	67.8	59.3
2	AQ2	45.3	65.5	5.1	63.5	55.2
3	AQ3	47.2	64.6	4.6	63.6	55.1
4	AQ4	40.3	56.0	4.4	55.7	47.4
5	AQ5	33.2	53.7	5.2	52.9	44.6
6	AQ6	38.3	52.1	3.8	51.4	44.2

7	AQ7	36.8	49.2	3.4	49.1	43.1
8	AQ8	29.3	41.2	3.3	40.9	36.0
9	AQ9	35.7	50.4	4.5	50.3	44.3
10	AQ10	39.5	51.3	3.3	51.0	44.0

Table 3.6 Sulphur Dioxide (SO_2 µg/mg3)

S.No	Station Code	Min	Max	Standard Deviation	Average	98 Percentile
1	AQ1	6.2	8.9	0.6	8.8	7.8
2	AQ2	6.2	9.3	0.8	9.1	7.8
3	AQ3	6.3	8.9	0.8	8.9	7.8
4	AQ4	6.0	9.3	0.9	9.0	7.6
5	AQ5	6.1	8.9	0.9	8.9	7.7
6	AQ6	6.0	9.2	0.9	9.1	7.7
7	AQ7	6.1	9.2	0.9	9.2	7.6
8	AQ8	4.8	9.2	1.3	9.2	7.0
9	AQ9	6.2	8.7	0.7	8.7	7.7
10	AQ10	6.1	8.4	0.7	8.4	7.7

Table 3.7 Nitrogen Oxide (Nox µg/mg3)

S.No	Station Code	Min	Max	Standard Deviation	Average	98 Percentile
1	AQ1	6.4	12.8	1.8	12.6	9.3
2	AQ2	7.1	11.3	1.3	11.2	9.2
3	AQ3	7.2	12.3	1.5	12.1	9.5
4	AQ4	6.2	14.3	2.0	13.5	8.9
5	AQ5	6.3	12.0	1.6	11.6	8.9
6	AQ6	6.0	12.2	1.6	11.8	8.1
7	AQ7	5.2	12.3	1.7	11.6	8.0
8	AQ8	5.3	11.3	1.5	11.3	7.6
9	AQ9	6.7	11.8	1.5	11.5	8.5
10	AQ10	6.0	10.7	1.3	10.5	8.0

Table 3.8 Ozone(µg/mg3)

S.No	Station Code	Min	Max	Standard Deviation	Average	98 Percentile
1	AQ1	7.0	8.7	4.4	7.4	8.4
2	AQ2	7.0	7.9	0.3	7.4	7.9
3	AQ3	7.0	8.0	0.3	7.4	8.0
4	AQ4	7.0	8.1	0.4	7.5	8.1
5	AQ5	7.0	8.2	0.4	7.6	8.2
6	AQ6	7.0	8.3	0.4	7.4	8.1
7	AQ7	7.0	8.2	0.4	7.4	8.1
8	AQ8	7.0	8.4	0.4	7.4	8.3

9	AQ9	7.0	8.5	0.5	7.6	8.5
10	AQ10	7.0	8.4	0.4	7.5	8.4

Hg was also monitored and found to be below detection level (BDL) at all locations.

3.4.2 National Ambient Air Quality Data

National Ambient Air Quality Standards for ambient air are notified under the Environment (Protection) Act, 1986 are as follows:

Table 3.9: NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Time Weighted Average	Concentration in µg/m³	
		Industrial Residential, Rural & other areas	Ecologically Sensitive area (Notified by Central Government)
Sulphur Dioxide	Annual *	50	20
	24 hours**	80	80
Nitrogen Oxides	Annual*	40	30
	24 hours**	80	80
Particulate matters (Size less than 10µm) or PM_{10} µg/m³	Annual*	60	60
	24 hours**	100	100
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$ µg/m³	Annual*	40	40
	24 hours**	60	60
Ozone	8 hrs**	100	100
	1 hrs**	180	180
Lead	Annual*	0.50	0.50
	24 hours**	1.0	1.0
Carbon Monoxide (mg/m³)	8 hrs**	02	02
	1 hrs**	04	04
Ammonia	Annual*	100	100
	24 hours**	400	400
Benzene	Annual*	05	05
Benzo (a) Pyrene (BaP) Particulate phase only	Annual*	01	01
Arsenic	Annual*	06	06
Nickel	Annual*	20	20

Source: Pollution Control Acts Rule and Notifications issued There under by Central Pollution Control Board
* Annual Arithmetic Means of minimum 104 measurements in a year at a particular site taken twice a

Table 3.9: NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Time Weighted Average	Concentration in µg/m³	
		Industrial Residential, Rural & other areas	Ecologically Sensitive area (Notified by Central Government)
week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year, 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

It can be observed from the above tables that the present baseline AAQ values are well within the standards prescribed by Central Pollution Control Board.

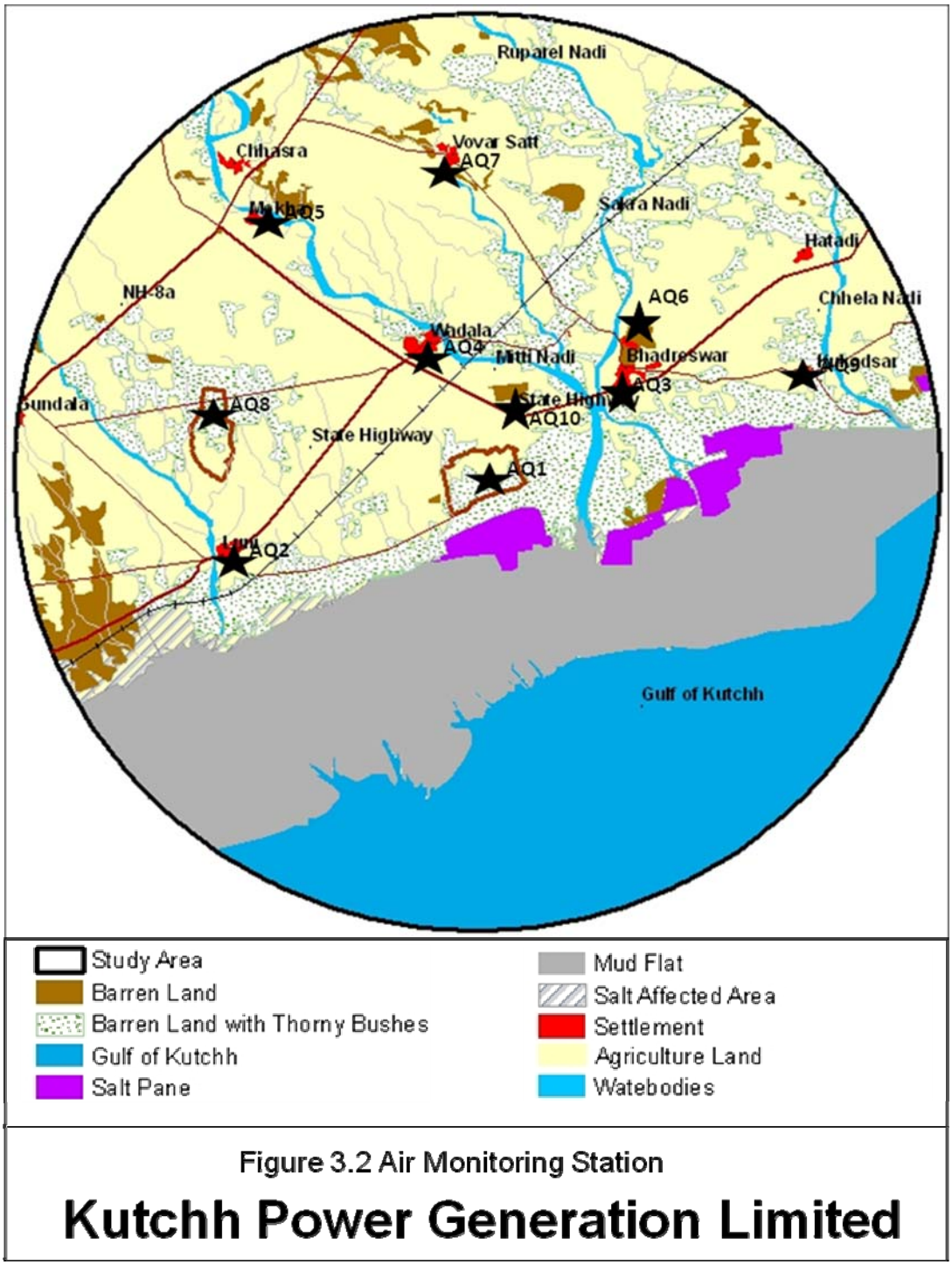


Figure 3.2 Air Monitoring Station

Kutchh Power Generation Limited

3.5 HYDRO-GEOLOGICAL SETTINGS

The area is characterized by the sedimentary basin of Kutch that occupies the entire district of Kutch in Gujarat State of Western India close to its western border with Pakistan. It

is an east-west oriented pericratonic rift basin at the westernmost periphery of the Indian craton. The basin is a fossil rift at the southern end of the Indus shelf and is bordered on the north by the fossil rifts of Thar and Southern Indus basins. To the south occurs another parallel rift basin, the western offshore extension of Narmada rift, with the Saurashtra horst between them. The north–south trending Cambay rift crosses the two parallel rifts. Together the three rifts form an inter-connected rift system around the foundered cratonic block of Saurashtra at the trailing edge of the Indian continental plate. Mesozoic, Tertiary and Quaternary sediments fill up the Kutch basin. The sediment fill thickens from less than 500 m in the north to over 4000 m in the south and from 200 m in the east to over 2500 m in the west. To the north, Precambrian basement rocks are exposed in Meruda Takkar and Nagar Parkar (in Pakistan) hills. To the east, the Precambrian rocks, under cover of alluvium, extend over the North Gujarat plains. To the west the basin extends across the continental shelf while to the south, the uplifted Saurashtra platform covered by Late Cretaceous sediments and Deccan Trap lava delimit the basin. The region is conspicuously featured by lowlands. The uplands are rugged hilly terrain exposing the Mesozoic rocks in the North bordered by thin strips of gently dipping Cenozoic rocks which form coastal plains. The lowlands are extensive plains, alluvial or mud and salt flats (*Rann*) and grassy undulations (*Banni)*. The highlands are the areas of uplifts and the plains are intervening basins. No outcrop is seen within the featureless plains and consequently subsurface information is lacking for these areas excepting for some geophysical and well data. In filteration tests of the area reveal hydraulic permeability in the range of 1.8 x 10^{-6} m^2 to 2.6x 10^{-6} m. to avoid leaching into ground water; it is recommended to provide lining to the Ash pond area.

3.6 WATER ENVIRONMENT

3.6.1 Water Environment

Selected water quality parameters of ground water resources within the study area have been studied for assessing the baseline water quality and may be used to evaluate anticipated impact due to the proposed power plant.

Water source of an area is broadly classified into the following categories

- Surface water: Rivers, Drains, Canals, Ponds.
- Ground water: Accumulation of water in deeper strata of ground.

The only natural source of recharging for both surface and groundwater source is from precipitation (rainfall). Five ground water samples collected from the impact zone were examined for physico-chemical and heavy metals parameters. The analysis of the collected samples was carried out by the Gujarat Institute of Desert Ecology (GUIDE), Bhuj, which is an institute of Government of Gujarat.

No fresh water body such as river, stream or village ponds/tanks were encountered in the impact zone. This fact may be attributed to highly porous sandy soil prevalent in most part of the study area. The analysis of the ground water samples have been compared with the standards for drinking water as per IS: 10500 (Bureau of Indian standard: 2002).

3.6.2 Ground Water Quality

The ground water samples were monitored from five locations as shown in **Figure 3.3.** Table **3.10** depicts the analysis results of the ground water samples and described below:

Table 3.10 Ground Water Quality

Parameters	Units	Ground water Sample							Drinking Water Standard	
		GW1 (Bhadreswar Village)	GW2 (Plant Site)	GW3 (Wadala)	GW4 (Lumi)	GW5 (Ash Pond Area)	GW 6 (Near State Highway)	GW 7 (Gundala)	Desirable limit	*Permissible Limit
Colour Appearance	-	Colourless	Colour less	Colourless	Colourless	Colourless	Colour less	Colourless	-	-
Turbidity	NTU	Nil	Nil	Nil	Nil	Nil	Nil	Nil	5	10
pH	-	7.6	7.4	8.2	8.4	7.8	7.6	7.7	6.5-8.5	-
Conductivity	µmho/cm	780	2520	1190	580	2440	2200	2120	-	-
Alkalinity	mg/l	200	720	600	162	808	804	754	200	600
Chloride	mg/l	36	554	215	44	699	652	602	250	1000
Total dissolved solids	mg/l	678	1279	845	410	1340	1387	1245	500	2000
Sulphate	mg/l	65	71	69	66	71	68	67	200	400
Nitrate	mg/l	5.7	6.3	6.6	5.9	7.3	6.8	6.2		
Total hardness as CaCO3	mg/l	312	504	218	184	488	423	399	300	600
Calciu	mg/l	70	92	41	33	73	72	69	75	200

m as Ca++										
Magnesium as Mg++	mg/l	33	66	27	24	58	52	45	30	100
Suspended Solid	mg/l	3	4	3	2	4	4	3	-	-
Kjeldhal nitrogen	mg/l	0.34	0.36	0.34	0.30	0.38	0.39	0.32	-	-
Ammonium Nitrogen	mg/l	0.14	0.16	0.14	0.17	0.16	0.15	0.13	-	-

3.6.3 Ground Water Quality & Analysis

- **pH:** All the samples of ground water meet the desirable limit (6.5 to 8.5) as per IS: 10500.
- **Turbidity:** All the samples of ground water meet the desirable limit (5 NTU)
- **Alkalinity:** Total alkalinity in the water samples of ground water ranges from 162 to 808 mg/l. However all the samples are within the permissible limit for drinking water (600mg/l) and can be used in case alternative sources of potable water where not available.
- **Total Dissolved Solids:** It varies between 410 mg/l to 1340 mg/l. Only one sample GW4 (Lumi) is under desirable limit. However all the samples have T,D,S within the permissible limit of drinking water (2000mg/l)
- **Chlorides:** The chlorides concentration in the ground water near coastal area is influenced by ingress of salt (Sodium Chloride). Concentration of chloride value varies between 44 mg/l to 699 mg/l. except ground water samples of GW2 & GW5, all are within the desirable limit of drinking water.
- **Sulphate:** Sulphate content in the ground water sample ranges from 65 mg/l to 71 mg/l.
- **Other Parameters:** Other parameters like copper, lead, zinc and cadmium were found to be lower than the desirable limit.
- The analysis results are indicative of high TDS due to presence of higher level of sodium and chlorides in the water. However, most of the parameters analyzed suggest that water may be used for potable purpose if there is no alternative source of water available as per BIS standard for drinking water (IS 10500: 2002).

Figure 3.3 Water Monitoring Station

Kutchh Power Generation Limited

3.7 NOISE ENVIRONMENT

The baseline assessment of prevailing noise levels in and around the study area is an important parameter in preparation of impact assessment report. Impact of noise sources on environment depend upon the sources which are generating noise and their respective characteristics. Noise levels are more annoying in the night time particularly in the residential area. The environmental impact of noise can have several effects varying from annoyance to hearing loss depending on loudness of noise levels.

3.7.1 Noise Level Reconnaissance Survey

Reconnaissance survey has been made to identify the major noise generating sources in the study area. The main activities generating noise in the study area are rail and road traffic. To understand the noise in the study area, a survey was conducted using sound-level meter. The noise monitoring locations and analyzing data are given in the **Table 3.11** and reflected in the **Figure 3.4**

Table 3.11 Noise Monitoring

Noise location	Day		Night	
	L Max	L Min	L Max	L Min
Plant Site	51.00	46.00	45.00	38.00
Lumi Village	53.10	42.20	44.10	39.40
Bhadreswar	54.60	47.40	45.40	38.20
Wadala	53.00	43.50	45.00	36.40
Mokha	53.10	41.50	43.20	33.50
Chhasra	47.30	40.00	40.20	32.10
Inter Section of SH & Railway line	56.00	48.00	46.00	38.00
Hatadi	42.60	34.10	36.70	32.30
Ash Pond Site	53.00	43.00	44.00	37.00
Near Sea Sore	52.00	43.00	43.00	38.00
Source: GreenC Survey				

Noise level monitoring was carried out for 24 hours. Noise levels measured over a given period of time of interval, enable to describe scenario of noise using statistical techniques. Hourly Leq values have been computed for day time and night time separately.

L_{day}: Average noise levels between 06.00 hrs to 22.00hrs
L_{night}: Average noise levels between 22.00 hrs to 06.00hrs.

The L_{dn} for a given location in a community may be calculated from the hourly Leq's, by the following equation

$$L_{dn} = 10 \log 1/24 \{\sum_{i=1}^{16} 10^{(leq1/10)} + \sum_{i=1}^{8} 10^{[(leq\ i+10)/10]}\}$$

Where L_{day} is the equivalent sound level during the daytime (6 am to 9 pm) and L_{night} is equivalent sound level during the night time (10 pm to 6 am). The hourly recorded noise

level at various locations in the study area show fluctuations because of change in traffic movement, commercial and domestic activities.. However as there are no industrial sources of noise generation it is observed that the noise levels at each location is within the

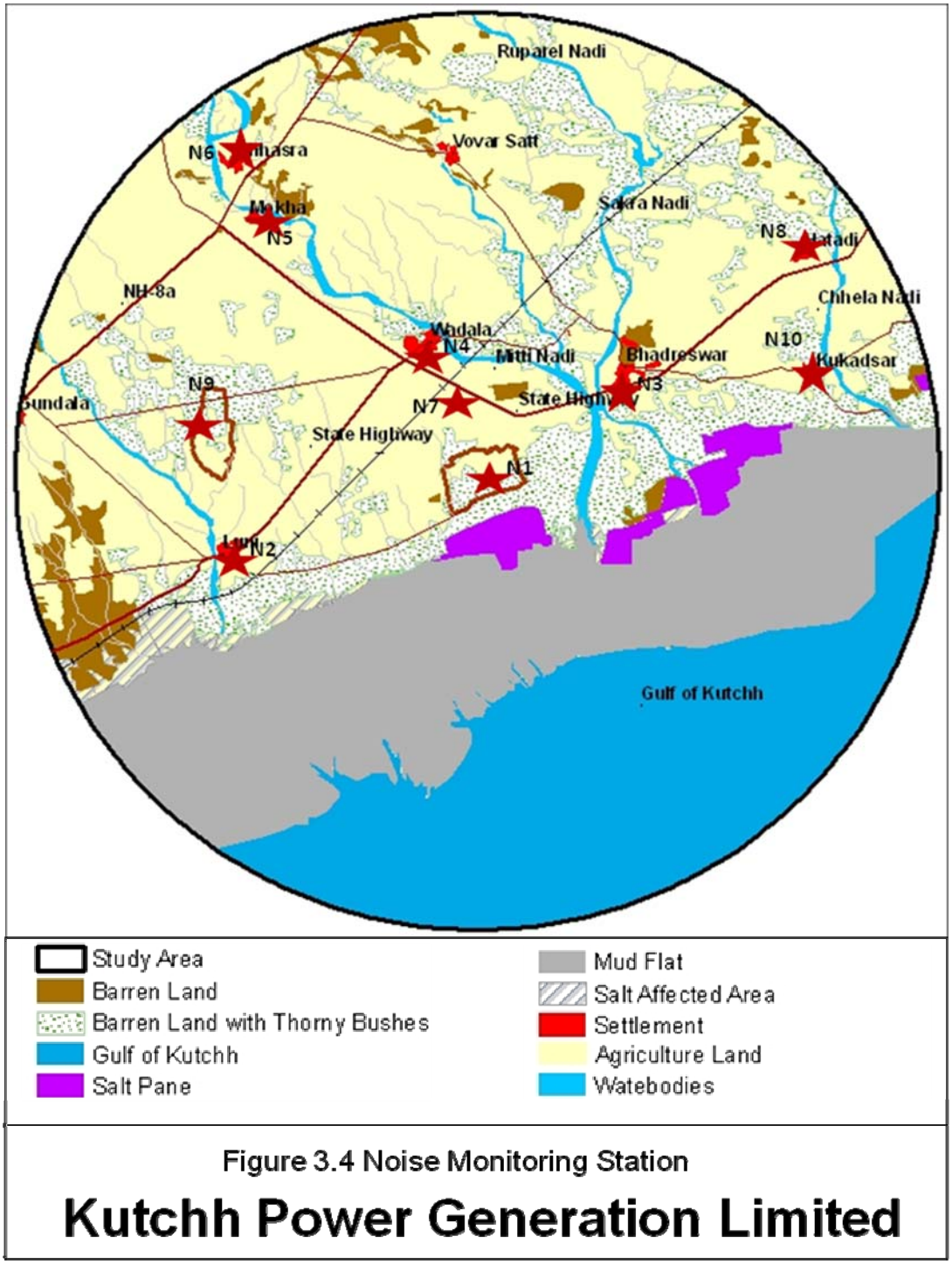


Figure 3.4 Noise Monitoring Station

Kutchh Power Generation Limited

prescribed standards.

3.8 SOIL ENVIRONMENT

Soil sampling was carried out at five locations during the study period as shown in **Figure 3.6**. The Values of important physical and chemical parameters of these soil samples are given in **Table 3.13**. From the tabulated values, the following conclusions can be made about physical and chemical characteristics of the samples.

Table 3.12 Soil Sampling Location

Location Name	Code	Dis. (km)	Dir.
Plant Site	S1	0.0	-
Ash Pond Site	S2	5.0	WSW
Bhadreswar Village	S3	2.5	NE
Wadala	S4	2.5	N
Lumi	S5	4.5	W

Table 3.13 Soil parameter

Sr No	Parameters	Unit	S1	S2	S3	S4	S5
1	pH	pH unit	8.4	8.2	8.05	8.16	8.5
2	Bulk density	gm/cm^3	1.33	1.28	1.40	1.21	1.37
3	Water holding Capacity	%	21.6	31.6	33.2	28.5	25.7
4	Soil texture	----	Sandy	Sandy	Sandy	Sandy	Sandy
5	Soil colour	----	Red Brown	Dark Brown	Red Brown	Dark Brown	Dark Brown
6	Nitrogen as N	%	0.22	0.64	0.18	0.73	0.52
7	Phosphorus	gm/Kg	0.007	0.78	0.011	0.67	0.81
8	Potassium as K	gm/Kg	0.26	0.18	0.12	0.30	0.22
9	Calcium as Ca	gm/Kg	0.157	0.163	0.152	0.168	0.160
10	Nitrate as NO3 -N	gm/Kg	0.008	0.056	0.017	0.061	0.040
11	Sulphate	gm/Kg	0.059	0.163	0.076	0.147	0.114
12	Electrical Conductivity	µmho/cm	187.0	162.0	196.0	252.0	223
13	Organic matter	gm/Kg	2.30	6.45	1.97	7.56	8.23
14	Chloride	gm/Kg	0.133	0.141	0.128	0.126	0.156
15	Particle size Distribution						
	a) Gravel	%	17.20	4.08	19.04	4.30	3.06
	b) C Sand	%	14.30	17.23	11.40	19.20	26.22
	c) C – M Sand	%	50.15	48.43	38.34	54.12	39.32
	d) C – F Sand	%	15.23	25.42	26.70	18.34	28.20

	e) Silt & Clay	%	3.12	4.84	4.52	4.04	3.2
16	Moisture	%	1.1	0.8	1.5	1.7	1.3

3.8.1 Observation & Interpretation

Physical Parameters

Water Holding Capacity (WHC): Water holding capacity of soil samples of the study area ranges from 21.6% to 33.2 %.

Soil Texture: Texture of soil is sandy and its colour is dark brown or reddish brown.

Chemical Parameters

pH: pH was determined by taking ratio of 1:2 of soil and distilled water. The pH of the soils in the study area is found to be in the range of 8.05 to 8.5 indicating alkaline soils.

Organic Matter: The content of organic matter in the soil samples were observed to be between 1.97 gm/kg to 8.23 gm/kg

Electrical Conductivity: Electrical conductivity of the soil samples ranges from 162 µmho/cm to 252 µmho/cm.

Chloride: Chloride of the soil samples ranges from 0.126gm/kg to 0.156gm/kg.

Nitrogen: The content of available nitrogen in the soil samples were found in the range 0.18% to 0.73%.

Available Phosphorous: The content of available phosphorous in the soil samples were found between 0.007 gm/kg to 0.81 gm/kg. This is one of the important parameters of soil, which determine the soil fertility.

Available Potassium: The content of available potassium in the soil samples were found between 0.12m/kg to 0.30gm/kg.

Figure 3.5 Soil Monitoring Station

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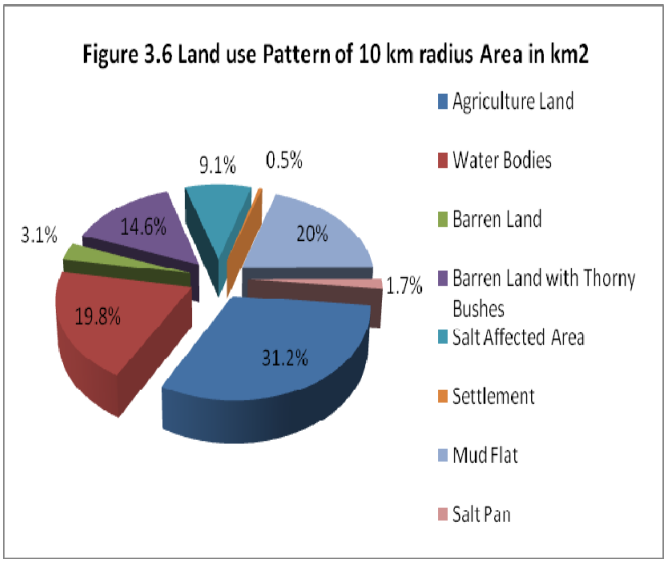
3.9 LAND USE PATTERN

3.9.1 Land use Pattern of 10 km radius

Table 3.14 Land use Pattern of 10 km radius

Land Type	Area in km²	Area (%)
Agriculture Land	98.05	31.2
Water Bodies	62.12	19.8
Barren Land	9.70	3.1
Barren Land with Thorny Bushes	45.86	14.6
Salt Affected Area	28.69	9.1
Settlement	1.42	0.5
Mud Flat	62.63	20.0
Salt Pan	5.47	1.7
Total	314	100

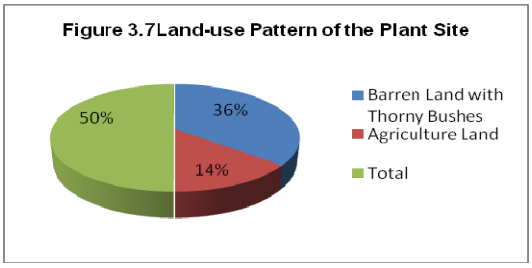


The term land use used in the report means both land use and land cover. The land use of the study area was carried out by utilizing three principal resources, namely, (i) Survey of India topo-sheet of 1:50,000 scale; (ii) Satellites imagery data without any cloud cover; and (iii) ground validation for interpretation of the FCC imagery. **Table 3.14** describes distribution of land area in km² and percentage. The land use table can be meaningful in the pie diagram **(Figure 3.6)** and land-use map **(Figure 3.7)**. From the above table it can be seen that about 31.2% of the land in the 10km radius is agriculture land, 14.6% are barren land with thorny bushes, 20% occupies by mud flat land. Water bodies cover 19.8% of the total land .Settlements cover approximately 0.5% of the total impact area. All the details of land use pattern of 10 km radius are described in table 3.14

3.9.2 Land use Pattern of Project Site

Table 3.15 Land-use Pattern of the Plant Site

Land Type	Area in ha.	Area (%)
Barren Land with Thorny Bushes	228.59	71.4
Agriculture Land	91.41	28.6



Total	320.0	100	

It can be seen from **Table 3.15** that the area of project site is predominated by barren land with thorny bushes 71.4%) & rest of the land i.e. 28.6% is agriculture land.

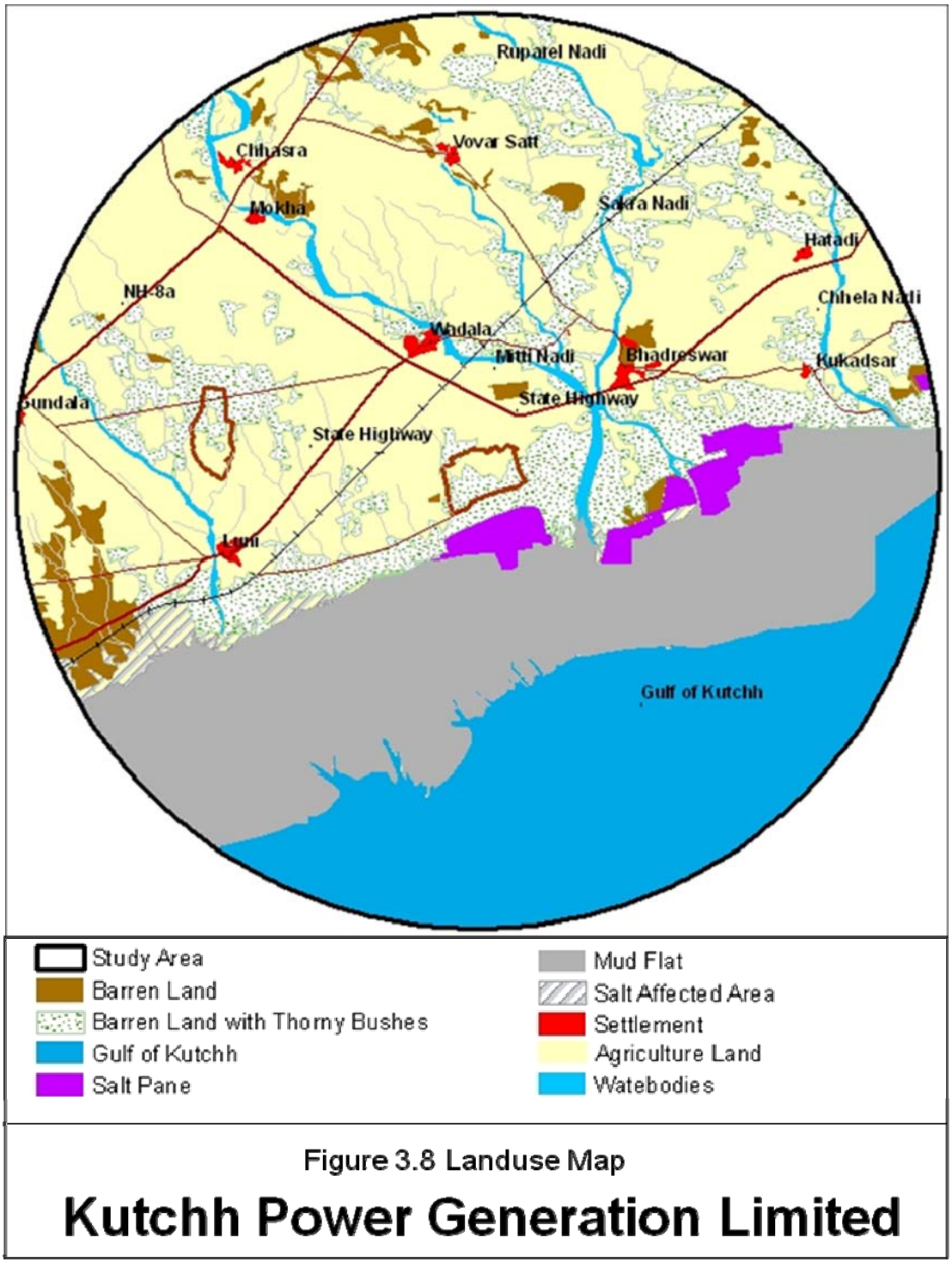


Figure 3.8 Landuse Map

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3.10 SOCIO - ECONOMIC ENVIRONMENT

Socio-economic studies are one of the important aspects of Environmental studies. The socio-economic parameters viz. population growth, density, sex ratio, health, work force participation, occupational structure, literacy etc, play an important role in determining the impact of the proposed activity on the human population of the study area, directly or indirectly. These impacts may be beneficial or detrimental. There are 15 villages coming within the 10 km radius. Socio economic environment includes description of demography, available basic amenities like housing, health care services, transportation, communication, education and cultural activities. Fishing community is present in Luni, Bavdi & Bhadreshwar villages. These three villages contribute about 10% of the fish catch of entire Kutchh district. Average annual fish production in each of the village ranges between 1400-2400 MT. Boat fishing and Pagadiya fishing are adopted by the Waghers (a traditional fishing community), who lives in Banders (temporary village hamlets) set up by the fisher folk. On the southern side, there are some salt pans which also contribute to the local livelihood.

Table3.16 Demographic Profile

S.No	Parameters	Numbers
1	Households	3246
2	Total Population	15952
3	Male	8074
4	Female	7878
5	Population under 6 year of age	2671
6	Proportion of Male	50.62%
7	Proportion of Female	49.38%
8	SC	2052 (12.86%)
9	ST	921 (5.77%)

Source: Census data 2001,

Demographic Profile

As per 2001 Census, the study area has total population of around 15952. The demographic status of the study area is reported in **Table3.16**. Percentage of non-workers is high in comparison to total worker i.e. main and marginal worker. The total main workers are engaged in industries as contract labor and in agricultural sector as agricultural labor. It may be seen from the **Table 3.17** that the total number of main workers is more than the

marginal workers. Thus, there is some permanent employment opportunity in the study area.

Average Household Size: From the above demographic tables it can be seen that the total households in the Study Area is about 3246 having population 15952. Thus the average household size is 4.91.

Distribution of Population in the Area: The total no. of male population of the study area is 8074 compared to female population of 7878 which is lower than male. The gender ratio is found to be 976.

Social Set-up: The Scheduled Caste population in the study area is 12.86% and Scheduled Tribe population is 5.77% in the study area.

Occupational Structure: The occupational structure of the area shows that among the total population of 15952 the total number of workers are 5591. Out of the total working population, main workers are 78.49% and the marginal worker is 21.51%. Data shows that majority of the population are engaged in cultivation or work as agricultural workers. The seasonal employment is very low as marginal workers are low. The people are engaged in fishing and other secondary jobs apart from cultivation so they are not dependent on seasonal employment of agriculture. The economic condition in the area is also not very sound. Apart from agriculture, people are also engaged as agricultural laborers, or work in local industries, power plants, or as house hold workers. Thus the area lacks permanent employment opportunities apart from agriculture.

Table3.17 Occupational Structure

S.No	Parameters	Numbers
1	Total worker	5591
2	Male Worker	4219
3	Female Worker	1372
4	Total Non Worker	10361
5	Male Non Worker	3855
6	Female Non Worker	6506
7	Main worker population	4388
8	Marginal worker population	1203
Source: Census data 2001,		

Infrastructural facilities: As per the 2001 census, the area is well developed in terms of schooling, drinking water facilities as well as power supply and banking facilities. All the facilities available in the area are presented in **Table 3.18**.

Table 3.18 Infrastructure Facilities

S.No	Facilities	Types of each Facility	Number of Facility
1	Education facilities	Primary school	17
		Secondary school	3
		Senior secondary school	2
2	Medical Facilities	Dispensary	3
		RMP	1
		SMP	1
		MCW Facilities	1
		CHW	14
3	Drinking Facilities	Tap	16
		Well	23
		Tank	24
		Tube well	28
		Hand pump	28
4	Transportation Facilities	Bus services	14
5	Post office facilities	Post office	8
6	Bank & credit societies facilities	Commercial Bank	4
		Credit society	22
		AC Society	6
		NAC Society	4
7	Power supply	Electricity used for domestic use	4
		Electricity used for agriculture use	1
		Electricity used for all other use	11

Source: census data 2001, Gujarat

CHW: Number of Community Health workers
AC: Number of Agricultural Credit Societies
NAC: Number of Non Agricultural Credit Societies
RMP: Number of Registered Private Medical Practiotioners
SMP: Number of Subsidised Medical Practitioners
MCW: Number of Maternity and Child Welfare Centre

Economic Situation of Fisher folk: The working structure of fishing in the Kutch coast by Pagadiyas and row boats. Although the motorized boat fishing was started in 1980s. Still traditional fishing has been continuing with respect to their economic conditions. After the super cyclone in 1998, the fisher-folk was drastically affected and their livelihood was deteriorated as a result, the money lenders middleman enforced the community to sell their fish at predetermined price for the year by which the price were 40-50% lower than the market price. These exploitative terms set by the merchants lead to a situation where the fisher-folk become bonded workers.

After the Bhuj earthquake in 2001, several involvements were made on these issues of fisher-folk and it revealed about the area is lack of infrastructure and the main reason is backwardness.

In Kutchh, Small scale "artisanal" fishing contributes around 40% of the marine fish production. It is a full time occupation and generates 75% of employment generation. The

fisherfolk appears to be poor and backward due to exploitation of money lenders as well as marketing problems.

There are three fishing villages in the study area; i.e. Luni, Bavdi & Bhadreshwar which contribute about 10 % of the fish catch of entire Kutchh district.

3.11 ECOLOGICAL ENVIRONMENT

The term ecological environment would cover all living forms such as plants and animals of the study area. The plant species observed in the study area are in the form of scanty natural growth, degraded bushes – typical of a saline soil with hot and humid climate, isolated agricultural fields and grass lands.

Flora: As recorded in the Bombay Gazetteer 1880, and Gazetteer of India Kachchh 1971, the district has no forests with only few trees distributed scantily across the area. Thakar Jaikrishna Indraji surveyed the vegetation of areas near Bhuj and the Botanical Garden of Bhuj and recorded the flora species in his book "Plants of Cutch and their Utility" in 1926.

Commonly grown kitchen gardening/horticulture plants in the urban area around the project site are Guava, Mango, Lemon, coconut and Chikoo etc. as well as some vegetables like Tomato, Potato, Brinjal and Lady Finger. Flat alluvial plains and buried pediment plains with moderate to deep soils support good crops. The main crops are groundnut, maize, pearl millet and green gram.

Table 3.19: List of Trees and Shrub Species found in the Study Area

Sr. No.	Local Name	Botanical Name	Family
A. Trees and Shrubs			
1	Achi	*Tamarix dioica*	Tamaricaceae
2*	Amli	*Tamarindus indica*	Caesalpinicacea
3	Ankol	*Alangium salvifolium*	Alangiaceae
4*	Aval or Avar	*Cassia auriculata*	Caesalpinicaceae
5*	Babul	*Acacia nilotica*	Fabaceae
6	Bordi	*Zizyphus mauritiana*	Rhamnaceae
7*	Cheni Bor	*Zizyphus numularia*	Rhamnaceae
8	Chatri Bawal	*Acacia planofrons*	Mimosaceae
9*	Gunda	Cordia dichtoma	Boraginaceae
10*	Dumro	*Capparis gradis*	Cappar indaceae
11	Gongad (Kanjo)	*Xeromphis uliginosa*	Rubiaceae
12	Gangeti	*Grewia tenax*	Tiliaceae
13*	Gorad	*Acacia senegal*	Mimosaceae
14*	Gugal	*Commiphora mukul*	Burseraceae
15	Gundi	*Cordia dichotoma*	Ehret iaceae

Table 3.19: List of Trees and Shrub Species found in the Study Area

Sr. No.	Local Name	Botanical Name	Family
16	Ingoria	*Balanites aegyptia*	Simarubaceae
17*	Jamun	*Syzygium cumini*	Myrtaceae
18*	Kanthar	*Capparis sepiaria*	Papilionaceae
19	Kantharo Thar	*Euphorbia nivulia*	Euphorbiaceae
20	Karamdi	*Carissa carandus*	Apocynaceae
21	Kasid	*Cassia siamea*	Caesalpiniaceae
22	Kathgundi	*Cardia monica*	Ehretiaceae
23*	Kerdo	*Carpparis aphylla*	Cappar idaceae
24*	Khair	*Acacia catechu*	Mimosaceae
25*	Khakro	*Butea monoperma*	Papilionaceae
26	Khijdo	*Prosopis cineraria*	Mimosaceae
27	Khip	*Leptadenia spartium*	Asclepiadaceae
28*	Kundher	*Premna obtusifolia*	Verbenaceae
29	Luo or lue	*Grewia villosa*	Tiliaceae
30	Luno	*Suaeda fruticosa*	Chinopodiaceae
31	Limdo	*Azadirachta indica*	Meliaceae
32*	Mango	*Mangifera Indica*	Anacardiaceae
33	Mindhol	*Xeromphis spinosa*	Rubiaceae
34	Moto akdo	*Callotropis gigantia*	Asclepiadaceae
35*	Peepal	*Ficus tseila*	Moraceae
36	Ron	*Soyamida febrifuga*	Maeliaceae
37	Rohido	*Tecomella undulata*	Bignoniaceae
38	Sandasado	*Delonix elata*	Caesalpiniaceae
39	Saruguva	*Moringa oleifera*	Moringaceae
40	Sarasado	*Albizia oderatissima*	Mimosaceae
41	Saru	*Casuarinas equisitifolia*	Cauarinaceae
42*	Sissoo	*Dalbergia sisoo*	Caesalpiniaceae
43*	Tad	*Borassus flabellifer*	Arecaceae
44*	Taluka Mandvi bavdi	*Acacia jacquemontii*	Mimosaceae
45*	Umra	*Ficus glomerata*	Moraceae
46	Vad	*Ficus benghalensia*	Moraceae
47	Vilayati baval (Gandabawal)	*Prosopis juliflora*	Mimosaceae
48	Vingo	*Maytenus emerginata*	Celastraceae
	Mangroves		
49	Cher	*Avicinnia officinalis*	Avicinniaceae
50*	Karod	*Rhizophora mucronata*	Rhizophoraceae
51*	Khari Jar	*Salvadora persica*	Oleaceae
52*	Mithi jar	*Salvadora persica*	Oleaceae
B. Climbers			
1*	Amarvel	*Cuscuta reflexa*	Convolvulaceae
2*	Gunja	*Abrus precatorius*	Fabaceae
3*	Chanota	*Abrus precatorius*	Fabaceae
4	Fagvel	*Rivea hypocrateraformis*	Convolvulaceae
5*	Galo	*Tanospora cordifoila*	Menispermaceae
6	Malkankan	*Celastrus paniculata*	Celastraceae
7	Malvel	*Combratum decandrum*	Combrataceae
8	Vidari	*Pueraria tuberosa*	Fabaceae
C. Grass Species			
1*	Baru	*Sorgham halepense*	Poaceae

Table 3.19: List of Trees and Shrub Species found in the Study Area

Sr. No.	Local Name	Botanical Name	Family
2	Dab saliu	*Heterophogon contortus*	Poaceae
3	Dungri Zenzvo	*Bothriochola ischaemum*	Poaceae
4	Darabh	*Desmostachya bipinnata*	Poaceae
5*	Daro	*Cynodon dactylon*	Poaceae
6	Dhramnu	*Cenchrus setigerus*	Poaceae
7	Gandharu	*Cymbopogon jwarancusa*	Poaceae
8	Jinjvo	*Dichanthium annulathum*	Poaceae
9	Kadvano	*Aeloropus lagopoides*	Poaceae
10	Kans	*Sacchaum spontaneum*	Poaceae
11	Khariu	*Dinebra retrofelxa*	Poaceae
12	Khovan (Gandhir)	*Eleusine compressa*	Poaceae
13	Lamodu	*Arisida histricula*	Poaceae
14	Bhongoru	*Apluda mutica*	Poaceae
15	Mosti	Iseilema prostratum	Poaceae
16	Ratad	Themeda cymbaria	Poaceae
17	Rois	Cymbooogon martini	Poaceae
18	Saniar	Schima sulcatum	Poaceae
19	Saravu	Bothriochloa intermidia	Poaceae

(Source: Working Plan of Kutch – S. K. Sinha & R. R. Joshi)
** Species Observed by Consultant Team*

Fauna: Actual counts of birds were made following the standard survey technique. Observations were made during a week through the chosen transect for sighting birds and animals. The number of animals and birds observed in five-kilometer stretch of the site were directly counted and listing was made. The milometer of the car/jeep was used to measure the stretch of the study transect. Birds were noted, counted and identified with the help of binocular and standard field identification guides. Other animals were directly counted from their respective habitation.

Presence of Sea in the study supports the wildlife habitats. Direct sighting of Chinkara, Jackal, Wild bore, Fox, Wolf and Wild Cat was not observed. However local peoples narrated their personal experience on observation of pug-marks and roars of wild animals heard a distance and visually seen wild animals searching for food in night time close the human habitation area.

The over-all picture about fauna in the study is that the carnivorous animals are dominant over the herbivores ones. However, Wild Ass and Nilgai were mainly observed in agriculture fields during farming activity. Mongoose was found at some locations only.

Table 3.20: Common Fauna of the District

Common Name	Scientific Name	Schedule
Wild Ass*	*Equus heminonus*	I

Table 3.20: Common Fauna of the District

Common Name	Scientific Name	Schedule
Chinkara	*Gazella gazella*	I
Wildbore	*Sus scrofa*	III
Jackal	*Canis aureus*	II
Fox	*Vulpes bengalensis*	II
Wolf	*Canis lupas pallipes*	I
Wild cat*	*Felis chaus*	II
Porcupine	*Hystrix indica*	IV
Mongoose*	*Herpestes edwardsi*	II
Nilgai*	*Boselaphus tragocamelus*	III
Spiny tailed lizard	*Varanus bengalensis*	I
Tortoise	*Testudinidae*	IV
Dhaman	*Plyas mucosus*	II
Sand Snake	*Psammophis condanorus*	IV
Blind snake	*Typhlina brathina*	IV
(Source – EIC report) ** - Species observed by GREENC team*		

Avifauna: The dominant birds of the study area are Little Erget, Common Crow, Sparrow, Owls, Quail, Pigeon, Cuckoo, Myna, Bulbul and Intermediate Erget. These birds were found in the close association with man and cattle's. Most of these birds recorded in the study area are omnivorous in habit preferring grains, insects and worms etc. as their principal food.

Table 3.21: Birds found in the Project Area

Common Name	Scientific Name
Flamingo	*Phoenicopterus rubber*
Ghorad	The great Indian bustard, *Choriotis nigriceps*
Saras Crane*	*Grus spp.*
Common crane*	Siberian white crane, *Grus leucogeranus*
Peacock / Peafowl*	*Pavo cristatus*
Partridge	*Phasianiclae*
Jungle fowls*	*Gallus spp.*
Sandgrous	*Petrocks spp*
Ibis (Glossy)*	*Plegadis falcinellus*
Pelicans	*Pelecanus onocrotalus*
Little egret*	*Egretta egretta*
Black drongo	*Dicruru adsimitis*
Babbler	*Turdodides caudatus*
Kingfisher*	*Alcedo atthis*
Dove	*Streptopelia spp.*
Common Crow*	*Vermin*
Sparrow*	*Passer domesticus*
Peacock*	*Polyplectron bicalcaratum*
Parakeet*	*Psittacidae*
Dove	*Columbidae*
Owls*	*Strigidae*

Table 3.21: Birds found in the Project Area

Common Name	Scientific Name
Hawk	*Fam. Accipitidae*
Partridge	*Phasianiclae*
Quail*	*Phasianidae, coturnix Coturnix*
Pigeon*	*Columbidae*
Cuckoo*	*Cuculidae*
Myna*	*Sturnidae*
Bulbul*	*Pyenonotidae*
Great White Pelican	*Pelecaniclae*
Great Crested Grebe	*Podicipitidae*
Little cormorant	*Phalacrocorax niger*
Grey Heron	*Ardeidae*
Great Egret	*Ardeidae*
Intermediate Egret*	*Egretta gularis*
Painted Stork	*Ciconiidae*
Black Ibis	*Threskiornithidae, Pesudibis papillosa*
Spoon Bill	*Platalea ieucorcorodia*
Greater Flemingo	*Phoenicopterus rubber*
Northern Pintail	*Ansa acuta*
Common Teal	*Anatidae*
Spot Billed Duck	*Anatidae*
Gadwall	*Anas strepera*
Eurasian wigeon	*Anas Penelope*
Northern shoveller	*Anas clypeata*
Ferruginous Pochard	*Aythya nyroca*
Tufted Ducks	*Anatidae*

(Source: DCF, Bhuj & EIC report)
** - Species observed by GREENC team*

Table 3.22: Marine fish landing & production in Kutchh District

Common Name	Production 2006-07 (In KG)	Production 2007-08 (In KG)
White Pomfret	*1347933*	*1289013*
Black Pomfret	*39085*	*83752*
Bombay Duck	*6611282*	*3161041*
Thread Fin	*1006678*	*1312777*
Jew Fish	*1334616*	*2061965*
Hilsa	*125159*	*150929*
Other Clupeids	*2909689*	*2852312*
Coilia	*3574529*	*1529956*
Shark	*3093257*	*2435931*
Mullet	*2190231*	*2319952*
Cat fish	*1860303*	*2394041*
Eel	*196500*	*228717*
Leather jacket	*328353*	*925483*
Seer Fish	*366139*	*730680*
Indian Salmon	*74589*	*151000*
Ribbon Fish	*2094765*	*1831437*
Silver Bar	*934785*	*1346728*
Perch	*195414*	*280195*
Small Scieneidies	*3681989*	*4278536*
Shrimp	*7414998*	*7382769*
Prawns (M)	*1756322*	*1935805*

Table 3.22: Marine fish landing & production in Kutchh District		
Common Name	**Production 2006-07 (In KG)**	**Production 2007-08 (In KG)**
Prawns(J)	*883926*	*485948*
Lobster	*89164*	*41941*
Crab	*225485*	*480778*
Levta	*151*	*24681*
Cuttle/Squids	*32559*	*49119*
Tuna	*0*	*1103*
Sole	*314991*	*342776*
Miscellaneous	*16669758*	*18615266*
Total	***59352650***	***58724631***
(The data shows there is a decreasing trend of fish landing and production in the region as per stastical survey		

4. ANTICIPATED ENVIORNMENTAL IMPACTS AND MITIGATION MEASURES

4. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

4.1 BACKGROUND OF THE STUDY

The construction and operational phase of the proposed project comprises various activities each of which may have an impact on environmental parameters. Various impacts during the construction and operation phase on the environment have been studied to estimate the impact on the environmental attributes and are discussed in the subsequent section. The probable impacts of each of these activities on various sectors of environment have been mentioned below in two stages:

- Constructional Phase
- Operation Phase

4.2 IMPACT DURING CONSTRUCTION PHASE

The impact during construction will be localized and short term with permanent changes in use of project side land as compared to the current conditions. Impact will be primarily related to the civil works and less intensive impact is expected during erection of the equipment and trial operation. The details of the activities and probable impact are discussed below.

4.2.1 Air Impact

The main source of emission during the construction phase is the movement of equipment and vehicles at site. Equipment deployed during the construction phase is also likely to result in marginal increase in the levels of SO_2, NO_x, and Particulate matter. The impact will be reversible, marginal and temporary in nature. Proper upkeep and maintenance of vehicles, sprinkling of water on roads and construction site, providing sufficient vegetation etc are some of the measures that would significantly reduce the impact during construction.

Because of the construction activities of Kutch Power Generation Limited, anticipated impact will be there in the ambient air quality due to fugitive dust emission because of earth moving equipments, transportation and site leveling activities. However, water

sprinkling will be regularly carried in order to arrest the fugitive dust to the maximum extent possible.

The impact will be for short duration and confined within the project boundary and is expected to be negligible outside the plant boundaries. However, the plant site being cordoned off by a high boundary wall and planned green belt such particulate impacts will be confined only within the plant site.

4.2.2 Noise Impact

The study area is likely to experience increment in ambient noise level due to heavy construction traffic for loading and unloading, fabrication and handling of equipments and material. The areas affected are those close to the site.

To minimize the impact on nearby communities, construction schedules would be optimized to daytime working and in night activities will be scaled down. Extensive earthmoving and movement of heavy equipment would be conducted only during regular working hours (day time).

Overall, the impact of generated noise on the environment during construction period is likely to be insignificant, reversible and localized in nature and mainly confined to the day hours. The noise level will drop down to the acceptable level, once construction period will be over.

4.2.3 Impacts on Water Environment

During construction, workforce of about 2000 may be present on the project site. The generation of domestic sewage, grey water and subsequent discharge will impact surface water and to a limited extent groundwater. The main pollutants are organic components and microorganisms with the potential to cause contamination of surface water and groundwater. To address potential impacts on water quality, disinfected latrines (e.g., through regular liming) will be used as main component of the sanitation system.

Construction process would include fabrication of concrete and related water usage. The resulting wastewater could potentially carry inorganic solids and react alkaline above applicable discharge standards. The potential impact is considered minor as it mostly occurs during construction period and has no long-term impact with view to persistent pollution. Alkaline wash water containing excessive amounts of cement will be settled and neutralized before discharge.

Project proponent will try to complete water drawl scheme before start of implementation and draw water to meet the construction water requirement from the planned scheme. Also the domestic water need for construction workers will be made available from the nearby villages.

The overall impact on water environment during construction phase due to proposed project is likely to be short term and insignificant.

4.2.4 Ecological Impacts

The initial construction work at the project site involves site clearance. The Site is almost barren land with some thorny bushes. The site is neither an ecologically sensitive nor a place of ecological importance. There would be minimum requirement of tree felling for the construction of project. Therefore, significant ecological impact is not envisaged during construction phase of the proposed Bhadreswar Thermal Power Plant.

4.2.5 Socio-Economic Impacts

The workers in the study area constitute about 35% of the total population. This indicates the availability of sizeable manpower locally, required for the construction activity. The project will provide either direct or indirect job opportunities to the local population as far as possible. There will be some migration of skilled labor force from outside the study area during construction phase, which may put some pressure on the local settlements and resources. So, the demographic impact is envisaged to be marginal and temporary in nature.

However, the flow of workforce and material will affect the socio-economic status of the people in the area. The positive impact may be the increase of employment opportunities for un-skilled and semi-skilled workers. Growth/expansion of shops, dhabas, small hotels and other allied services will also open up avenues for employment. The subsequent improvement in the status of the people will also help in increasing the health and education status of the people.

4.2.6 Impact on Land

Prior to construction, leveling and grading of land will be done. During construction, the vegetation cover may be disturbed. The undulating landscape may be flattened down in the process of developing the site during construction phase.

Soil disturbances and impacts on local geology will occur mainly because of site preparation activities and disposal of excavated or scrapped materials. Secondary effects may occur due to erosion and windblown fugitive soil. The soil layer will also be disturbed because of the proposed activity.

The land acquired for proposed site is almost barren with some thorny bushes so the impact on land use pattern will be minor. Land-use and land-cover of the area will be changed into industrial land use and the changes will be permanent in nature. Thus construction activity will bring in certain immediate changes in the land use pattern of the proposed project area and its vicinity.

The construction activities will attract a sizeable labour population. However, local labour force will be preferably employed to reduce size of construction worker camps. This impact is envisaged to be insignificant due to the following reasons.

- Temporary labour colonies, with adequate potable water and sanitary facilities shall be provided in the areas already acquired for the project.
- This will be only a temporary change (restricted to construction period). After construction phase, the areas acquired by labor colonies shall be reverted back as per the requirement for other purposes.

Solid waste during the construction phase will consist primarily of scrapped building materials, excess concrete and cement, rejected components and materials, packing and shipping materials (pallets, crates, Styrofoam®, plastics etc.) and human waste.

However, it is expected that there will be generation of sizeable amount of garbage, for which suitable disposal methods have to be devised. Otherwise, it may lead to health hazard for the workers. The methods for disposal and/or recycle of the waste materials are given in the Environment Management Plan.

4.3 MITIGATION MEASURES DURING CONSTRUCTION PHASE

4.3.1 Mitigation of Air Impact

The generation of dust, suspended particulate and emission of Nitrogen Oxide in the atmosphere will increase due to fuel combustion machines and transport vehicles during the construction phases. Land surfacing activity and vehicular movement will lead to increase in the level of dust and NO_X in the atmosphere. In order to minimize smoke generation, the vehicles shall be maintained properly, and only “PUC” certified vehicles of contractor shall be deployed at site for ensuring that diesel powered vehicles are properly maintained to minimize the exhaust emission as well as noise generation.

Fugitive dust emission will occur due to construction activity, like handling of material and transportation within the plant premises. Extensive tree plantation will be carried out along the plant boundary to control spread of fugitive emission. During dry weather conditions, it is necessary to control the dust emission arising out of the excavation, leveling, and transportation and stockpiling activities by water sprinkling.

4.3.2 Mitigation of Noise Impact

Noise produced during construction phase may have significant impact on the existing ambient noise levels. The noise level of the vehicle and machine shall be within prescribed norms by regular maintenance and up keep. It is recommended that the high noise generation equipment viz. compressors should not be operated during the night. The noise level of the vehicle and machinery shall be kept within prescribed norms by regular maintenance and up keep.

Adequate personal protective equipment like ear plugs and ear muffs should be provided to the person to reduce the effect of noise.

4.3.3 Mitigation of Water Impact

It is planned to have no housing facility within the site area and most of the Operational worker will be accommodated in a common colony with the power plant. Wastewater will be only generated from restrooms and offices. The domestic waste water will be negligible, so there is no possibility of the same getting released into any water body.

4.3.4 Mitigation of Land Impact

The land of the proposed thermal power plant is more or less flat. It is predominantly covered by sandy soil. Minor leveling would be required during construction. Before commissioning the earth work, available sparse vegetation of the top soil would be removed. Due to the construction and transportation activities, dust will be generated. Water will be regularly sprinkled to reduce dust. Low lying area will be filled with earth excavated during the construction work.

4.3.5 Mitigation of Ecological Environment

All the construction work will be carried out in the premises of the plant.

- **Green Cover**

In order to prepare the site for the construction work there might be cleaning of thorny bushes present at the site. To counter the said situation proper landscaping and tree plantation in advance would be advantageous. KPGL group have developed sizable green cover in and around projects. It is recommended that the KPGL group follows same line of environment preservation by plantation at the site & its surroundings.

- **Flora & fauna**

Very scanty vegetation cover is observed at the plant site. Thus, the floral significance at the proposed plant site is negligible and impact of construction on flora will be negligible.

Similarly, no faunal species of significance have been observed near the plant site. Neither domestic animals nor any wild life was encountered at site during study period. The reason may be the lack of food, water or shelter in the site area.

4.4 IMPACT DURING OPERATION PHASE

The impacts during the operation phase will be continuous in nature. The proposed super critical thermal power plant will be of 3300 MW of power generation. The environmental parameters to be affected by the operation of the proposed power plant are illustrated in this section.

4.4.1 Impact on Air

Fugitive Emission

The air borne fugitive dust from the plant is likely to be deposited on the topsoil in the immediate vicinity of the plant boundary. However, the fugitive emission is likely to be controlled to a great extent through proposed control measure like dust suppression system and highly efficient Electrostatic Precipitators. The impact of fugitive emissions from all sources is likely to be restricted over a limited area (up to a maximum distance of 500 m from the source). In the ash disposal area, a water cover over the deposited ash in the entire ash pond will be maintained to effectively check the fugitive emission.

Air Modeling

The impact on ambient air quality is assessed hereunder considering the following:

- The air quality impacts have been predicted for the proposed power plant assuming that the pollution due to the existing activities has already been covered under baseline environmental monitoring.

- Site-specific meteorological parameters have been recorded by using continuous recorders. Short term 24 hourly GLC's incremental values were estimated using the site-specific meteorological conditions.

The various measures proposed to minimize the pollution from the power plant are as follows:

- A tri-flue and a bi-flue chimney of height 275 mts each are proposed for wider dispersal of pollutants.
- Electrostatic Precipitators with 99.98% efficiency will be installed to limit the particulate (SPM) emission within 50 mg/Nm^3.
- The NO_X emissions from the boilers will be controlled by controlling combustion measures, which will be approached by way of low NO_X burners
- Fugitive dust will be controlled by adopting dust extraction and dust suppression measures and development of green belt along the periphery of the proposed power plant.

Model and Methodology for Computation

The predictions for air quality during operation phase were carried out for suspended particulate matter (SPM), sulphur dioxide (SO_2) and oxides of Nitrogen (NO_X) concentration using Air Quality model "Industrial Source Complex Version 99155 (ISCST3)" developed by the US Environmental Protection Agency (USEPA) in 1995 for atmospheric dispersion of stack emissions from point source. For the modeling purpose three pollutants namely, SPM, SO_2 and NO_X are considered.

The options used for short-term computations are:

- The plume rise is estimated by Briggs formulae, but the final rise is always limited to that of the mixing layer;
- Stack tip down-wash is not considered;
- Buoyancy Induced Dispersion is used to describe the increase in plume dispersion during the ascension phase;
- Calms processing routine is used by default;
- Wind profile exponents is used by default, 'Irwin';
- Flat terrain is used for computations;
- It is assumed that the pollutants do not undergo any physico-chemical transformation and that there is no pollutant removal by dry deposition;
- Cartesian co-ordinate system has been used for computations; and
- The model computations have been done for 10 km with 1 km interval.

Model Input Data

Stack Emission Details

The details of stack emissions for proposed project are given in **Table 4.1**.

Table-4.1: Details of Stack Emissions

S. No.	Parameters	Units	5 x 660 MW
1	Coal Used	Bended Coal (70% Indigenous + 30% Imported)	
2	Stack Height	m	275
3	Number of stacks	no.	2
4	Number of Flues in each stack	-	3+2
5	Internal Exit Diameter of flue	m	7.4
6	Flue gas velocity/flue	m/sec	22
7	Flue gas temperature	°C	140
9.	Emission Rates (Per flue)		
	Sulphur dioxide	gm/sec	722.4
	Oxides of Nitrogen	gm/sec	748.2
	Particulate Matter	gm/sec	68.3

Meteorological Data

Data recorded at the continuous weather monitoring station on wind speed, direction, and temperature at one-hour interval for three months [Oct-Nov-Dec, 2009] was used as meteorological input.

Stability Classification

The percentage occurrence of stability class for the monitoring period and used for the model is given in the **Table 4.2**.

Table 4.2: Stability Classification

Stability Class	Frequency of Occurrence
A	19.7
B	18.5
C	26.1
D	13.7
E	14.8
F	7.2

Mixing Height

As site specific mixing heights were not available, mixing heights based on CPCB publication, "Spatial Distribution of Hourly Mixing Depth over Indian Region", Probes/ 88/2002-03 has been considered for Industrial Source Complex model to establish the worst case scenario. Mixing heights considered for modeling are in **Table 4.3.**

Table 4.3: Mixing Height

Hour of the day	Time period (Oct-Nov-Dec) Mixing Heights* (mts)
7	50.0
8	50.0
9	100.0
10	500.0
11	600.0

Hour of the day	Time period (Oct-Nov-Dec) Mixing Heights* (mts)
12	600.0
13	1000.0
14	1200.0
15	1000.0
16	1000.0
17	1000.0
18	700.0

**** - For remaining hours mixing heights has been considered as 50 m.***

Presentation of Results

In the present case model simulations have been carried using the hourly Triple Joint Frequency data. Short-term simulations were carried to estimate concentrations at the receptors to obtain an optimum description of variations in concentrations over the site in 10-km radius covering 16 directions. The incremental concentrations are estimated for the monitoring period due to operation of the all the units of the project.

Resultant Concentrations after Implementation of the Project

The maximum incremental GLCs due to the proposed project for SPM, SO_2 and NO_X are superimposed on the 98 Percentile baselines SPM, SO_2 and NO_X concentrations recorded at the monitoring locations during the field monitoring period Post-monsoon, 2009. The cumulative ground level concentrations (baseline + incremental) after implementation of full capacity are tabulated in **Table 4.4** and shown in **Figure 4.1 to 4.3.**

Table- 4.4: Cumulative Resultant Concentrations after Plant Operation

On 24 Hourly basis in µg/m³

Name of the Location	Distance	Direction	Monitored Ground level Concentration			Incremental Ground level Concentration			Resultant Ground level concentration		
			SPM	SO_2	NO_X	SPM	SO_2	NO_X	SPM	SO_2	NO_X
Plant Site	0	-	154.7	7.8	9.3	0	0	0	154.7	7.8	9.3
Lumi Village	4.5	W	151.5	7.8	9.2	0.2	1.9	2	151.7	9.7	11.2
Bhadreswar Village	2.5	ENE	152.7	7.8	9.5	0.4	3.9	4	153.1	11.7	13.5
Wadala	2.5	N	141.9	7.6	8.9	0.8	8.5	8.8	142.7	16.1	17.7
Mokha	7	NNW	138.8	7.7	8.9	1.1	11.2	11.6	139.9	18.9	20.5
Bhadreswar	4.5	NE	133.5	7.7	8.1	2.6	27	28	136.1	34.7	36.1
Vovar Satt	7	N	129.4	7.6	7.8	1.8	19.2	19.9	131.2	26.8	27.7

Ash Pond Site	5	WSW	128.1	7.0	7.6	1.9	19.9	20.6	130.0	26.9	28.2
Kukadsar	8	ENE	139.8	7.7	8.5	1.5	16.3	16.9	141.3	24.0	25.4
Bhadreshwar (Near SH)	1.5	NE	143.0	7.7	8.0	0.8	8.5	8.8	143.8	16.2	16.8
Maximum			154.7	7.8	9.3	2.6	27	28	154.7	34.7	28.2
Minimum			128.1	7.0	7.6	0	0	0	130.0	7.8	9.3

From the above table it is observed that the ground level concentrations (after implementation of project) will be well within the prescribed standards of MoEF / CPCB. The maximum monitored ground level ambient air quality concentration values were found to be 154.7, 7.8 and 9.3 µg/m3 for SPM, SO_2, and NOx respectively. The maximum resultant Ground level Concentrations of the study area after the operation of thermal power plant are likely to be 154.7 µg/m3 for SPM at plant site, 34.7 µg/m3 at Bhadreswar for SO_2, 36.1 µg/m3 at Bhadreswar for NOx. It is found that the GLC for SO_2 and NO_X will be well within the prescribed norms of CPCB.

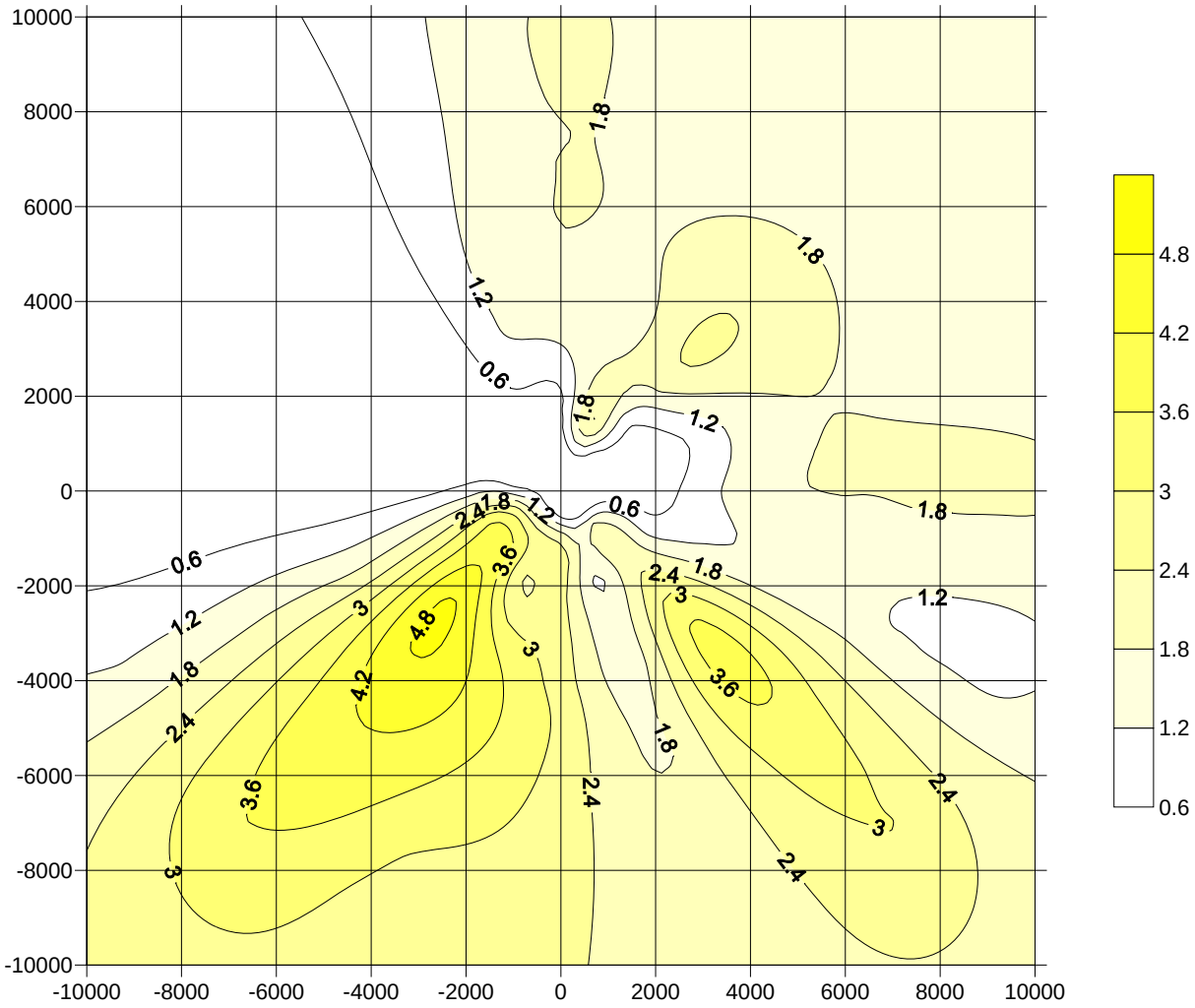
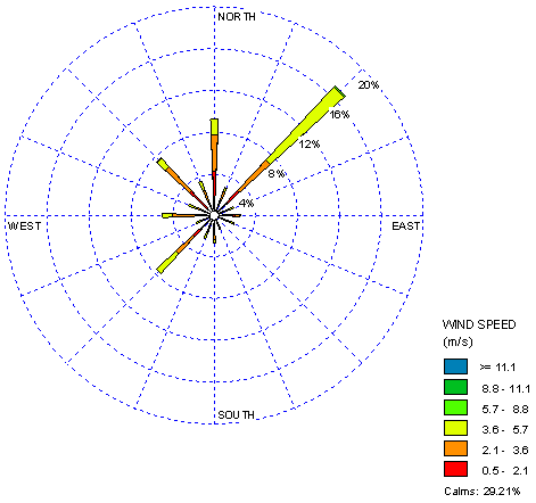


Figure 4.1- Short Term 24 hourly GLCs of SPM



5. ALTERNATIVES

5. ANALYSIS OF ALTERNATIVES

5.1 INTRODUCTION

Kutch Power Generation Limited proposes a Thermal Power Plant with an ultimate capacity of 3300 MW. Demand for Power in Gujarat/Western Region has been steadily increasing with the progressive expansion of the electrical supply system covering larger areas of population and industry. As per CEA estimates there is substantial shortfall in meeting the energy demand of Gujarat state and the western region. The proposed Thermal Power Project at Bhadreswar will eventually generate 3300 MW power in the region thereby reducing the power supply-demand gap in Gujarat state and Western Region.

5.2 ALTERNATIVES OF LOCATION

Two locations were considered as being potentially suitable for the project site. These two sites are located in the kutch District. Selection of the project site was based on the following criteria:

- Nearest Railway Station
- Road Connectivity
- Nearest Water Body
- Site Contour
- Land-use
- Source of Water

5.2.1 Comparision Analysis

Table 5.1 Comparative Statement of the Sites

S. No.	Consideration	Site I	Site II
1	**Location**	Bhadreswar	Hatadi Village
2	**Latitude**	22°53'18.4"N	22°55'57.3"N
3	**Longitude**	69°52'01.6"E	69°54'53.9"E
4	**Nearest Railway**	Anjar (30 kms)	Anjar (25 kms)

	Station		
5	**Road Connectivity**	8 km from NH-8A	9.0 km from NH-8A
6	**Nearest Water Body**	2.0 Km (Mithi River)	0.5 Km (- River)
7	**Site Contour**	15-22 m	20-35 m
8	**Land-use**	About 30% Agriculture Land	About 75% Agriculture Land
9	**Source of Water**	Sea (3.5 kms)	Sea (9 kms)
SUITABILITY		Most Suitable	Alternate Considered

- The site consist most of the barren land more than 70% compare to alternate one consist only 20% barren land.
- No homestead displacement
- The site is well approachable to Railway Network SH & NH
- No forest land involved.
- The site is more than 500m away from any of the Riverine Flood Plain / State & National Highway/ Railway Line

5.3 FUEL ALTERNATIVES

The fuel used for Thermal Power Plant will be blended Coal (Imported / Indian) with average calorific value 4000 kcal/kg. The coal will be imported from the countries like Indonesia, China and Australia through Adani Port. The coal will be transported from Adani Port to the proposed site by dedicated railway line and the Indian coal will be transported through railway to the proposed site from their respective coal linkages.

5.4 ALTERNATIVES FOR TECHNOLOGY

As already mentioned, the proposed plant will be using super-critical technology. The thermal efficiency of the power plant can be improved by using the steam at super critical condition. The improvement in overall efficiency of the plant compared to sub critical parameters will be at least 2% if the super critical parameters are implemented. The importance of thermal efficiency of the thermodynamic cycle and the methods to

improve the thermal efficiency of the cycle are also analyzed. The indirect costs such as reduction in maintenance cost, auxiliary power consumption, ash dyke area and environmental benefits such as reduction in green house gases; water requirements, etc. are additional to the above increase in efficiency.

Importance of Efficiency: Since the time thermal power stations have been engineered, there is a quest for efficiency improvement. One such effort in that direction is supercritical parameters (i.e.) the pressure above 225kg/cm^2 and temperature above 374.15ºC. The supercritical parameters for each 660 MW boiler are: 256 kg/cm^2 of pressure and 568ºC SH and 568ºC RH of temperature.

Methods of Increasing Rankin Cycle Efficiency: The steam power cycle efficiency can be improved by the following methods:

- **Raising supply temperature by super heating:** Increasing the turbine inlet temperature of steam will raise the heat supply to the boiler more than the heat rejection.
- **Raising inlet pressure of steam:** Increasing the pressure will mean increase in saturation temperature at which steam evaporates thus increasing the average inlet temperature.
- Efficiency can be improved by dropping the final pressure (or temperature) at which heat is rejected.
- **Regenerative heating:** Heating the feed water pumped to the boiler by bleeding steam from turbine.
- **Reheat cycle:** Reheating of steam in boiler after it has already expanded in high pressure (HP) turbine will avoid moisture formation in low pressure (LP) Turbine. Also more heat content of steam before LP turbine will improve efficiency.

5.4.1 Supercritical Conditions

The critical condition of water: Critical pressure = 225.56 Kg/cm^2

Critical temperature = 374.15º C

At most elevated condition the steam is supercritical. Thus, if water is at a supercritical pressure and is heated the temperature will increase continuously. At a particular value the water will flash instantaneously into steam and super heating will commence. There is no change of specific volume from the liquid to the dry steam state.

5.4.2 Supercritical Boiler

A Boiler operating at a pressure above critical point is called Supercritical Boiler. Supercritical Boiler has no drum and heat-absorbing surface being, in effect, one

continuous tube hence called 'Once through Supercritical Pressure Boilers'. Boiler Feed Pump pressurizes the water in boiler, sensible heat is added in feed heaters, economizer and furnace tubes, until water attains saturation temperature and flashes instantaneously to dry saturated steam and super heating commences.

5.4.3 Advantages of Supercritical Thermal Cycle:

- Improvement in power plant efficiency is more than 2%
- Reduction in coal consumption
- Reduction in Green house gases
- Overall reduction in Auxiliary Power Consumption
- Reduction in requirement of Ash dyke land & Consumptive water.
- Sliding pressure operation due to once through system.
- Uniform distribution of heat due to spiral wall arrangement leading to less Boiler tube failure, thereby improving system continuity and availability of the station.
- Low thermal stress in turbine.
- Less start up time of the boiler.

6. ENVIORNMENT MONITORING PROGRAMME

6. ENVIRONMENT MONITORING PROGRAMME

6.1 ENVIRONMENT MANAGEMENT CELL STRUCTURE AND RESPONSIBILITIES

A separate environment management cell comprising of a team of experienced and qualified personnel reporting to a very senior level executive preferably an environmental engineer is proposed. He will be assisted by well trained staffs comprising of environmental and safety specialists.

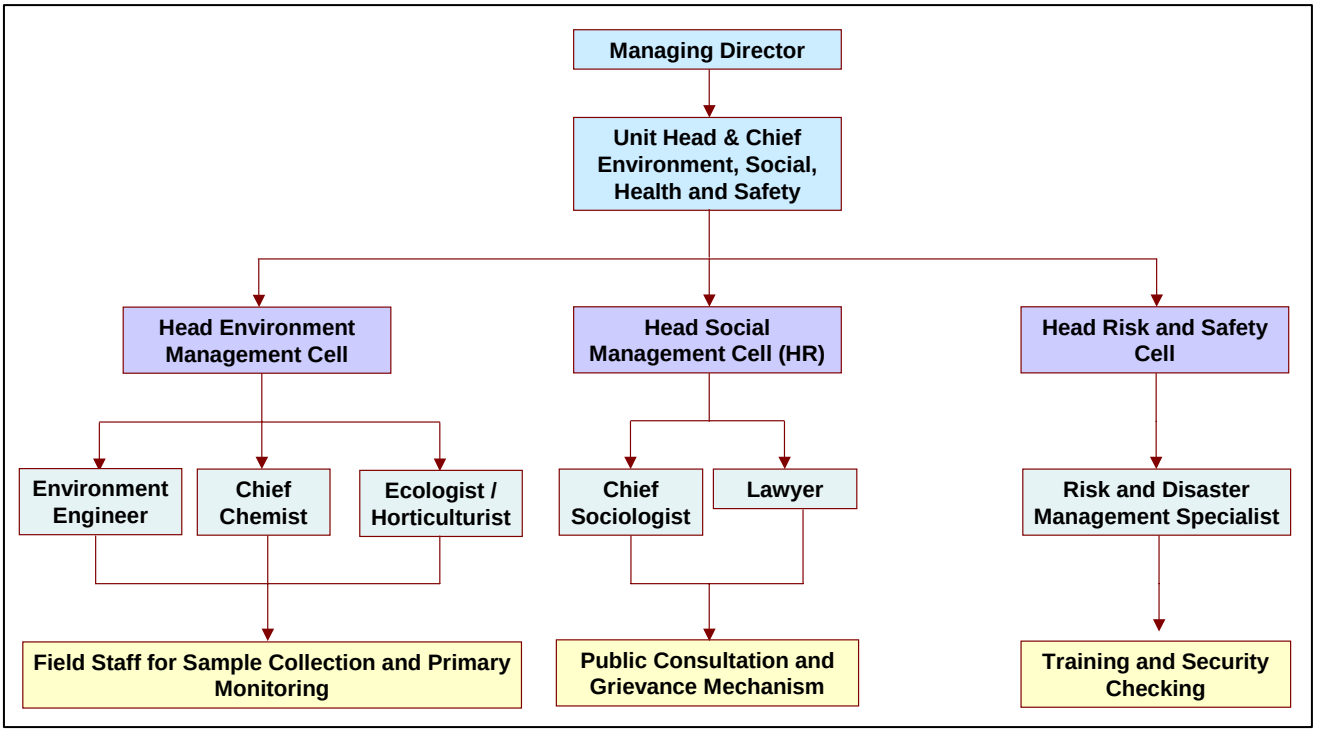
Staff will be trained for environment control measures like air, water quality monitoring, solid waste management, noise abatement etc. Staff would also be trained to operate ESP and other pollution control equipment at optimum efficiency.

The Environment Management Cell will be responsible managing following activities related to environment function of proposed Power Plant:

- Coordinate and manage the EMP implementation during pre-construction, construction and operation phase
- Appoint dedicated environment staff to manage environmental monitoring responsibilities
- Manage and coordinate environmental monitoring and control
- Coordination with other sections of the plant and government agencies in relation to environmental management activities
- Implement and monitor mangrove protection and plantation activities
- Safety specialist will ensure safe working practices in all the sections of the plant

6.2 IMPLEMENTATION OF ENVIRONMENT & SOCIAL MANAGEMENT SYSTEM (ISO 14000)

A structured and certified environment management system is suggested at the industry level for ensuring that all the activities, products and services conform to the environmental and social requirement. For the proposed thermal power plant, the Environmental and Social Management System set up and its role and responsibilities will be based on the requirement as per ISO 14000 certification. The company is also committed to pursue Occupational Health and Safety Assessment System OHSAS 18001 to be certified by national and international certifying agencies. These shall include latest international technologies and practices.



Qualification Chart of Personnel of EM Cell

Environmental Engineer	B.E./M.E Environmental Engineering with 5-10 years experience
Chief Sociologist	Master in Social Work with 5-10 years experience in the relevant manners
Risk and Disaster Specialist	B.E./M.E Mechanical Engineering with 5-10 years experience
Chief Chemist	Post Graduate in Chemistry with minimum 5 years of experience in water and air analysis
Lawyer (Social and Labour's Law)	LLB in relevant manner with at least 5 years experience
Horticulturist/Ecologist/Botanist	Post Graduate in Chemistry with minimum 5 years of experience in water and Air analysis
Chemist and Lab technician	Graduate in respective area
Field Staff for Sample Collection	Degree in Chemistry
Field Staff for Public Consultation	Degree in Social Work

6.3 ENVIRONMENT MONITORING PROGRAMME

Table 6.1: Environment Monitoring Program

Aspect	Parameters	Frequency	Location	Equipment used	Annual Monitoring Cost (INR)
Ambient Air Quality	SPM, RPM, SO_2, NO_x	Twice in a week and 24 hour at each station	Five site within the Impact area, including power plant site	Respirable dust Sampler	520000 @ 1000 per sample
Stack Emission	SPM, SO_2, NO_x	Continuous	Each Stack	In-situ continous monitors	
Meteorology	Temperature, wind speed and direction, Relative humidity, Rainfall, atmospheric temperature	Continuous on hourly basis	One site inside the plant	Anemometer with data logger and printer facility, thermo hygrograph, Rain gauge	146000 @ 400 per day
Surface water quality	Physical, chemical and biological parameters including heavy metals	Monthly	4 locations within the impact zone including sea water	Standard laboratory Equipment	150000 @ 3000 per sample
Ground water quality	Physical, chemical and biological parameters including heavy metals	Monthly	Five station with ash disposal area	Standard laboratory Equipment	180000 @ 3000 per sample
Plant effluents	Physical and chemical properties including heavy metals	Monthly		Standard laboratory Equipment	60000 @ 5000 per sample
Soils	Physical and chemical parameters	Once every years	Ten locations including ash disposal site	Standard laboratory Equipment	50000 @ 5000 per sample

Aspect	Parameters	Frequency	Location	Equipment used	Annual Monitoring Cost (INR)
	with organic content and heavy metals				
Noise level	Noise	Once in a week	Five station close to air quality monitoring stations	Noise level meter	130000 @ 500 per day
Ecology	Visible damage to crops, density and diversity of fish, mangrove	Yearly	Sea Water	Standard laboratory Equipment	

6.3.1 Budget

The approximate Environment Management Cost to be incurred by the project proponents are given in **Table 6.2.**

Table 6.2: Cost Provision for Environmental Measures (3300 MW TPP)

Sr. No.	Description of Item	Cost (Rs. in Crores)
1	Electrostatic Precipitators	233.33
2	Stacks	116.67
3	Ash Handling unit	66.67
4	Ash pond dyke	108.33
6	Effluent Treatment Plant (ETP)	29.17
7	Dust Suppression System	2.08
8	Control of Fire & Explosion Hazards	25.00
9	DM Plant Waste Treatment Systems	2.50
10	Sewage Collection, Treatment & Disposal (STP)	2.92
11	Environmental Lab Equipment and on line Monitoring equipments	0.42
12	Green Belt	7.25
Total		**594.34**

6.4 SUMMARY OF MITIGATION AND ENHANCEMENT MEASURES

The specific environmental impacts and mitigation measures at pre-construction, implementation and operation phases are summarized in **Table 6.3.**

Table 6.3: Environment Impacts and Mitigation Measures

Possible Impact	Mitigation during planning and design	Mitigation during construction	Mitigation during operation
Air Impact	Incorporate consultant and engineers advice	Spray water on dry surface generating dust particles Regulate vehicle emission	Implementation of ESP and bag filters Provide proper ash utilization Plan Green belt development
Soil Quality Degradation	Consider strategies to avoid soil quality degradation	Removing top soil for construction, turfing and plantation after civil works.	Continuous monitoring of soil quality. Green belt development. Proper ash utilization.
Drainage and irrigation	Sea water will be the source of water for the power plant. So, there will be no impact on local drainage and irrigation system	-	Rain water harvesting plan will be prepared and implemented to improve the fresh water hydrology of the area
Groundwater depletion and quality degradation	Sea water will be the source of water for the power plant. So, there will be no impact on groundwater system	-	Rain water harvesting will improve the ground water regime
Surface water pollution	Incorporate the guidelines suggested by National Institute of Oceanography (NIO)	It will utilize the intake and outfall facilities.	Discharge of effluent will be based on the recommendation of NIO
Aquatic Ecosystem	Suitable Intake and Outfall point selection based on the NIO Study	It will utilize the intake and outfall facilities.	Discharge of effluent will be based on the recommendation of NIO
Terrestrial ecosystem (disruption to flora and fauna)	Suitable site selection and alignment of roads	Suitable site selection avoiding unnecessary disruption of existing vegetation	Green belt development conserve local biota
Disruption of road traffic	Suitable planning for traffic movement as per time schedule	Practice caution in use of vehicles	Monitoring road trafficking situation

Possible Impact	Mitigation during planning and design	Mitigation during construction	Mitigation during operation
Disturbance to water supply	Minimize impediments to water supply	Establish adequate alternative water supply	Establish adequate alternative water supply and Continuous monitoring
Occupational health hazard	-	Providing health inspection and vaccination Organizing proper disposal procedure of waste Providing adequate sanitary facilities to personnel and workers	Providing health inspection and vaccination Periodic health check-up
Safety of workers		Adopt appropriate safety measures Provide first aid services Make workers aware of risks and how to avoid these risks.	Workers would be provided with hand gloves ear muffs, safety boots, safety goggles, helmets etc. Workers should be trained to follow safe working practices Proper hospital facility would be provided

7. ADDITIONAL STUDIES

7. ADDITIONAL STUDIES

7.1 INTRODUCTION

As per the conditions of the Terms of Reference given by EAC for preparation of the EIA/EMP Report, several studies were to be conducted to provide a clear picture of the project area. The suggested studies/activities include:

- Public Hearing
- R&R Plan
- Area Drainage study
- Risk Assessment Plan
- Disaster Management Plan

7.2 PUBLIC HEARING

As per the conditions of the EIA Notification 2006, public consultation should be held for the project. "Public Consultation" refers to the process by which the concerns of locally affected persons and others who have plausible stake in the environmental impacts of the project or activity are ascertained with a view to taking into account all the material concerns in the project or activity design as appropriate. Public consultation process comprises of two parts, viz Public Hearing and written response from stakeholders.

The Public Hearing shall be arranged in a systematic, time bound and transparent manner ensuring widest possible public participation at the project site(s) or in its close proximity District -wise, by Gujarat Pollution Control Board (GPCB). The EIA report will be submitted to the Gujarat Pollution Control Board along with other relevant documents and additional studies. The GPCB will process the application for Public Hearing and conduct the hearing within 45 days of the date of application.

For obtaining responses in writing from other concerned persons having a plausible stake in the environmental aspects of the project or activity, the concerned regulatory authority and the GPCB shall invite responses from such concerned persons by placing on their website the Summary EIA report along with a copy of the application in the prescribed form, within seven days of the receipt of a written request for arranging the public hearing.

Confidential information including non-disclosable or legally privileged information involving Intellectual Property Right, source specified in the application shall not be placed on the web site**.** The regulatory authority concerned may also use other appropriate media for ensuring wide publicity about the project or activity. The regulatory authority shall, however, make available on a written request from any concerned person the Draft EIA report for inspection at a notified place during normal office hours till the date of the public hearing. All the responses received as part of this public consultation process shall be forwarded to the applicant through the quickest available means.

After completion of the public consultation, the applicant shall address all the environmental concerns expressed during this process, and make appropriate changes in the draft EIA and EMP. The final EIA report, so prepared, shall be submitted by the applicant to the MoEF for appraisal. The applicant may alternatively submit a supplementary report to draft EIA and EMP addressing all the concerns expressed during the public consultation.

1.1 R & R PLAN

The Resettlement and Rehabilitation (R&R) Plan arises as a result of acquisition of land. However, based on the long experience of implementation of thermal power projects, Kutch Power Generation Limited along with state government considers the following principles.

- Involuntary resettlement shall be avoided to the extent possible or minimized wherever feasible, exploring all viable alternative project designs;
- Where displacement is unavoidable, people losing assets, livelihood or other resources shall be assisted in improving or at a minimum regaining their former status of living at no cost to themselves; and
- Community participation in planning and implementing resettlement should be encouraged.

No R&R is involved for the project site. ROW will be obtained with mutual consent and as per the standard laws.

1.2 AREA DRAINAGE STUDY

The scope of work for area drainage study based on the work order and availability of data is as given below:

- Study of available information having a bearing on the area drainage plan including review of topographical features of the proposed power plant areas for the power project and its surrounding area.
- Review and analysis of rainfall information to arrive at design storm scenarios of various return periods.
- Preparation of digital elevation model for the study area for delineation of catchments and delineation of drainage network for comparison with drains of various return periods.
- Compilation of land use, soil and other characteristics of the catchments for determining rainfall excess using an appropriate method.
- Application of event based model for the estimation of flood hydrographs considering historical as well as design rainfall for different return periods.
- Site visits for reconnaissance survey and on the spot collection of data necessary for satisfactory completion of the area drainage study.

1.3 RISK ASSESSMENT PLAN

As per the Environment Protection Act, Section 8 and rules under Manufacturing and Storage of Hazardous Chemical rules 1994 4(2), an occupier of an existing industrial plant

shall have identified the major accident hazards and taken adequate steps to prevent such major accidents. Occupier shall provide to the persons working on the site with the information, training and equipment including antidotes necessary to ensure their safety. Also rule 10 (4&6) stipulates that the Occupier shall have to update Safety Audit report once in a year by conducting a fresh Safety Audit. The factories Act 1948, rule 7A specifies the general duties of occupier such as to ensure the health, safety and welfare of all workers while they are at work in the factory and to maintain all places of work in the factory in condition that is safe and without risk to health. In light of above, risk assessment is one such tool to identify hazards at industrial site and take engineering and managerial steps to mitigate the same.

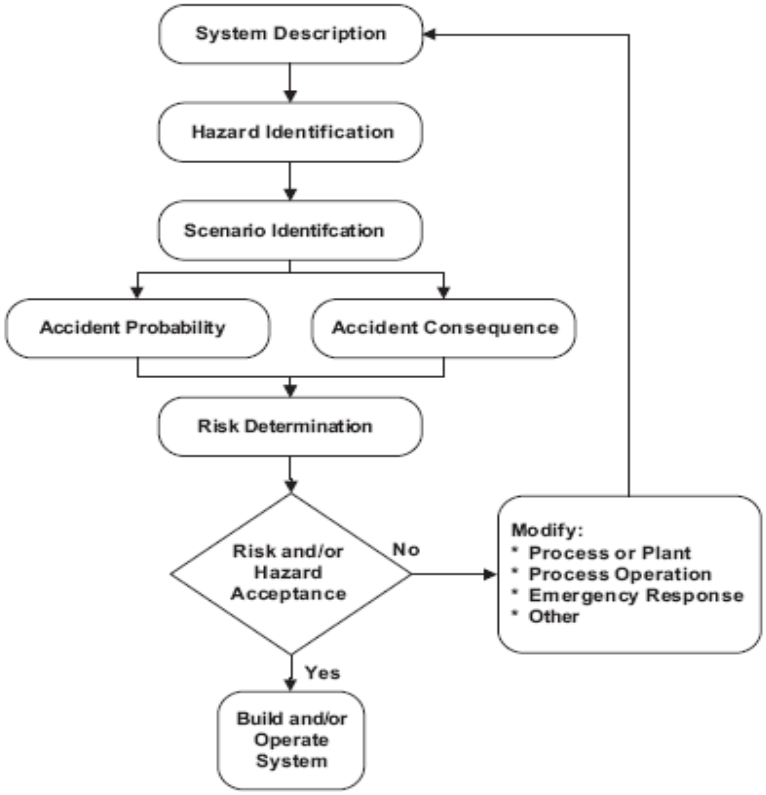


Fig. 1. The hazard identification and risk assessment procedure (Crowl & Louvar, 2002).

Risk assessments supply information to decision makers and require practical data to provide a foundation for their validity and to establish confidence in their output. The present study is based upon the field survey conducted on the stretch and data obtained from numerous published sources. The major limitation of all these data is that they are for developed countries. The absence of root data pertaining to our cases has prevented near ideal calculation of the risk. Nevertheless, the probability and frequencies used in the report still holds good for similar scenarios and hence used without any modification or correction factor. Risk Assessment in such scenarios depends upon numerator and denominator data. Numerator data for risk assessments are based on counts of incidents and accidents that, in the past and Denominator data indicate the level of exposure for hazardous materials. The present case study has been designed to suit the needs of coal based thermal power station.

7.6 APPLICABLE STATUTORY RULES AND REGULATIONS

The responsibility for complying with the provisions of various statuary rules and regulations on Safety, Health and Environment lies on the management or the Project Proponent which is as follows:

- Environment protection Act 1986 and Rules made there under including the Manufacture, Storage & Import of Hazardous Chemicals Rules, 1989 (MSIHC) amended in 1994 & 2000
- Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996
- Public Liability Insurance Act 1991, amended 1992 and the Public Liability Insurance Rules 1991, amended 1993
- Factory Act 1948 & Factory Rules
- Petroleum Act 1934 and Petroleum Rules 1981 amended 2002
- Gas Cylinder rules 2004 and Static & Mobile Pressure Vessels (SMPV) (unfired) Rules 1981 amended in 1993
- The Electricity Act 2003 and India Electricity Rules 1956.

7.7 RISK ASSESSMENT PROCESS

The hazards associated with the above are detailed in the following sections. The broad risk assessment methodology for evaluating and assessing risks from handling and storage of chemicals are:

- Identification of hazards arising from storage and processing
- Establish failure frequencies for selected scenarios
- Perform Consequence Analysis
- Assess the Vulnerability
- Provide Risk Reduction Strategies including emergency plans

7.8 IDENTIFICATION OF HAZARDS

Hazard identification is one tool by which hazards associated with a chemical can be properly identified for further assessment and more importantly adequate safety measures can be adopted to screen off personnel from exposure to the same.

Another aim of hazard identification is to keep the plant engineering integrity in accordance with the best design principle for safe and reliable operation. Hazard identification can be achieved from various angles as described below:

- **First –**Listing of all equipments located in an area can be done, which is called equipment inventorization and describe all the activities, which are associated with the each type of equipment including its maintenance. If a particular piece of equipment is not in use, it may be listed in the column “Equipment currently not in use”.

- **Second –** A list of all on-going projects in a process/storage/handling area may be prepared and the main experimental procedures for the work could be described.
- **Third –** A list of all "designated" or "day-to-day" activities performed within the battery limits of the plant can be enumerated.

Identification all types of hazard associated with each activity

The following main hazards may exist in the factory under the situations given below.

Table 7.1 Types of Hazards

Hazard	Potential location
High temperature and pressure.	Boiler House, Generator Area
Fire & explosions (due to inflammable/ combustible materials).	Storage House, Boiler Feed Chamber, Testing
Toxic and corrosive chemicals	Waste water treatment, chlorine dosing
Toxic and poisonous gases and dust	Conveyor system, Coal handling plant
Electricity (Receiving/Clue ration/ Distribution).	Entire area specifically generator section, distribution, control rooms
Disposal of wastes	Ash dyke, spent oils, electrostatic precipitator
Work at heights	Boiler house, cooling towers
Work in confined spaces / vessels / tank etc.	Maintenance section, control room
Specific jobs carried under highly hazards atmosphere (CO_2, NH_3, toxic vapours etc.)	Ammonia dosing system
Non-working of safety devices, inter locks, failure of high RPM machineries	Turbo-generator section
Failure of boilers etc.	Boiler area
Any other consequences due to leak of Ammonia, Chlorine gases	Dosing system, testing and quality section
Hazards during heavy equipment handling (Crane, etc.)	Boiler, Turbine and Maintenance section
Road accidents	Receipt and dispatch section, loading/ unloading gantry

The hazard identification method for the project was performed by analyzing physico-chemical properties of the substances and evaluating them against the system specific backdrop. The site-specific parameters were taken into account. In this section, following hazards have been dealt with:

- Mechanical hazards
- Electrical hazards
- Chemical hazards
- Physical hazards

7.8.1 MECHANICAL HAZARDS

The mechanical hazards are those arising from mechanical operations such as material handling in different sections such as wagon tipper area, coal handling plant, boiler room, electrostatic precipitator area and those during maintenance operations. In power plant, major material handling equipments are Wagon Tipplers for unloading coal from Rail-Wagons, Belt Conveyors for coal handling, EOT Crane in Turbine House, HT Workshop, Chlorination Plant and other areas.

Belt conveyers of coal plants should be provided with pull-cord to stop in case of emergency. Efforts should be made to monitor these as sometime these cords may be slack thereby loosing its efficiency. It is suggested to check and set right these to maintain them in perfect working order always. Side screen guards should be provided with conveyor guard so that a chance of coal falling is prevented.

At the time of wagon tipping adequate precaution shall be taken to prevent movement of locomotive and keep human being away from hazard zone. It would be a good practice by automatic switching of red light on rail-track. Beside there should be enough provision of water sprinklers to cease the fire. A siren should generally be blown every time wagon tipping process is carried out.

All cranes and lifting machines should be regularly inspected and tested by competent person. Date of testing and next due date of testing should be marked on the machines and record of testing with date should be maintained in a log book for inspection by statutory authority and future reference. Moreover safe working load should be written on these. It is suggested to get implemented all the statutory points of these tackles religiously.

7.8.2 ELECTRICAL HAZARDS

The electrical hazard identification has been conducted taking into consideration the following aspects for the project:

- Layout of electrical installation
- Suitability/adequacy of electrical equipments with respect to classified hazardous areas.
- Maintenance / preventive maintenance practice
- Testing / inspection schedules
- Standard operating practices
- Work permit systems
- PPEs and First – Aid practices
- Training programmes on Electrical Safety
- Compliance of IE Rules
- Healthiness of electrical installation

- Lighting protection / protection against static charges

Single Line Diagram

Main control Rooms, LT & HT rooms near control room should have respective single line diagrams with chief control officer or shift engineer as may be the case. They should be under safe custody to prevent any trespassing or theft by unauthorized personnel. Further, it is suggested that:

Mimic diagram on front and backside of all HT Switchgears.

- Changes in electrical system should be made through laid down procedures, approved by competent authority. "As built" drawings must replace existing drawing in all places.
- In Coal Handling Plant, un-authorized entry should be prohibited through lock & key. Only authorized persons should have access to the key. The same procedure may be followed in Electrical Rooms, Switchyard and other electrical premises too.
- Electrical Installations must have suitable markings. Danger boards are be located as per IE Rules.

EOT Cranes

EOT cranes shall be provided with adequate "Danger Marking'' as per norms and in addition to "travel cut off" by limit switch. This will be applicable for EOT crane at Turbine House, HT workshop.

Mandatory Requirements

Availability of shock treatment charts, proper rubber mats, sand buckets etc. are mandatory in Electrical Rooms. These should be available in electrical rooms, near and below Main Control Rooms. The same should be made available in other electrical rooms such as compressor, CW system, Water Treatment Plant etc.

Electrical Equipment in Hazardous Area

- Area classification drawings
- It is a mandatory requirement that electrical equipments be compatible to hazard area condition.
- Electrical Equipment to be used as per approval area classification
- In FO tank area and FO station, all electrical items should confirm to respective hazardous area (IS – 5572)
- In fuel oil station, pump motors are flame proof but terminal box and joints are not as per required flameproof footings. Cable laying in FO pump station should be as per respective area classification. Use of normal torch, mobile phones etc. should be prohibited.

Electrical Shock/ Flash / Injury Hazards can arise from

- RCCBs –selection, installation and maintenance
- Aspect of Nuisance Tripping and bypassing of RCCBs
- Bypasses fuses, MCB (Miniature Circuit Breaker), etc.
- Use of re-wirable fuses
- Earthing defects
- Use of double insulated (class II) tools, centre tapped power supply, extra-low voltage equipment for confined spaces
- Accessible live parts
- Electrical rubber mat
- Wrong identification of equipment / feeders
- Defective electrical portable tools
- Non use of necessary PPEs (Personal Protective Equipments)
- No Interlocks provided for multiple power sources
- No interlocking system in place
- MCC (Motor Control Centers) /PCCs (Power Control Centers) / DBs (Distribution Boards) flash incidents
- Operational clearance not as per IER 51
- Tripping hazards due to loose cabling/cords, etc.
- Inadequacy of illumination in electrical rooms/around panels, DBs, etc.
- Failure of stand-by power supply (Diesel Generator set)

Electrical Fire Hazards can arise from

- Storage of combustible materials near electrical equipment / fuse units/ RCCBs/ Master switch in warehouses
- Improper cable joint procedures as per manufacturer
- Earthing defects
- Use of non-standard fuse wires
- Bypassing of protection devices
- Deteriorated insulation
- Selection, deployment of PFEs ((Portable Fire Extinguishers)
- Sealing of cable passes, openings, baffle walls (Passive Fire Protection)
- Tracking possibility
- Unused openings in live panels, etc.
- Possibility of ground fault / short circuit
- Failure of Mechanical protection to cables
- Loose terminations due to improper supports, crimping
- Improper gland installation, wrong lug size
- Over-rated fuses, wrongly set protection relays, etc.

7.8.3 HAZARDOUS CHEMICALS AND SUBSTANCES

Apart from coal, hazardous chemicals handled at the site are:

- Chlorine

- Hydrogen
- LDO / HFO
- Ammonia

Storage Details of other chemicals are as follows:

Chemicals used as 100% along with quantity	Hydrochloric Acid (1200 Kg/day)	Sodium Hydroxide (1000 kg/day)	Sulfuric Acid (6150 kg/day)	Hydrazine (5 kg/day)	Ammonia (36 kg/day)	Ferric chloride (4350 kg/day)
Storage types and dimensions	Horizontal storage tank (2.75m dia x 6.6m LOS)	Horizontal storage tank (2 m dia x 3.1m LOS)	Horizontal storage tank (2.75 m dia x 6m LOS)	carboys	carboys	Horizontal storage tank (2.75 m dia x 5.75 m LOS)

Antiscalant (3110 kg/day)	Bio-dispersant (780 kg/day)	Bioside (2110 kg/month)	Polyelectrolyte (420 kg/day)	Sodium Hexa Meta phosphate (96 kg/day)	Sodium Bi sulfite (180 kg/day)	Tri sodium Phosphate (48 kg/day)
carboys	carboys	carboys	carboys	carboys	carboys	carboys

Storage hazards

In normal course of storage, acid tanks may not pose any risk to the personnel. The storage tanks would also operate under normal atmospheric conditions and hence storage overpressure hazards will not arise. Acid exposure during maintenance cleaning operations and transfer from road tankers could pose a direct health hazard to the operating personnel. In identifying storage hazards from acid storage tanks, it is important to observe that mechanical failures can give rise to acid spills or leaks.

In the event of external damage to tank during maintenance operations, spill could pose a health hazard to the personnel. Statistics involving past incidents indicate that all of the above-ground liquid storage tanks that fail appear to have had defective welds. The failure of liquid storage tanks can stem from inadequate tank design, construction, inspection, and maintenance. Hazard reduction and prevention starts with good design and construction.

The risk to tanks already in service can be reduced through tank maintenance and weld inspection. To minimize effects from possible tank failures, there should be a secondary containment such as a dike surrounding the tank. In each of the tank failures mentioned, welding has been the main cause of failure. To ensure durability and integrity, it is imperative that the tank is welded correctly.

Several standards and specifications outline the proper techniques and procedures for welding including API-653, *"Tank Inspection, Repair, Alteration, and Reconstruction."* Another cause of storage system failure is the malfunctioning of excess flow valve.

Chemicals used as 100% along with quantity	Ferric chloride (4350 kg/day)	Polyelectrolyte (420 kg/day)	sodium Hexa Meta phosphate (96 kg/day)	Sodium Bi sulfite (180 kg/day)	Hydrazine (5 kg/day)	Ammonia (36 kg/day)	Tri sodium Phosphate (48 kg/day)
Concentration of chemicals	30 %	100%	62% as P2O5	---	52%	25%	17-17.5%
Storage pressure and temperature	Atmospheric Pressure & Ambient Temperature	Atmospheric Pressure & Ambient Temperature	Atmospheric Pressure & Ambient Temperature	Atmospheric Pressure & Ambient Temperature	Atmospheric Pressure & Ambient Temperature	Atmospheric Pressure & Under shed	Atmospheric Pressure & Ambient Temperature
Carboys capacity	NA	30-35 Lt	NA	NA	35kg to 200 kg	35 to 150 Lt	NA

Chemicals used as 100% along with quantity	Hydrochloric Acid (1200 Kg/day)	Sodium Hydroxide (1000 kg/day)	Sulfuric Acid (6150 kg/day)	Antiscalant (3110 kg/day)	Bio-dispersant (780 kg/day)	Biocide (2110 kg/month)
Concentration of chemicals	30-33%	48%	96-98%	Not specified as per manufacturer standard	Not specified as per manufacturer standard	Not specified as per manufacturer standard
Storage pressure and temperature	Atmospheric Pressure & Ambient Temperature	Atmospheric Pressure & Ambient Temperature	Atmospheric Pressure & Ambient Temperature	Atmospheric Pressure & Ambient Temperature	Atmospheric Pressure & Ambient Temperature	Atmospheric Pressure & Ambient Temperature
Caroys capacity	NA	NA `	NA	30-35 Lt	30-35 Lt	30-35 Lt

Loading Losses

Loading losses are the primary source of evaporative emissions from rail tank car, tank truck, and marine vessel operations. Loading losses occur as organic vapors in "empty" cargo tanks are displaced to the atmosphere by the liquid being loaded into the tanks. These vapors are a composite of (1) vapors formed in the empty tank by evaporation of residual product from previous loads, (2) vapors transferred to the tank in vapor balance systems as product is being unloaded, and (3) vapors generated in the tank as the new product is being loaded.

Transfer Pipework/ Road Tanker Loading and Unloading	Rupture Pool fire Flash fire VCE	Puncture Pool fire Flash fire VCE	Small hole Flash fire

Failure of Storage Tanks

Storage tanks can fail due to very high internal pressure or external pressure (as in case of vacuum). The presence of a hazardous (toxic/flammable) substance only adds to the consequence, if any from the release of the chemical. Shell and side beam failures are a good possibility when there is inflammable vapour building inside a tank. These have caused tank bursting or collapsing in the past. Vertical splitting along beam is more probable than tank overturning.

Rapid build-up of ignitable vapours due to external act like flange welding during maintenance, often cause the storage tank to explode violently. These incidents involve shell to bottom beam failures and are common to old steel atmospheric tanks. Vapours can ignite either outside or inside the tank-causing fire. Corrosion of tank bottoms can also lead to slow spillage, which may lead to tank collapse. A relevant standard for good atmospheric tank design is laid in API -650, welded steel tanks for oil storage, which need to be adopted. The unit will have storage tanks for storing hazardous chemicals.

Table 7.2 Failure mode and causes of Risk

S. No.	Failure Mode	Probable Cause	Remarks
1.	Flange/Gasket failure	Incorrect gasket, Incorrect installation.	Attention to be paid during selection and installation of gaskets.
2	Weld failure	It is normally due to poor quality of welds	Welding should be done by certified welders with right quality of welding rods. Inspection and radiography must also be done.
3	Pipe corrosion erosion or failure due to stress	Some times fabrication or installation leaves stress in the pipes. Erosion or corrosion also is sometimes the cause.	Pipes material for construction should be selected correctly. Design should take care of erosion effects and installation of pipes should not leave any stress.
4	Over pressurization of pipeline	Over pressurization can occur due to failure of SRV or incorrect operation.	Necessary precaution should be taken to prevent over pressurization.
5	Deficient installation of pipes	Pipes design and installation is sometimes not as per appropriate standard.	It must be ensured that installation is as per correct standards.

S. No.	Failure Mode	Probable Cause	Remarks
6	Leaks from valve	A leak from glands, bonnets or failures of valves spindle is sometimes the cause.	Right selection of valves and their maintenance should be ensured.
7	Instruments failure	Multifarious instruments are used for control of process parameters. Any such instrument failure can cause mishap.	Reliability & working of instruments must be ensured through proper selection and maintenance.
8	Failures of protective system	Protective system like SRV, bursting discs, vent header, drain lines etc. are provided to take care of abnormal conditions.	Reliability of protective system must be ensured through inspection and proper maintenance.
9	Operational effort	Plant operational parameters should not exceed beyond the permissible limits.	Operating procedures must be strictly followed.
10	Other failures	There are other external reasons causing the failures.	Design and operating philosophy must consider all possible reasons.

The chemicals and other materials used in thermal power plants usually do not involve banned or phased out materials. Kutchh Power Generation Limited to ensure that the transformers purchased/ imported are free from oil containing polychlorinated bi/ ter-phenyls (PCBs or PCTs)

7.8.4 COAL

According to available literature sources for coal hazards, coal is susceptible to spontaneous combustion, most commonly due to oxidation of pyrite or other sulphidic contaminants in coal. Coal preparation operations also present fire and explosion hazard due to the generation of coal dust, which may ignite depending on its concentration in air and presence of ignition sources. Coal dust therefore represents a significant explosion hazard in coal storage and handling facilities where coal dust clouds may be generated in enclosed spaces.

- Unwanted non-coal materials like shale and stones are generally present with occasional presence of iron pieces like shovel teeth etc. Some of **the common**

problems of power plants due to poor and inconsistent raw coal quality are listed below:

- Damage to conveyor belts, crusher elements and frequent choking of chutes and feeders;
- Reduced pulverising capacity of the mills, higher erosion of grinding elements and reduced availability of mills due to higher outages;
- Reduced flame stability requiring additional oil support;
- Sagging and fouling of the water walls;
- Faster erosion at the coal burners and flue gas path;
- Increased requirement of land for dumping of ash, and ash handling equipment;
- Reduced Plant Load Factor (PLF) as well as reduced station thermal efficiency;
- Higher emissions and related environmental impacts.
- Several other operational problems may also arise due to poor and inconsistent quality of coal.

Coal Handling Unit

Component	Type of defect	Affecting factor	Reasons
Transfer Chute Liners, Grinding jib of crushers.	Reduction in thickness due to wearing of surface	Continuous coal flow	Friction between coal and component
Transfer Chute Liners, Grinding jib of crushers.	Development of cracks, holes	Impact of coal	Crack generated from the holes for fixing of bolts
Transfer Chute Liners, Grinding jib of crushers	Pitting	Corrosive component of coal	Chances are more when wet coal flows through.
Conveyor structures	Reduction in thickness due to wearing of surface and pitting	Corrosive component of coal	The accumulation of coal on structures
Conveyor structures	Catastrophic structure failure	Cyclic Loading	As a result of manufacturing, fabrication defects or localized damage in service,
Crusher Rotors, Motor shafts, Suspension Bars, Arms	Development of cracks	Impact of coal	Due to internal flaw
Bearings	Development of cracks	Improper loading,	Due to internal flaw
Conveyor pulleys	Due to End disc failure	Cyclic loading	Failure of the weld between the hub and the end disc in

Component	Type of defect	Affecting factor	Reasons
			welded-in hub designs.
Drive foundations	Bolt failure, Frame failure	Cyclic loading	A result of manufacturing, fabrication defects or localized damage in service,
Conveyor pulleys	Failure of locking assembly	Cyclic loading	Failure of locking bolts

7.8.5 DIESEL HAZARDS

Diesel vapour can irritate eyes, nose, throat and lungs. Excessive short-term exposure can lead to dizziness, drowsiness, loss of coordination, blood pressure elevation, headaches, nausea, asphyxiation and lung damage. Breathing diesel vapors for long periods of time can cause kidney damage and reduce the clotting ability of blood.

Diesel fuel can irritate the skin and aggravate any existing skin condition. A large skin exposure can lead to severe redness, pain and chemical burn blisters. If the fuel is not cleaned from the skin quickly, it is absorbed into the blood stream where it can cause symptoms identical to inhalation exposure.

There has not been enough research to positively associate exposure to diesel fuel with cancers. However in one study, there was evidence of increased risk for lung cancer in men estimated to have had substantial exposure to diesel fuel. There was also an indication of an increased risk for cancer of the prostate in these workers.

7.8.6 FUEL OIL HAZARDS

Fuel oils comprise of mixtures of petroleum distillate hydrocarbons. The various kinds of fuel oils are obtained by distilling crude oil, and removing the different fractions. Fuel oil is any liquid petroleum product that is burned in a furnace for the generation of heat or used in an engine for the generation of power.

General Hazard/Toxicity Summary:

The most toxic components of fuel oils are the aromatics, such as benzene, toluene, xylene, naphthalene and others. These aromatics are relatively highly soluble in water. After the aromatic fraction, toxicity decreases from olefins through naphthenes to paraffins. Within

each of these groups, the lower molecular weight hydrocarbon tend to be more acutely toxic. Fuel oils have a moderately broad range of volatility and solubility.

Long-term potential hazards of some of the lighter, more volatile and water soluble compounds (such as toluene and xylenes) in fuel oils include contamination of groundwater. Long-term water uses threatened by spills include potable (ground) water supply. Chronic effects associated with middle distillates are mainly due to exposure to aromatic compounds

Required oil storage capacity (LDO+HFO) has envisaged on one month fuel oil consumption. One storage tanks of 500 m^3 capacity will be provided to store LDO. In the event of spilling its contents through a small leakage or due to rupture of the pipeline connecting the tank and on ignition, fire will eventuate. As a worst case it is assumed that the entire contents are leaked out.

7.8.7 Failure Scenarios of LDO tank

The spill out of LDO on ignition will result in a pool fire. The injuries in this case are mainly caused by heat radiation. The heat radiation intensities due to the pool fire are computed using the Aloha Risk Assessment Model for Pool fire. The results obtained are presented in below **Table 7.3.**

Table 7.3 Input data used for Modeling Purpose

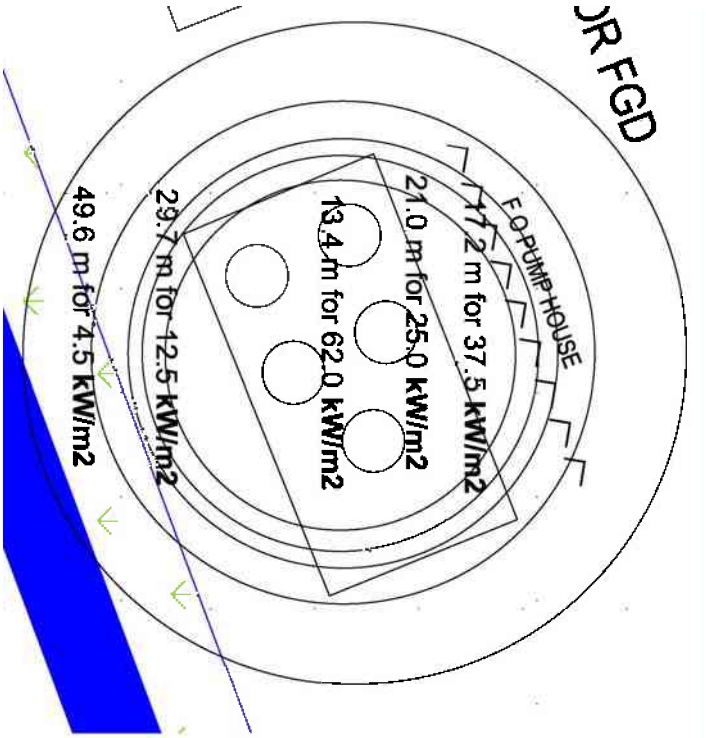
CHEMICAL	LIGHT DIESEL OIL
ATMOSPHERIC DATA	
Wind Speed	2 meters/second
Air Temperature	35° C
Relative Humidity	50%
SOURCE STRENGTH - Leak from short pipe or valve in vertical cylindrical tank	
Tank Diameter	10 meters
Tank Length	7.5 meters
Tank Volume	589 cubic meters
Chemical Mass in Tank	496 tons
Circular Opening Diameter	2 inches
Burn Duration	ALOHA limited the duration to 1 hour

Failure of LDO tank

Table 7.4 Distances of Occurrence of Various Thermal Radiation Intensities due to Rupture of all five LDO (5x300 KL) Tanks

Radiation Intensity (kW/m²)	Distance (m)	Types of Damages from Radiation Intensity
62.0	13.4	Spontaneous ignition of wood
37.5	17.2	Sufficient to cause process equipment damage to
25.0	21.0	Minimum energy required to ignite wood at infinitely long exposure (non piloted)
12.5	29.7	Minimum energy required for piloted ignition of wood, melting plastic tubing etc.
4.5	49.6	Sufficient to cause pain to personnel unable to reach over within 20 sec; however blistering of skin (Ist degree burns) is likely
1.6	83.1	Will cause no discomfort during long exposure

Figure 7.2 Distances of Occurrence of Various Thermal Radiation Intensities due to Rupture of all five LDO (5x300 KL) Tanks

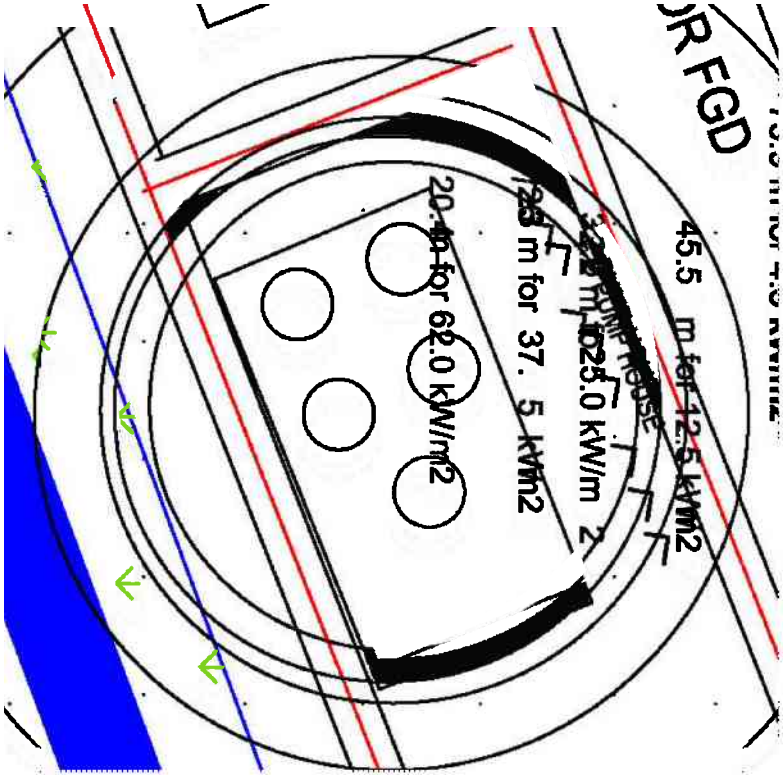


Failure of HFO tank

Table 7.5 Distances of Occurrence of Various Thermal Radiation Intensities due to Rupture of all five (5x2000 KL) Heavy Fuel Oil (HFO) Tanks

Radiation Intensity (kW/m²)	Distance (m)	Types of Damages from Radiation Intensity
62.0	20.4	Spontaneous ignition of wood
37.5	26.3	Sufficient to cause process equipment damage to
25.0	32.2	Minimum energy required to ignite wood at infinitely long exposure (non piloted)
12.5	45.5	Minimum energy required for piloted ignition of wood, melting plastic tubing etc.
4.5	75.9	Sufficient to cause pain to personnel unable to reach over within 20 sec; however blistering of skin (Ist degree burns) is likely
1.6	127.3	Will cause no discomfort during long exposure

Figure 7.3 **Distances of Occurrence of Various Thermal Radiation Intensities due to Rupture of all five HFO (5x300 KL) Tanks**



7.8.8 Damage

Criteria for heat radiation

Incident Radiation Intensity (kw/m²)	Type of damage
62.0	Spontaneous ignition of wood
37.5	Sufficient to cause damage to process

	equipment
25	Minimum energy required to ignite wood at infinitely long exposure (non piloted)
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing etc.
4.5	Sufficient to cause pain to personnel if unable to reach cover within 20 seconds; however blistering of skin is likely
1.6	Will cause no discomfort to long exposure
0.7	Equivalent to solar radiation

7.8.9 Summary of results

The vulnerable zone of heat radiation intensities due to failure LDO tanks extends upto a distance of about 13 m (2 kw/m^2) from the centre of pool.

7.8.10 Consequence Analysis

Consequence analysis of certain failure cases are carried out with the objective to study how many persons are involved in an accident and are likely to killed or injured or how large is the area, which is likely to be destroyed or rendered unusable so that a true assessment of the safety of the plant can be made.

LDO storage tank failure will result 100% lethality within 13 m from the centre of the pool. No manual attendance at this location is envisaged.

7.8.11 Chlorine handling and dosing systems

The dosing site would house 4 cylinders in operation and standby. The site hence would house 3.6 MT of chlorine inventory stored at any point of time **(THRESHOLD QUANTITY IS 10 MT, Ref: Schedule 2, Chemical Accidents (EP&R) Rules, 1996).**

7.8.12 Leakage of Chlorine Tank

Consequences of any of the following failure modes results in a chlorine leak. The scenarios of consequence depend upon:

- Quantity of chlorine leaked

- Location of leakage
- Atmospheric conditions such a wind velocity, temperature etc.

The consequence of chlorine release are, escape of chlorine in the work area (if the leakage is in the chlorinator are) and moving beyond work area. If the leak travels into open area, the leaked gas can drift in the direction of wind and diffuse over a distance. Chlorine being heavier than air, slumps down in its movement. This may result in various degrees of concentration of the chlorine at different distances are presented below. In computing the distance, worst conditions are considered with stability category of F, which may usually occur in nights with overcast sky and minimum temperature.

Input data used for Modeling Purpose

CHEMICAL	Chlorine
ATMOSPHERIC DATA	
Wind Speed	2 meters/second
Air Temperature	35° C
Relative Humidity	50%
SOURCE STRENGTH - Leak from short pipe or valve in vertical cylindrical tank	
Tank Diameter	0.76 meters
Tank Length	2.085 meters
Tank Volume	0.95 cubic meters
Chemical Mass in Tank	938 kilograms
Circular Opening Diameter	2 mm
Burn Duration	ALOHA limited the duration to 1 hour

Output - Threat Zone

Color of toxicity	Distance of Conc.	Probable Concentration
Red	646 meters	5 ppm
Orange	1.1 km	2 ppm
Yellow	1.5 km	1 ppm

Effect of Chlorine on Human Beings

The effects of various levels of chlorine inhalation vary with the individuals involved. The following list, taken from the Chlorine Institute's Pamphlet 90, Molecular Chlorine: Health

and Environmental Effects, is a compilation of chlorine exposure thresholds and reported responses in humans:

Parts of Chlorine (ppm)	Type of damage
0.2-0.4	threshold of odor perception with considerable variation among subjects (a decrease in odor perception occurs over time);
1-3	mild, mucous membrane irritation, tolerated for up to one hour;
5-15	moderate irritation of the respiratory tract;
30	immediate chest pain, vomiting, dyspnea, and cough;
40-60	toxic Pneumonitis and pulmonary edema;
430	lethal over 30 minutes;
1000	fatal within a few minutes.

7.8.13 Consequence Analysis

The total No. of employees at power plant would be about 500. The power plant would run in three shifts-24 hrs. thus at any point of time, the maximum strength of all cadres including greenbelt development workers of power plant in general shift would be 500.

The nearest settlement is located at distance of 2.0 km from the Chlorine handling place. In the present scenario the dispersion is likely to extend upto a distance 1.5 km. So, there will be no significant impact on nearby habitation due to chlorine release. The IDLH values are for the worst case scenario, whereas the probability of such meteorological conditions coinciding with the failure of the cylinder is remote.

7.8.14 Safety Measures for Chlorine Handling

All chlorine users should inspect valves for cracks. There have been ongoing reports of both cylinder and ton container valves being found with cracks in the area by the threads for the packing nut. There are at least three reported incidents in the U.S. and Canada where an actual leak of chlorine is known to have occurred. Fortunately, most have been

discovered at the chlorine packaging site before they were in use and before any leaks happened. There have been two recent cases where the chlorine cylinder valves developed the cracks at a customer site after they were fully inspected by both the valve manufacturer and the chlorine packager before shipment.

DOS	DON'Ts
Use chain pulley, crane for loading & unloading cylinders.	Do not unload cylinders on floor or type directly.
Filled cylinder is to be stored under proper shed	Filled container should never be exposed to any source of direct heat.
Cylinder filled or empty to be kept always on clean cemented and raised floor	Corrosive and inflammable material should never be stored in the cylinder storing area.
Use seamless pipe or copper tube (heavy gauge) for drawal of chlorine from cylinder.	Do not use rubber tube or ordinary rubber hose for withdrawal of chlorine from cylinder.
For connecting line with cylinder use clamp of special type	Do not use spanner or pipe wrench for operating cylinder valve.
Use proper key for operating the spindle of the cylinder valve	Do not connect the process line as such-back process. Liquid will take place.
Use a secondary isolating valve in between the cylinder valve and the process line for operational purpose.	Do not operate the cylinder valve frequently
Use a pressure gauge (diagram type) in between the cylinder valve and the secondary isolation valve.	Do not keep the cylinder in connection if it is not used regularly.
Fit the seal nut of the valve of cylinder when it is isolated and use ammonia torch for checking leakage.	Do not start operation before checking the pipe line joints and the valve
Cylinders are to be used on 1st come 1st serve basis	Do not take tonner if consumption is less, use baby cylinder.
Wind direction indicator should be installed in a suitable place	Do not keep any chlorine cylinder for more than 3 months.
A caustic solution sump is to be made near the cylinder storing and consuming area for emergency.	Do not spray water on the leaky points.
Use air breather and gas mask for attending leakage.	Do not proceed to attend chlorine leakage without safety appliance and stand by rescue arrangement
	Do not allow any untrained person to operate cylinder valve
	Do not use canister type gas mask when concentration of chlorine is high.

7.8.15 Steps during Chlorine Release

As soon as there is any indication of a chlorine release, immediate steps must be taken to correct the situation. People should not enter into atmospheres containing concentrations of chlorine in excess of the Immediately Dangerous to Life and Health Concentration (IDLH) of 10 ppm without appropriate PPE and back-up personnel.

Unnecessary people should be kept away and the hazard area should be isolated. People potentially affected by a chlorine release should be evacuated or sheltered in place as circumstances warrant. If near a fixed facilities, area chlorine monitors and wind direction indicators can supply timely information (e.g., escape routes) to help determine whether people are to be evacuated or sheltered in place.

When evacuation is used, potentially exposed persons should move to a point upwind of the release. Because chlorine is heavier than air, higher elevations are preferable. To escape in the shortest time, people already in a potentially affected area should move crosswind. When inside a building and sheltering in place is selected, shelter by closing all windows, doors and other openings, and turning off air conditioners and air intake systems.

People should move to the side of the building furthest from the release. Position potentially affected people so they have an escape route. A safe position may be made hazardous by a change in wind direction or by the release becoming larger. If fire is present or imminent, chlorine containers and equipment should be moved to a safe location, if possible. Non-leaking containers or equipment that cannot be moved should be kept cool by the application of water. This should continue until well after the fire has been extinguished and the containers are cooled. Containers exposed to excessive heat should be isolated until an examination can be conducted by the supplier.

Water should not be used directly on a chlorine leak. Chlorine and water react forming acids which could make the leak worse. However, where several containers are involved and some are leaking, it may be prudent to use a water spray to help prevent over-pressurization of the non-leaking containers.

7.8.16 Human effects – thermal radiation

The effects of fires on humans increase with the heat flux and exposure time. There is however, a threshold flux of 5KWm^{-2} suggested by various literatures for the same. The table below relates incident heat flux, Q and exposure time, to be effects on humans and for reference the limiting flux for secondary fires:

Table7.6: Thermal Radiation for Human Exposures

Q KW m^{-2}	Time	Effects
4	Long(>1 min)	Limiting “safe’ flux for humans
12.6	Long	Limiting flux for ‘secondary fires
6.5	~ 20s	Blistering of skin

11	~ 10s	Blistering of skin
20	~ 5s	Blistering of skin

This table indicates that for long exposures, people both indoors and out are at risk if the flux is greater than 12.6 KWm^{-2} whereas only people outdoors are at risk if the flux is in the range 4-12.6 KWm^{-2}. To simplify the analysis three assumptions are made:

- Probability of a person being outdoors is 0.15;
- Probability of a person outdoors taking cover is 0.5 for fluxes in the range 6.5-12.6 k W m^{-2} (i.e. time to take cover 20 seconds);
- Probability of a person outdoors taking cover is 0.9 for fluxes in the range 4-6.5 kW m^{-2} (i.e. time to take cover < 1 minute).

7.8.17 Human effects – explosion

Explosion damage consists of the effects of thermal radiation and the effects of pressure waves generated in the blast. The effects of thermal radiation were covered in the previous section. Humans are resilient to overpressures generated in an explosion as shown in the table below:

Table7.7: Explosion Overpressure for Human Exposures

Psi	kPa	Human Effects
5	34	Threshold of eardrum damage
10	69	Threshold of lung damage
40	276	Threshold of mortality

An explosion causes casualties primarily via damage to structures, eg house collapse, flying glass etc.

Table7.8: Peak Overpressure

Psi	kPa	% C	Structural Damage
<1	<7	0	Window breakage
1-3	7-21	10	Walls collapse
3-5	21-34	25	Reinforced structures distort Storage tanks (unpressurized) fail
5-7	34-48	70	Wagons and plant items overturned
>7	>48	95	Extensive damage

Where %C = percentage of people becoming casualties including fatalities.

There is difficulty in generating reliable data for large events by extrapolation from historical data of small events. One possible explanation is that small spills, if unignited are likely to be under-reported. Once an unignited cloud starts to disperse towards areas of population,

there is still a chance of ignition prior to its reaching them. Again judgement values are used viz:

Table7.9: Ignition Probability

Cloud passes over	Ignition probability
Open land	0
Industrial site	0.9

7.8.18 Ignition of cloud over population

Should a cloud reach an area of population, the probability of ignition at the edge of the area will be taken as several times that of ignition over the area.

Table7.10: Ignition Probability over Population

Type of ignition	Ignition probability
Edge / edge: edge of unignited cloud just reaches edge of population area when ignition occurs	0.7
Central: unignited cloud right over population when ignition occurs.	0.2
Non-ignition	0.1

The components of the total hazard value include a wide variety of measures relating to a chemical's toxicity and physical-chemical properties such as vapor pressure, tendency to bioaccumulate, corrosivity, and so on.

7.8.19 Ammonia

Anhydrous ammonia is 99.5 percent commercial grade ammonia (with 0.5 percent water) as compared to aqueous ammonia, which is a solution of ammonia and water. A saturated aqueous ammonia solution is 47 percent ammonia by weight at 0°C and at atmospheric pressure (by comparison, household ammonia is a 5 percent solution). Anhydrous ammonia is a colorless non-flammable liquefied gas. Anhydrous ammonia is very volatile and boils at 33.5 degrees Celsius (°C) under atmospheric pressure.

Its vapor is lighter than air [vapor density = 0.6 and air = 1] and has the same pungent odor as household ammonia. Anhydrous ammonia must be pressurized or refrigerated to be maintained as a liquid. Air mixtures of ammonia are difficult to ignite. The auto ignition temperature is 650°C. The lower explosive level is 16 percent by volume, and the upper explosive level is 27 percent by volume.

Accidental releases of anhydrous ammonia to the air from the storage and unloading system or truck can cause a potential hazard to the public, and the environment. Direct accidental releases of anhydrous ammonia or aqueous ammonia to surface water can cause damage to aquatic life[1].

Although ammonia vapor is lighter than air, the vapors from a leak may hug the ground appearing as a white cloud. Chemically ammonia is 82% nitrogen (N) and 18% hydrogen (H) and has the chemical formula NH_3.

Solubility of ammonia in water is high. One cubic foot of water will dissolve 1300 cubic feet of ammonia vapor making water the primary weapon for first responders. When ammonia reacts with water the base ammonium hydroxide (NH_4OH) will form.

Since ammonia is very soluble in water there will be no layering effect when liquid ammonia is spilled into a surface water body. Booms, pads, sweeps and pillows that are usually used to contain and recover petroleum are ineffective on spills of ammonia into surface water.

Ammonia is a nonflammable gas but will ignite at a temperature of 49°C within vapor concentration limits between 15% and 28%. (Paper ignites at 232°C, coal at 398.9°C). Outside conditions that would support these vapor concentrations are rare.

Ammonia will corrode galvanized metals, cast iron, copper, brass or copper alloys. All ammonia piping, valves, tanks and fittings are constructed of steel. Liquid ammonia boils at any temperature greater than -28°F and will expand to 850 times its liquid volume. One gallon of liquid will expand to 850 gallons or 113 cubic feet of gas.

7.8.20 Pressure and Temperature

Whenever a liquid is confined in a closed vessel at a temperature greater than its boiling point there will be a measurable pressure against the confining walls. Since ammonia boils at -33°C a tank pressure will always be measurable.

Hence, with volume constant, a drop in pressure caused by a tank valve leak will cause the liquid temperature to drop. If the liquid temperature continues to drop to boiling point, ammonia auto refrigerates stopping the boiling. At this point the ammonia and tank are

[1] *Final Environmental Assessment, Colbert Fossil Fuel Plant Units, Alabama, United States of America*

much less dangerous to handle. A tank that rapidly loses pressure will be covered with frost. The frost is the result of the tank shell cooling below the freezing point of water and moisture from the air condenses on the tank and freezes.

Pressure change can also take place when the tank is infringed upon by fire. The flames heat up the tank walls, which increases the temperature of the confined liquid ammonia causing more vaporization of Ammonia and increasing tank pressure. Spraying adequate water on the shell can keep the situation under control.

Due to its properties and the manner in which it is stored, NH_3 can create a dangerous situation when accidentally released. The following are some examples of how the misuse of NH_3 and its equipment can result in accidents[2]:

- Filling tanks beyond recommended capacity. They should be no more than 85 percent full.
- Knocking open the hose-end valve accidentally.
- Moving applicator tank before filling hoses have been disconnected from the nurse tank.
- Venting pressure release valve while a person is in line of discharge.
- Breaking a transfer hose, especially an old or misused one.
- Failing to bleed hose coupling before disconnecting. On hot days, the black hose gets much hotter than the tank and could result in a higher pressure build up.
- Rupturing of low-pressure hose due to pressure buildup when knives plug.
- Releasing ammonia when knives are unplugged.
- Overturning an applicator or nurse tank while in transit or in the field.

Table7.11: Ammonia Concentration Limits Concentration Application Reference

25 ppm (17.75 mg/m^3)	Recommended exposure limit for 10-hour work day during a 40-hour work week	NIOSH Guide and ACGIH
35 ppm (24.85 mg/m^3)	Short-term exposure limit not to be exceeded in a 15-minute period	NIOSH Guide and ACGIH
500 ppm (355 mg/m^3)	Concentration that is immediately dangerous to life or health for a worker without a respirator with an exposure time greater than 30 minutes	NIOSH Guide and ACGIH
197 ppm (140 mg/m^3)	The concentration that defines the endpoint for a hazard assessment of off-site consequences	40 CFR 68
50 ppm (35.5 mg/m^3)	Permissible exposure limit	OSHA

The American Industrial Hygiene Association provides a toxic endpoint concentration for ammonia for emergency response planning as 197 ppm (140 mg/m^3 [milligrams per cubic

[2] *University of Nebraska Cooperative Extension EC94-738-B*

meter] or 0.14 milligrams per liter [mg/L]). It is defined as the maximum airborne concentration below which nearly all individuals can be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action5.

At low concentrations in air, ammonia vapour irritates the eyes, nose and throat. Ammonia is very soluble in water and forms a high pH solution. Therefore, as it enters the body, it is readily absorbed with immediate impact local to the point of entry. Inhalation of high concentrations produces a sensation of suffocation, and quickly causes burning of the respiratory tract and may result in death.

Anhydrous liquid ammonia is reported for causing severe burns on contact with the skin and if swallowed, it will cause very severe corrosive action in the mouth, throat and stomach. Severe eye damage may result from direct contact with the liquid or exposure to high gas concentrations. Long-term disability is mainly due to corneal and respiratory injuries[3].

The worst-case scenarios for accidental release of ammonia would be the sudden and complete failure of a tank resulting in the release of a full tank of ammonia.

The duration of these tank leaks and process line leaks would be based on the assumed time required for employees to isolate and contain the leak. The minimum ignition energy is 100 mJ, compared with 0.29 mJ for methane4. Explosions can occur in flammable mixtures in vessels or enclosed spaces. Ignition is difficult and the possibilities of an explosion in the open air have been generally discounted in different reports.

The withdrawal valve contains an internal valve that will safely close when liquid flows out of the tank too quickly. This "excess flow valve" will shut cutting off the flow of ammonia when, for example, a hose ruptures or the withdrawal valve shears off. The excess flow valve will not open again until the withdrawal valve has been closed which allows pressure to equalize on both sides of the excess flow valve seat.

[3] *Pinnacle Risk Management Pty Limited, Tooheys Lidcombe Site, Hazard and Risk Assessment, New South Wales, Australia, March, 2007*

[4] *Lees F.P., Loss Prevention in the Process Industries, 2nd Edition 1996*

Table 7.12: Effect of Ammonia on Human Health

Concentration (ppm)	Effect on Health	Exposure Period
25	Odour detectable by most persons	Maximum for 8 hour working period
100	No adverse effect for average worker	Deliberate exposure for long periods not permitted
400	Immediate nose and throat irritation	No serious effect after 30 minutes to 1 hour
700	Immediate eye irritation	No serious effect after 30 minutes to 1 hour
1700	Convulsive coughing; severe eye, nose and throat irritation	Could be fatal after 30 minutes
2000 – 5000	Convulsive coughing; severe eye, nose and throat irritation	Could be fatal after 15 minutes
5000 – 10000	Respiratory spasm and Rapid asphyxia	Fatal within minutes

Their effects on humans increase with the gas concentration and exposure time. The table below shows the exposure time, t and the concentration, C, which would be expected to produce a lethal dose to half of the exposed population

Time	Concentration in air (kg m^{-3}) Ammonia
1 min	-
5 min	$7 - 10^{-3}$
15 min	$3.5 - 10^{-3}$
30 min	$1.2 - 10^{-3}$
1 hr	$5 - 10^{-4}$

Ammonia	**Formula:** NH_3	CAS#: 7664-41-7	RTECS#: BO0875000	IDLH: 300 ppm
Conversion: 1 ppm = 0.70 mg/m^3	**DOT:** 1005 125 (anhydrous); 2672 154 (10-35% solution); 2073 125 (>35-50% solution); 1005 125 (>50% solution)			
Synonyms/Trade Names: Anhydrous ammonia, Aqua ammonia, Aqueous ammonia [Note: Often used in an aqueous solution.]				
Exposure Limits: **NIOSH REL:** TWA 25 ppm (18 mg/m^3) OSHA PEL†: TWA 50 ppm (35 mg/m^3) ST 35 ppm (27 mg/m^3)			Measurement Methods (see Table 1): NIOSH 3800, 6015, 6016 OSHA ID188	
Physical Description: Colorless gas with a pungent, suffocating odor. [Note: Shipped as a liquefied compressed gas. Easily liquefied under pressure.]				

Chemical & Physical Properties: **MW:** 17.0 **BP:** -28°F **Sol:** 34% **Fl.P:** NA (Gas) **IP:** 10.18 eV **RGasD:** 0.60 **VP:** 8.5 atm **FRZ:** -108°F **UEL:** 28% **LEL:** 15%	**Personal Protection/Sanitation:** **Skin:** Prevent skin contact **Eyes:** Prevent eye contact **Wash skin:** When contam (solution) **Remove:** When wet or contam (Solution) Change: N.R. **Provide:** Eyewash (>10%) Quick drench (>10%)	**Respirator Recommandations:** **NIOSH** **250 ppm:** CcrS*/Sa* **300 ppm:** Sa:Cf*/PaprS*/CcrFS/ GmFS/ScbaF/SaF **§:** ScbaF:Pd, Pp/SaF:Pd, Pp:AScba **Escape:** GmFS/ScbaE
[**Note:** Although NH_3 does not meet the DOT definition of a Flammable Gas (for labeling purposes), it should be treated as one.]		
Incompatibilities and Reactivities: Strong oxidizers, acids, halogens, salts of silver & zinc [**Note:** Corrosive to copper & galvanized surfaces.]		
Exposure Routes, Symptoms, Target Organs: **ER:** Inh, Ing (solution), Con (solution/liquid) **SY:** Irrit eyes, nose, throat; dysp, wheez, chest **pain:** pulm edema; pink frothy sputum; skin burns, vesic; liquid: frostbite **TO:** Eyes, skin, resp. sys.	**First Aid:** **Eye:** Irr immed (solution/liquid) **Skin:** Water flush immed (solution/liquid) **Breath:** Resp support **Swallow:** Medical attention immed (solution)	

7.9 DISASTER MANAGEMENT PLAN

Disaster is a sudden occurrence of hazard with a magnitude which could restrict the normal pattern of life in the facility and/or in vicinity causing extensive damage to life and/or property. A Disaster Management Plan gives a clear organizational structure and elaborates the duties to be performed by individuals (including outside agencies), when situation demands, so as to reduce the probability/severity of community suffering and property damage. The activities among other things include providing help in arranging for food, shelter, clothing, medical attention and other life sustaining requirements.

7.9.1 IDENTIFICATION OF MAJOR HAZARD POTENTIAL

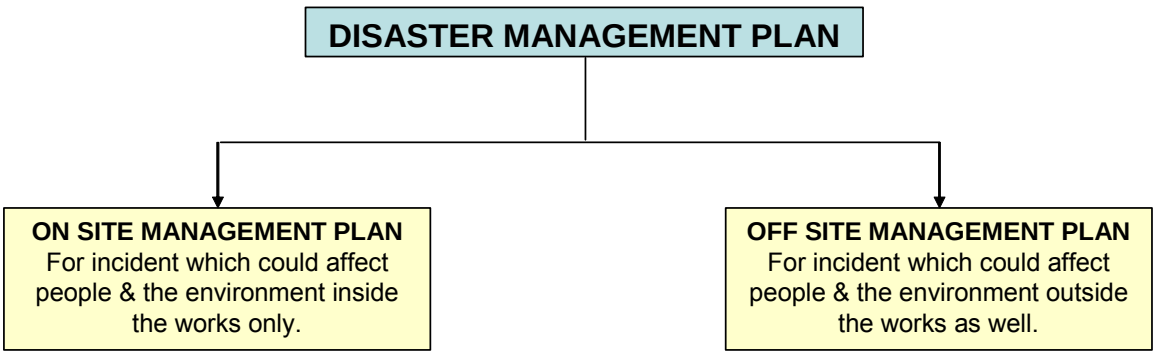
A thermal power plant stores a number of chemicals and flammables/combustible materials which are hazardous in nature. Considering the process and materials to be used at Bhadrerwar Thermal Power Plant, the following hazards are identified along with the probable areas of occurrence.

Table7.13: Associated Hazards of TPP

Nature of Hazard	Potential Areas / Locations

Fire Hazards	Coal handling Plant / Coal Conveyor Cable Galleries / Cable Trays in all plant sections Fuel oil Handling and Storage Areas Transformer and Switch Yard Areas Oil and Lubricants Stores Boiler Area
Explosion Hazard	Hydrogen generation plant Transformers Boiler Coal dust in mills and boilers
Bursting of Pipelines & Vessels	Steam pipes due to high pressure / temperature Oil and Acid Lines
Release of gases / dust	Chlorine in Water Treatment Plant Pulverized coal dust from mills and associated piping Fly ash from chimneys and ash ponds and ESP hoppers Coal dust in transfer points and CHP crusher
Release of liquid	Chemical tanks in Water Treatment Plant Fuel oil tanks in Fuel oil handling section

7.9.2 TYPES OF DISASTER MANAGEMENT PLAN



7.10 ON SITE DISASTER MANAGEMENT PLAN

An on-site disaster is caused by an accident that takes place in hazardous installations and effects are confined to the factory premises involving the people working in the factory. The on-site disaster management plan dealing with eventualities is the responsibility of the occupier, who is to prepare / implement necessary measures to contain the severity of cause of disaster to the bare minimum.

7.10.1 OBJECTIVES

The on-site disaster management plan is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operation in the same order of priorities. The objective of the emergency plan is to make use of the combined resources of the plant and the outside service to achieve the following.

- The availability of resources for handling emergencies
- Safeguard the personnel located in the premises
- Minimize damage to property and environment
- Organize rescue and treatment of affected persons
- Initially contain and ultimately bring the incident under control
- Identify any casualties
- Provide authoritative information to the news media
- Secure the safe rehabilitation of affected persons
- The command, co-ordination and response organization structure along with efficient trained personnel
- Regular review and updating of the DMP
- Preserve relevant records and equipment for the subsequent enquiry into the cause and circumstances of emergency.

ACTION PLAN FOR ON-SITE EMERGENCY

Identification of Responsibilities

The onsite disaster management plan identifies Chief Incident Controller (General Manager of the Project), Work incident controller (AGM/DGM) and Designated Key Personnel of emergency control centre. The plan also specifies responsibilities of these personnel in case of an emergency and draws an action plan to be followed. Chief incident controller and works incident controller shall be assisted by two support teams as follows.

Support team to Chief Incident Controller {CIC}	Consisting of heads of personnel, Material and Finance Division; to function in consultation with CIC for the following: • Contacting statutory authorities. • Arranging for relievers and catering facilities • Giving information to media. • Contacting media centers and nursing homes • Providing all other support, as necessary. • Arranging for urgently required materials through • Cash purchase or whatever means.
Support team to Work Incident Controller {WIC}	Consisting of Sr. Manager (Admn), Sr. Supdt. (Operation), Sr Supdt. (Elect. maintenance), Sr Suptd. (Mech. Maintenance) And any more persons depending upon the need to assist the (WIC) in manning communication and passing Instruction to the team. One steno secretary shall also be available with WIC for recording all information

	coming In and instruction going out.

In addition to the support teams mentioned above, there will be a team for each functional area, as described below:

Task Force	• To identify source of hazard and Try to neutralize/contain it. • To isolate remaining plant and keep that in safe condition. • To organize safe shutdown of plant, if necessary. • To organize all support service like operation of the fire pump, sprinkling system etc.
Maintenance Team	• Attend to all emergency maintenance jobs on top priority. • To take step to contain or reduce the level of hazard created due to disaster. • To organize additional facilities as desired.
Fire Fighting Team	• To rush to fire support and extinguish fire. • To seek help from outside fire fighting agencies. • To evacuate persons effected.
Auto base team	• To make the auto base vehicles ready to proceed for evacuation or other duties, when asked for • To send at least one mechanic at the site of incidence where he may help in attending minor defects in ambulance, fire tenders or other vehicles • To arrange petrol / diesel supply • Make all arrangements regarding transportation.
Communication Team	• To maintain the communication network in working condition. • To attend urgent repairs in the communication system, if required. • To arrange messengers for conveying urgent messages when needed.
Security team	• To provide two men at all gates. • To ban entry of unauthorized persons. • To allow the ambulance /evacuation vehicles etc. to go through the gates without normal check.
Administration team	• To rescue the casualties on priority basis • To transport casualties to first aid post, safe place or medical centers • To account the personnel. • To pass information to the kith and kin of fatal or serious injured persons.
Safety team	• To arrange required safety equipment • To record accidents. • To collect and preserve evidences in connection with accidents injuries • To guide authorities on all safety related issues.
Medical Team	• To arrange first aid material / stretchers immediately and reach to site of incidents • To arrange for immediate medical attention. • To arrange for sending the casualties to various hospitals and nursing homes etc. • To ask specific medical assistance from outside including through medical specialist in consultation with CIC / WIC
Monitoring team	• To measure gas concentration, in case of gas leakage at various

	places.

Essential Staff

In plant immediately affected or likely to be affected as decided by chief Incident controller, efforts will be needed to make shut down and make process units safe. This work will be carried out by plant supervisor and essential operators provided they can do it without exposing themselves to undue risk. Some workers/ supervisors will also be required to help the above works for example Attendants, Messengers, Drivers, First-aiders, and Steno-Typist etc. These will be essential staff and it is the responsibility of the works incident controller centers so that they can be readily contacted. It is the responsibility of the work incident controller to remove all non essential staff to assembly points.

First Information

The first person who observes/ identifies the emergencies shall inform by shouting and by telephone to the shift engineer and fire station about the hazards. The shift engineer will inform to works incident controller, chief incident controller and also telephone operator, who shall communicate it to all key officers about the emergency.

Capability Analysis (Existing Structure)

The project shall be well equipped with fire protection system and a full-fledged fire station operated by Security Force (Fire Wing). The fire station will have sufficient staff with round the clock service. Various firefighting equipment such as foam tender, DCP tender, High Pressure Portable Pump, Pump Mounted Jeep etc. to handle the fire promptly and actively. Hydrant landing valves /yard hydrant fitted at various locations of the plant to supply water for first fighting work.

Portable and mobile fire extinguisher of various types (CO_2, DCP, Soda Acid, Foam type, Water) shall be installed at strategic location of the plant including main plant, control rooms, switch gears, laboratories, office sites, administration building.

Fuel Oil tank shall be provided with fixed foam system. A mixture of water and foam concentrate, thrown on to the top surface of oil converts into foam to extinguish the fire.

Medical Assistance Capabilities

The project shall have its own hospital with suitable no. of beds, situated in a central place. It shall be equipped with all necessary facilities, such as ambulances (available round the clock), specialist doctors in all major specialties and paramedical staff. In addition to the medical facilities to be provided in the plant, other nearby hospitals like government,

private, primary health centers etc. will also be equipped for the facilities required in emergency disaster situations to cater the services.

Communication System

- Communication system envisaged at proposed 3300 MW TPP includes
- Public address system in the main plant area.
- Telephone and intercom facilities at all desks and officials.
- Intercom telephone connections with facilities of incoming P&T call at residences to all officers and other important persons.
- Mobile Phones are also provided to important officials.
- Cable TV and Internet facilities in Entire Township for internal communication.

Emergency Power Supply

Emergency lights shall be provided at all vulnerable points for lighting arrangements as well as to operate basic minimum equipments for operating the plant safely. All units shall be provided with DG sets and battery systems, which come on automatically in case of power failure.

Emergency Safety Equipment

Various emergency safety equipments (such as self contained breathing apparatus, canister gas mask, emergency suits, gumboots, face shield, hand gloves, aprons, chlorine sealing kit etc.) shall be made available in areas like water treatment plant, and near all sections of the project.

Alarm

The project shall have various alarm systems to denote different kind of emergencies and restoration of normalcy. The purpose of the alarm is to advice all persons on the outburst of major emergency. Other than this alarm a siren audible to a distance of 5 km range should also be available.

Emergency Control Center

A permanent Emergency Control Center (ECC) shall be established, which will be manned by the chief incident controller, the officials nominated as key personnel and Sr. Executives of outside services shall be called in for assistance if required in emergencies. No other shall have access to the control centre. ECC will be equipped with adequate means of communication.

Evacuation and Assembly Points

In an emergency, it may be necessary to evacuate non-essential workers from areas likely to be affected as precautionary measure, should the emergency escalate. The evacuation will be effected on getting necessary message from WIC. On evacuation, all the persons shall assemble at pre-identified and notified Assembly Points.

7.10.2 Evaluation of Functioning of Disaster Plan

In order to evaluate the functioning and effectiveness of procedure laid in disaster management plan; regular mock drills should be conducted. The Mock drills should be carried out step by step as stated below.

First Step	Test the effectiveness of communication system.
Second Step	Test the speed of mobilization of the plant emergency team
Third Step	Test the effectiveness of search, rescue and treatment casualties
Fourth step	Test emergency isolation and shut down the remedial measure.
Fifth step	Conduct a full rehearsal of call the actions to be taken.

Here are two types of mock drills recommended in disaster management plan- full Mock drill (to be conducted at least once in every 6 months) and Disaster management efficiency drill (to be conducted at least once in 3 months). The details of these drills presented as follows:

Full Mock Drill

This shall be conducted with plant head as Chairman; Head of O&M as Chairman; head of the Operation, Maintenance, Medical, personnel, CISF, Auto base and materials as members and head of safety as convener and it shall test the following.

Functioning of emergency control center, very specifically availability of all facilities etc as mentioned in the plan and its functional healthiness.

- To evaluate communication of the Disaster plan to all segments of employees, to familiarize them about their responsibilities in case of any disaster including evaluation of behavior of the employees and other.
- To ensure that all facilities as required under the plan from within or from nearby industries aid center under mutual assistance scheme or otherwise are available.
- To ensure that the necessities under material assistance scheme is properly documented and the concerned employees are fully aware in this regard.
- To ensure that employees are fully aware to fight any emergency like sealing of chlorine leakage, fire fighting other such cause.

Disaster Management Efficacy Drill

This shall be conducted with head of (O&M) as chairman and heads of personnel, Communication, CISF and Medical as Members and Head of safety as convener and it shall test the following:

- All employees are trained about their responsibilities / duties. They all are aware about evacuation routes, direction of evacuation of equipments to be used during evacuation or the method of evacuation.
- All employees are fully trained to rescue their colleagues, who are effected due to cause of disaster. In case they are unable to rescue their colleagues, they should know to whom they have to inform about such persons.
- All employees are fully trained in first aid use of desired equipments including breathing apparatus First Aid box etc. are available at the desired location.
- All warning alarms are functional. Public Address system is in healthy condition.
- All telephone lines/ communication systems are provided in control rooms and there is no removal of the facilities (as prescribed) for the control rooms.
- It is very clear amongst the concerned managers who shall call for assistance under mutual aid scheme or the facilities from within.
- It is clear at the plant, who shall declare emergency.
- It is clear at the plant, who shall inform the district authorities, State authorities and corporate center.
- The disaster management plan shall be periodically revised based on experiences gained from the mock drill.

7.11 OFF-SITE DISASTER MANAGEMENT PLAN

In Bhadreswar TPP, the following condition can ordinarily constitute an off-site emergency:

- Heavy release of chlorine, due to rupture of the shell, explosion in chlorine cylinder due to fire, or otherwise; resulting in it spread to neighboring areas.
- Major fire involving combustible materials like oil, and other facilities.

Under the Environmental Protection Act, the responsibility of preparation of Off-Site Emergency plan lies with the state government. The Collector/ Deputy Collector are ordinary nominated by State Government to plan Off-Site Emergency Plan.

The District Collector or his nominated representative would be the team leader of planning team, who shall conduct the planning task in a systematic manner. The members of planning team for off-site emergencies are Collector / Deputy Collector, District Authorities in charge of Fire Services and police and members drawn from Medical Services, Factory Inspectorate, Pollution Control Board, Industries and Transport. In addition to these members, there are Co-opted Members also from district authorities concerned,

civil defense, publicity department, Municipal Corporation, and non-official such as elected representative (MPs, MLAs, voluntary organization, non- governmental organizations etc).

7.11.1 Post Emergency Relief to the Victims

The Public Liability Insurance Act, 1991 provides for the owner who has control over handling hazardous substances to pay specified amount of money to the victims as interim relief by taking insurance policy for this purpose. The District Collector has definite role in implementation of this act. After proper assessment of the incident, he shall invite applications for relief, conduct an enquiry into the claims and arrange payment of the relief amount to the victims.

7.11.2 Disaster Prevention and Reduction

Kutchh Power Generation Ltd. recognizes, and accepts its responsibility for establishing and maintaining a safe working environment for all its employees. This responsibility arises from.

- Company's moral responsibility to its employees, to provide the best practicable conditions of work from the point of view of health and safety.
- The obligation to consult with its staff and their representative to implement policies and procedures developed as a result of discussions
- Statutory responsibility in respect of health, safety and welfare of employee emanating from relevant legislations such as the Factories Act., The Indian Electricity Act., The Explosive Act., The Boiler Act etc.

7.11.3 Responsibilities of the Company

The Company shall take all such steps which are reasonably practicable to ensure best possible conditions of work, and with this end in view the company shall do the following

- To allocate sufficient resources to provide and maintain safe and healthy conditions of work
- To take steps to ensure that all known safety factors are taken into account in the design, construction, operation and maintenance of plants, machinery and equipment.
- To ensure that adequate safety instructions are given to all employees.
- To provide wherever necessary protective equipment, safety appliances and clothing, and to ensure their proper use.
- To inform employees about materials, equipment or processes used in their work, which are known to be potentially hazardous to health or safety.
- To keep all operations and methods of work under regular review for making necessary changes from the point of view of safety in the light of experience and up to date knowledge.

- To provide appropriate facilities for first aid prompt treatment of injuries and illness at work.
- To provide appropriate instruction, training, retraining and supervision in health and safety and first aid and ensure that adequate publicity is given to these matters.
- To ensure proper implementation of fire prevention and an appropriate fire fighting service, together with training facilities for personnel involved in this service.
- To ensure that professional advice is made available wherever potentially hazardous situations exist or might arise.
- To organize collection, analysis and presentation of data on accident, sickness and incident involving personal injury or injury to health with a view to taking corrective, remedial and preventive action.
- To promote through the established machinery, joint consultation in health and safety matters to ensure effective participation by all employees.
- To publish/notify regulations, instructions and notices in the common language of employees.
- To prepare separate safety rules for each type of occupation/process involved in a project.
- To ensure regular safety inspection by a competent person at suitable intervals of all buildings, equipments, work places and operations.
- To co-ordinate the activities of the company and of its contractors working on the Company's premises for the implementation and maintenance of safe systems of work, to comply with their legal obligations with regard to the health, safety and welfare of their employees.

7.11.4 Responsibilities of the Employees

The establishment and maintenance of best possible conditions of work is, no doubt, the responsibility of Management, it is also necessary that each employees follows prescribed safe methods of work. He should take reasonable care for the health and safety of himself, or his fellow employees and of other persons who may be affected by his action at work. With this in mind, employees should be health and safety conscious and:

Report	Potential Hazards
Observe	Safety rules, procedures and codes of practice
Use	With all responsibilities care the tools, equipments should be used
Participate	In safety training course when called upon to do so.
Make use	Of safety suggestion schemes.
Take	An active and personal interest in promoting health and safety

7.11.5 Responsibility for Implementation

The ultimate responsibility for ensuring the implementation of the policy on health and safety at work of Kutchh Power Generation Limited lies at the corporate level and the

concerned General Managers at the Project/Station level. The Officers in charge of safety will be functionally responsible to the Corporate headquarter for ensuring that the policy is promulgated, interpreted and carried out in the manner expected.

Immediate responsibility for safety at work is that of the Management/Executives of each department/section who are primarily responsible to prevent accidents involving members of their staff and other persons. It is their responsibility to issue clear and explicit working instructions, compliance with which will ensure safe working and to require the effective use of approved equipment.

Accepted rules, procedures and codes of practice, which are formulated with proper regard to health and safety consideration, must be strictly observed by all concerned. Contracting Agencies executing works should be made responsible, through various measures including appropriate provisions in the contract, for discharging their safety obligations.

In designated areas of particular hazard the appropriate Executives are required to authorize, in writing, the commencement of any work and, before doing so, personally to satisfy themselves that all necessary safety precautions have been carried out. Such executives must themselves be authorized, in writing as competent to perform these duties. Safety Officers are appointed to advise Management on questions of safety at work including advice on the application in particular local situations of the system of work, implementation of Company's Rules and Relevant Codes of Practices in consultation with Area Engineer. They will be consulted in the interpretation of rules and codes being formulated by the Corporate Management and shall advice Management in the investigation and analysis of accidents and circulation of appropriate statistics.

Major Site Incidents

The General Manager at each Project/ Station is required to ensure that plans are devised for action in the event of fire, major site incident or necessity for evacuation procedure. These plans must be communicated to all staff and rehearsed from time to time.

Fire fighting training and the formation of fire-fighting team on a voluntary basis will be encouraged by the Project Station Management.

All accidents and dangerous occurrences will be reported immediately to the General Manager who will implement an established procedure to ensure that an investigation takes places and recommendations are made to prevent reluctance.

Accident Emergency Response Procedure/Measure

With a view to ensuring prompt report of accidents and dangerous occurrences to comply with requirements/obligations under different statues; and to inform the concerned authorities within the organization for keeping complete information of accidents for record and analysis and to take necessary preventive actions, a procedure for reporting of accidents dangerous occurrences has been framed. Separate procedures have been formulated for accidents causing injuries/fatalities and for dangerous occurrences.

Recovery Procedure

It is extremely difficult to formulate recovery procedure by other organization. Therefore, the contents of this section are indicative for the formulation of detailed recovery procedure.

The duration of recovery phase would depend upon the extent of damage caused due to disaster and the interventions initiated, thereafter. The management could restore normalcy only when speedy actions on the earlier phases are initiated.

On-site Crisis

On-site crisis management is the responsibility of Power Plant, for which Kutchh Power Generation Limited should identify following persons for the assessment of responsibilities on specific function of coordinating authority. In order to combat the emergencies, an organizational chart for on-site emergency should be periodically reviewed and updated. Following co-ordinators are required to co-ordinate various activities during the emergency.

Chief coordinator: He shall be the Superintending Engineer (SE) and Incident Control Coordinator (ICC). The ICC should be as assisted by the following team members.

- Fire fighting System
- Safety Coordinator
- Security Coordinator
- Medical Coordinator
- Material Management Coordinator
- Relief Service Coordinator
- Transport and Communication Coordinator
- Public Relation Coordinator

Making the Emergency Known to the General Public

In a situation where the public can be affected by the accident, two possible courses of action can be taken - evacuation or sheltering inside buildings and houses. Whichever

action is decided upon, the public must be informed of it. This can be quite a challenging task, to the point of becoming nearly impossible if an effective communication procedure is not already in place.

Siren system can only be effective if the public is already aware of what actions to take if the alarm is sounded. The content of the messages should be as brief and clear as possible, and provide information on the action to be taken. In addition, the public should be asked to refrain from using the telephone (to minimize the potential for line overload), and to notify neighbours of the emergency (again, without using the phone), should evacuation be recommended, the messages should inform the public of where the designated relocation areas are, and which evacuation routes to follow.

Training and Education

Regular training will be provided to all personnel who have a role in planning and operational response to an emergency. The main goal of training for emergencies is to enable the participants to understand their roles in the response organization, is the tasks associated with each position and the procedures for maintaining effective communications with other response functions and individuals. The training objectives are:

- To familiarize personnel with the contents and manner of implementation of the DMP and its procedures.
- To train personnel in the performance of the specific duties assigned to them in the DMP and in the applicable implementing procedures.
- To keep personnel informed of any changes in the DMP and the implementing procedures.
- To maintain a high degree of preparedness at all levels of the Emergency Response Organization.
- Train new personnel who have moved within the facility organization.
- Test the validity, effectiveness, timing and content of DMP.
- Update and modify the plan on the basis of experience acquired through exercises and drills.

Emergency Response Plan Review

The Emergency Response Plan and associated implementing procedures should be reviewed to ensure compliance with relevant regulations and applicable state and local emergency plans and written agreements with mutual aid agencies also.

The DMP should be reviewed under the direction of the Plant-In-Charge, which should encompass the plan, response procedures, equipment, training, drills and interfaces with local emergency management agencies. The need for changes is based upon the following aspects:

- Written evaluations of drills and exercises which identify deficiencies or more desirable methods, procedures, or organizations
- Changes in key personnel involved in the organization
- Changes in the facility organization structure
- Changes in state regulations
- Modifications to the facility which could affect emergency planning
- Recommendations received from other organizations and state agencies.

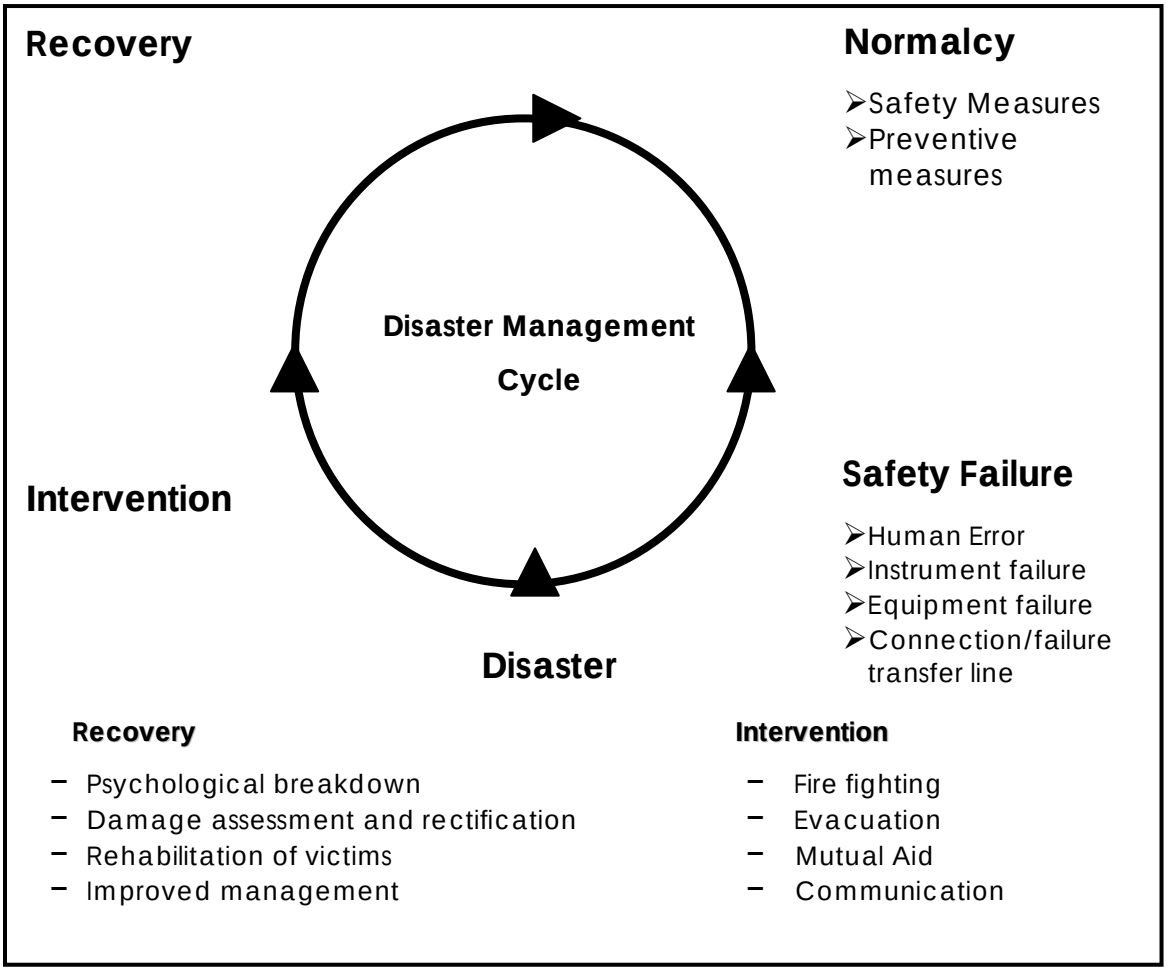


Figure 7.4 Disaster Management Plan

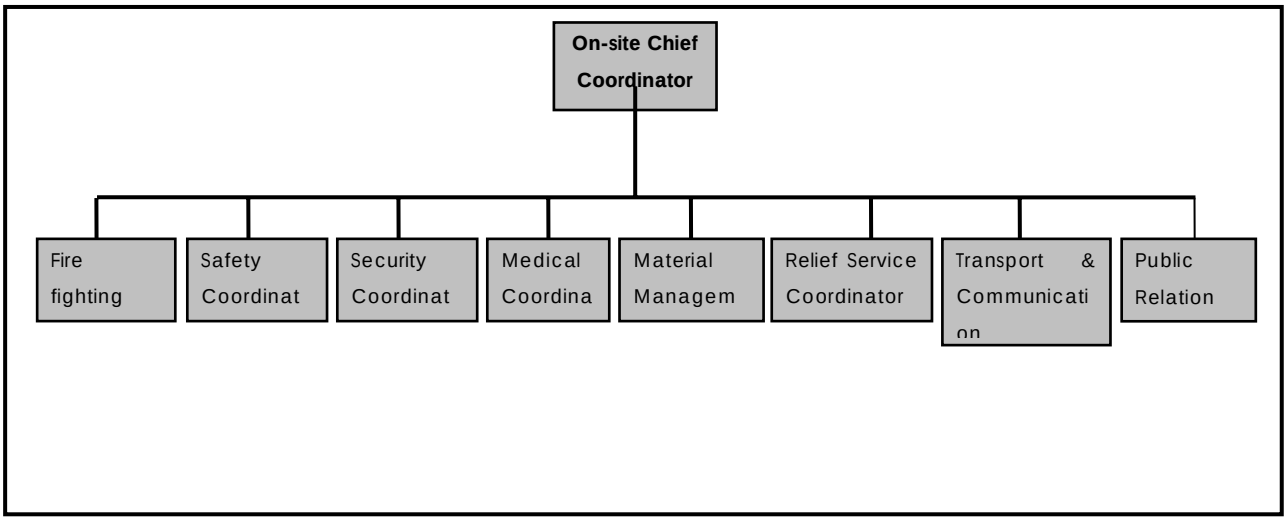


Fig 7.5: Organizational Chart Depicting Sequence of Action to be taken by Concerned Persons on an On-site Crisis

8. PROJECT BENEFITS

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8.1 IMPROVEMENT IN PHYSICAL INFRASTRUCTURE

At present, the infrastructure facilities of the study area are not well developed. It was found that accessibility to the area is poor and people have to depend on private modes of transport. Public transport was found absent due to bad road conditions and inaccessible during bad weather conditions. As a result, people, especially women were cut-off from the mainstream.

In this area water supply, power supplies are almost non-existent. The proposed power project will help in solving all these problems. Various infrastructural facilities like pucca roads, communication, electricity, water supply, educational and recreational facilities, hospitals, dispensaries, libraries etc. needed for the local society will be provided by the project proponents.

8.2 IMPROVEMENT IN SOCIAL INFRASTRUCTURE

Social and community infrastructure and services are insufficient at present considering the need of communities. The proposed project is expected to contribute towards upliftment of quality of life of local people and it shall generate inputs for industrial/ economic development in the region. They enhance the quality of life, equity, law & order stability & social well being through community support; safety & security; sports; recreation and culture; justice; housing; health & education. Guidelines are given to proponents for protection of workmen likely to be engaged from the nearby villages, as also a discussion towards the end covering community benefits. The following measures are suggested for minimizing the adverse impacts on socio-economic and human interest:

- Communication with the local community should be institutionalized on regular basis by the project authorities to provide as opportunity for mutual discussion
- For social welfare activities to be undertaken by the project authorities, collaboration may be sought with local administration, gram panchayat, block development office etc. for better co-ordination.

In order to maintain good Industrial Relations and to implement the project smoothly, following facilities have been envisaged at the proposed power plant:

- Essential facilities like Electricity, Drinking Water, Toilets, and Bathrooms, Proper fencing, leveled ground with proper drainage, sanitation arrangements, and adequate illumination arrangements shall also be provided. PCO, canteen and grocery shop are also envisaged near labour colony.
- Provision of ambulance with doctor and First Aid shall be kept at work place.
- All contract workers and staff shall be provided personal protective appliances and safety gadgets. Safety during project implementation will be accorded highest priority. Regular awareness programmes shall be conducted to create and sustain a safe working culture.
- Rest rooms, canteen, drinking water near the workplace shall be provided for contract workers as well as transporters etc. Hygienic working conditions shall be maintained at workplace.
- Designated officials will ensure proper maintenance of infrastructure created for contract labours and to take immediate corrective actions whenever required after regular inspection.

8.3 EMPLOYEMENT POTENTIAL

At present the socio-economic conditions of the people in the study area is not good mainly due to low agricultural productivity. It was found that it is difficult for the people to sustain their livelihood on agriculture and was looking for other means of livelihood. So the proposed project will have a positive impact on the socio-economic conditions of the people by providing direct and indirect employment in the plant. Also the project shall enhance economic growth of the area in general. Cost of land and other properties in the area will be increased.

Plant should ensure that every permanent worker has employment security benefits. They should be covered by proper insurance/other schemes such as benefits in case of injury, sickness, temporary and permanent disability through workers' compensation in the event occupational accidents and diseases, and compensation for survivors in the event of work-related death, to all workers in the plant, irrespective of their employment status.

Plant should have reasonable working hours that should not exceed the number of hours prescribed by India's law and regulations. The workers should be paid as per the minimum wages act.

During construction phase:

- Total employment -10,000 through contractor.
- About 20% of the employment will be provided to locals.

During operation:

- Total employment – 1,500 (proposed) to be provided during plant operation.
- All employable local youth will be provided training and on successful completion will be provided employment.
- Local youth will be provided financial support in completion of ITI course.
- All the schools of Mundra taluka (107 nos.) have already been adopted for development by Adani Foundation.
- All class 10 standards will be encouraged to take up admission in ITI, established by Adani Foundation.

Adani Foundation also seeks to reach out to communities surrounding the Adani Group's areas of operation by education 17,000 young minds with the following objectives:

- Provided quality education in each area
- Improve quality of life in each area
- Educate Girl children
- Protect children's right
- Gender equality
- Promote High school education in rural areas

8.4 OTHER TANGIBLE BENEFITS

The other benefits that the project will provide are as follows:

- Shall provide closer interaction and understanding between people from different regions, culture, social traits etc.
- Shall improve in the general living standards and knowledge sharing bringing modern outlook and vision for growth and economic prosperity.
- Shall benefit to State and Central governments by way of royalty, sales tax, duties etc. from this project. This in turn will help in development activities by Government in the area.

9. ENVIORNMENT MANAGEMENT PLAN

9. ENVIRONMENT MANAGEMENT PLAN

9.1 INTRODUCTION

In order to manage environmental issues, appropriate institutional arrangements along with suitable organizational structure need to be in place, with clear definition of a range of required activities, powers and responsibilities of the concerned agencies including project proponent. The assessment of environmental impacts and mitigation measures has been identified for effective operation of environmental management activities during the pre-construction, construction, commissioning and O&M activities. These have to be operated with necessary hardware and software to establish and monitor appropriate indicators for suitable remedial measures.

In this context, Kutch Power Generation Limited shall deploy qualified and competent staff for the project. Kutch Power Generation Limited is also in the process of developing appropriate human resources development policy with the support of the State Govt. In the absence of sufficient environment specialists, capacity strengthening of the existing engineers/staff to address environmental issues has been emphasized.

9.2 ENVIRONMENT MANAGEMENT PLAN

Power is the basic need not only for industrial and agricultural sector but also for economic development and improvement of quality of life of the people of a country. Electricity is the cleanest form of energy at the consumption point. However, coal fired power station has certain adverse impact on the environment. Therefore a number of safeguards have to be built in during the design stage itself.

The Environment Management Plan (EMP) outlines the environmental management system that will be implemented during the detailed design and construction works of the project for minimization of deleterious effects and implementation of enhancement measures. The EMP embraces environmental management issues comprising of, beneficial impacts as well as long-term adverse impacts and their remedial measures.

The plant management should implement sound Environment Management Plan (EMP), which will make environment protection an essential requirement. Prediction of the

potential environmental and social impact arising due to development activities are considered as the heart of EIA process. An equally essential element of this process is to develop measure to eliminate, offset, or reduce adverse impacts to acceptable levels and enhance the beneficial ones during implementation and operation of the projects. The integration of the project planning is done by clearly defining the environment requirements within an Environment Management Plan (EMP). The Management Action Plan aims at controlling pollution at the source level to the maximum possible extent with the available and affordable technology followed by treatment measures before they are discharged. Specifically, the EMP monitors and manages environmental aspects and issues of the project during construction and operation phase by:

- Identifying potential environmental impacts;
- Recommending mitigation measures for the negative impacts;
- Identifying opportunities for enhancement measures;
- Providing an organizational framework for operating Environment Management System and other functions of the project by assigning roles and responsibilities for environmental monitoring and management;
- Formulating Environmental Management Plan, which specify mitigation, monitoring activities and indicators to be attached to Annual and periodic activity plans for project implementation

The responsibilities for undertaking specific required activities at design; construction and operation stages are listed in **Table 9.1**.

Table 9.1: Responsibilities of different Organizations in Environment Management

Project Stage	Responsible Organization	Responsibilities
Participatory design	Project Consultants	Minimize non-avoidable losses in consultation with diverse stakeholders and prepare Environment Action Plan by specifying mitigation and enhancement measure for engineering design, bid & contract documents, non-structure program plans & periodic implementation plans
	Kutch Power Generation Ltd. (KPGL) Management	Review and approve environmental mitigation measures reflected as EMP and attached to documents mentioned above
Construction Phase	Contractors	Implement required environmental measures as reflected in EMP
	KPGL management	Supervise contractors & service providers for implementation of EMP and enforce contractual program requirements
	KPGL Engineers	Monitor and report environmental indicators
Operation	KPGL management	Provide budget to undertake environmental monitoring

	Environment Consultant	Carry out environmental monitoring and reporting
	National Institute of Oceanography	Carry out environment monitoring of Sea water at the Intake and Outfall points

9.3 COMPONENT OF ENVIRONMENT MANAGEMENT PLAN

In this chapter Environmental Management Plan has been dealt with both construction and operational phase of the proposed 5 x 660 MW Imported Coal based (Super Critical) Power Plant. The purpose of EMP for both construction as well as operational phase has been aimed to achieve the following objectives:

- To ensure adoption of state of art technological environmental control measures and implement them religiously
- Effectiveness of mitigatory measure in mitigation of impacts
- Description of monitoring program of the surrounding environment
- Institution Arrangements to monitor effectively and take suitable corrective steps for implementation of proper EMP
- Implementation schedule and reporting procedures

9.4 ENVIRONMENT MANAGEMENT PLAN: CONSTRUCTION PHASE

Based on the findings of the EIA and consideration of the necessity to limit environmental impact during construction, the following general guidelines have been devised for incorporating into the tender document. **Figure-9.1** outlines the implementation of the EMP during construction ensuring compliance with environmental rules, regulations and standards.

Details regarding infrastructure facilities to be provided during construction phase

- Housing in association with the contractors.
- Drinking water facility
- Sanitation/toilets with septic tank
- Rest room to be provided
- Medical facility to be provided
- Training on occupational health & safety for employees and casual workers.

Personal Protective Equipments (PPE) to be imparted during construction and operation phases.

The standard specifically covers personal protective equipment for:

- Head
- Eyes
- Face
- Hands
- Foot
- Body (protective clothing)
- Respiratory devices and
- Protective shields and barriers

List of PPE are given below:

- Safety Helmets
- Safety Shoes
- Hand Gloves
- Safety Goggles
- Ear Plugs
- Nose mask
- Welding / Cutting safety Goggles
- Face shield
- Ear plug

The company has developed a safety policy & procedure to be adopted at all sites.

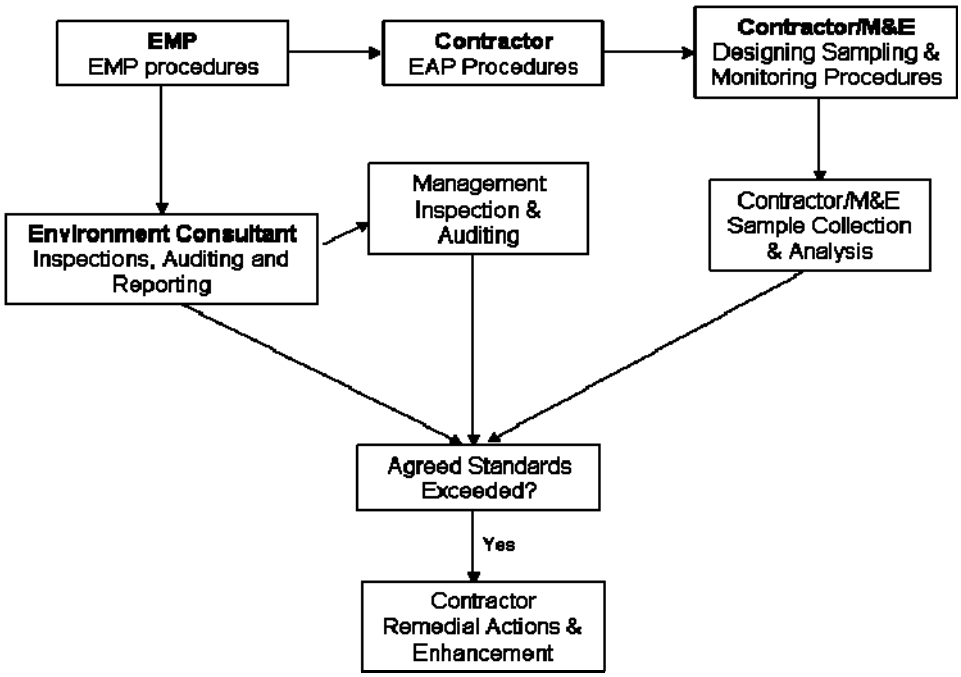


Figure 9.1: Outlines for EMP implementation during construction Phase

9.4.1 Contractor's Responsibilities with Respect to the Environment

General

The contractor's environmental responsibilities would be prescribed in the tender document and later on incorporated in contract. They would include the need to adhere to guidelines provided in the environmental clause in the contract. The contractor shall also take all reasonable steps to protect the environment and to prevent environmental damage & public nuisance resulting from construction activities.

Contractor shall comply with all statutory requirements, environmental regulations and environmental quality standards as stated in the Pollution Control Law Series PCLS/02/2006, CPCB and Ministry of Environment & Forest (MoEF), Govt. of India guidelines relevant to the proposed project.

Pollution from Wastes

Recycled aggregates will be used for filler applications and as sub-base for roads. Site grading operations will also involve stockpiling of backfill materials. The topsoil removed for the purpose of construction will be stored properly so that it can be reused later for green-

belt development. Recyclable wastes such as plastics, glass fibers and insulations will be sold to recyclers.

During the construction phase, many toxic substances such as paints, solvents, wood preservatives, pesticides and sealants will be used. The wastes generated will be stored in sealed containers, labeled and disposed as required by the Hazardous Waste Storage, Handling and Transportation Rules of Environment Protection Act 1989. Efforts will be made to use less of hazardous chemicals during rainy seasons and special care will be taken to store these materials. Employees and contractors have to be educated to handle hazardous wastes and materials.

Due care will be taken to avoid water pollution problems during rainy season due to washout of waste material from dumpsite. At construction site, petroleum powered equipments and temporary storage of petroleum products (Highly inflammable) may lead to fire hazard, if safety norms are not strictly followed. Therefore, care should be taken to avoid all sources of ignition at such places.

Protection of Human Health

Adequate sanitation facilities on construction site would be provided. All waste from the sanitary system would be disposed suitably to avoid environmental pollution. Wastewater should be routed through suitable designed septic tank and soak well, without contaminating either ground or surface water or causing a health risk.

Environment impacts during construction phase, about 3-5 years duration, will be mainly due to civil works as site clearing, foundation, construction, material and machinery transportation etc. The construction phase impact will be temporary in nature and localized phenomena except the permanent change in land-use pattern at the project site.

The land of the proposed thermal power plant is more or less flat. It is predominantly covered with underlying compacted dense sandy layer. Minor leveling would be required during construction. Before commencing the earthwork, available sparse vegetation would be removed. Due to the construction and transportation activities, dust will be generated.

Water will be regularly sprinkled to reduce dust. Low-lying area if any will be filled with earth excavated during the construction work.

The topsoil excavated from water reservoir area may be reused for development of landscapes and horticulture. The main mitigation measures for environmental control during construction are summarized in the **Table-9.2**.

Table 9.2: Main Environmental Mitigation Measures during Construction Phase

Mitigation Measure	Purpose	Failure consequence
Water sprinkling	Control of fugitive dust during construction and transportation activity	Increment in the SPM concentration
Transportation of construction material in covered trucks	Control of fugitive dust	Increase in dust emission
Regular maintenance of transport vehicle and provision of acoustic cover on construction machinery	Control of Noise	Increase the noise level of surrounding area
Traffic management and transport scheduling	Manage the public convenience due to traffic congestion on the highways	Congestion of Traffic and public disturbance along the road
Construction of temporary sediments tanks for construction effluent	Control of suspended solids to prevent the surface water quality	Contamination in surface water
Provision of environmentally safe camping area for migrant laborers	To provide a clean and healthy living condition for labours	Unhealthy living condition and spread of disease

9.5 ENVIRONMENT MANAGEMENT PLAN: OPERATION PHASE

During operation phase of the proposed project pollution impacts are envisaged on Air, Noise and Land/Biological components as per the impact predicted in this study. However, in order to ensure predicted impact levels and to further mitigate the impacts wherever possible from proposed project on individual environmental components, the following mitigation measures are recommended:

Air Environment

Coal based thermal power plants emit fly ash as the major pollutant besides varying degree of other pollutants namely: coal dust, sulphur dioxide and oxides of nitrogen etc. Therefore it is recommended to monitor the concentration of RSPM, SPM, SO_2 and NO_x in the ambient air at regular intervals on predetermined locations.

The control measures to combat air pollution due to proposed power plant have been formulated under two categories, i.e. for individual units as well as for the whole power plant in general.

For the fine dust control due to crushing operation, bag filters have been successfully tried in such operations. Better efficiency dry collection system shall prove to be long term cost effective because of possibility of coal recovery after blending as a domestic fuel.

For collection of fly ash in flue gas from the boiler, a high efficiency ESP is proposed to be designed and installed in this project, which will keep the emission level of the particulate matter within permissible limit. Sprinkling of water will be applied at the dust generating areas.

As far as gaseous pollutants namely: NO_x and SO_2 are concerned provision of tall stack i.e. 275m height for 5 x 660 MW units as per regulations in the EPA, 1986 is proposed to mitigate the adverse impact of SO_2 emission. The proposed plant will be utilizing low NO_x coal burners to restrict the NO_x emission within the permissible limit. Attempts shall be made to achieve/maintain the plant load factor (PLF) of at least 80%. This will certainly help in minimizing environmental damage. It is anticipated that a reasonably well-maintained system can operate over 80% PLF.

The imported coal will have higher calorific value and low ash and sulphur compared to ordinary Indigenous coal, therefore SPM and SO_2 levels in ambient air will not be very significant. The stack would have sufficient capacity to take care of emergency release conditions, for additional load of flue gas under boiler start up and shutdown periods. There would be installation of a permanent weather monitoring stations within the plant premises. The wind speed, wind direction, temperature, cloud cover, rainfall shall be monitored and recorded daily.

Water Environment

The project will have a open cycle cooling system. Steam generator blow down water would be flashed in an atmospheric flash tank. It is proposed to lead steam generator blow down after quenching with service water to a recovery pond. Almost entire blow down water shall be used for service water requirement, coal handling plant and fire fighting. Cooling water will be discharged into the sea through a discharge system suggested by NIO.

Fuel oil storage areas will be provided with concrete embankments to contain spills. Regular oily wastewater shall be treated before discharge. Areas that are prone to spillage will be connected to a drainage system and will undergo adequate treatment before discharge.

The drain and overflow water from the bottom ash handling system would be collected at the bottom ash sump where the ash would be settled and clarified water will overflow to clear water section of the basin.

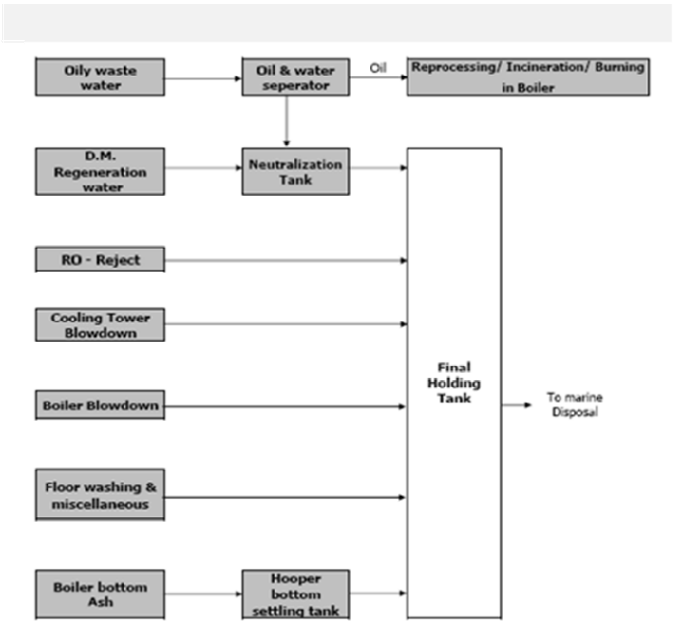


Fig 9.2 – Waste Water Treatment Scheme

Water treatment plant effluent comprises mainly of WT plant regeneration waste and filter backwash. The treated effluent and wastewater recovered from various sources would be collected in an effluent basin after quenching. This water can be used for horticulture purpose.

The measures recommended for ETP would be planned, completed and commissioned along-with the commissioning of the Proposed Power Plant.

- Evaluation of the effluent treatment plant for its performance after its commissioning should be undertaken at regular intervals to keep a check on the treated effluent quality.
- Trained personnel should be engaged for operating the effluent treatment plant.
- In-plant control measures should be implemented to minimize the quantities of wastewater generation.
- In addition to the above, to keep control on biological treatment, regular monitoring of effluent quality is also recommended.

Noise Environment

Manufacturers and suppliers of noise generating devices/machines like steam turbine generator, compressors and other rotating equipment shall be asked to use noise

absorbing material and enclosures by adopting appropriate design & state of art technology for fabricating/assembling machines.

Proper noise barriers/ shields etc shall be provided in the equipment whenever required. Noise from equipment shall be adequately attenuated by providing soundproof enclosure and insulation to minimize the noise level.

Recommendations for Noise management

- To reduce the impact of noise, shock absorbing techniques may be adopted
- All opening like covers, partitions may be acoustically sealed
- The operator's cabin (control rooms) should be properly insulated with special doors and observation windows
- The operators working in the high-noise areas would be strictly instructed to use ear-muffs/ear plugs
- Noise levels may be reduced by the use of absorbing material on floors, walls and ceilings
- There will be thick vegetation in the plant premises to attenuate continuous noise.

Ash Management

Considering use of blended coal (mix of indigenous and imported coal) with 32% Ash, it is estimated that on an average about 4.474 MMTPA of ash generated from all the units of KPGL plant. Fly ash will be collected from the economizer and heater and electrostatic precipitator hoppers and will be evacuated and conveyed directly to storage silos by vacuum conveying system in complete dry state. Bottom Ash evacuation shall be through scrap conveyor system for evacuating through bottom ash Hopper.

MoEF Govt. of India notification dated 27th August 2003 has laid down the guidelines & stipulations regarding utilization of fly ash. As per the new notification enacted under S.O. 2804 (E) dated 3rd November, 2009 by the Ministry of Environment and Forest; KPGL has comprehensive ash management plan for the utilization of fly ash to achieve 100% ash utilization by the end of 4th years after commissioning of plant by considering the sequential increase in Ash Utilization every year, as per the notification.

Fly Ash will be utilized for brick manufacturing, pavement & building block making, etc. There is also provision of making cement (PPC) and concrete mix work during various stages of plant constructional activities. Bottom ash will be utilized for proper low land filling and disposed off to proposed ash pond.

Infiltration tests of the area reveal hydraulic permeability in the range of 1.8 x 10^{-6} m^2 to 2.6x 10^{-6} m^2 to avoid leaching into ground water; it is recommended to provide lining to the Ash pond area. To prevent any leaching from the ash pond 40 mil HDPE lining will be provided. The area under supernatant collection lagoon will also be lined with 40 mil HDPE lining.

Ash disposal plan:

Year	Ash Generation MMT per year	Ash Utilization %	Total quantity MMT per year	Ash to sent to Ash pond
1st	4.474	50	2.237	2.237
2nd	4.474	70	3.131	1.343
3rd	4.474	90	4.027	0.447
4th	4.474	100	4.474	-
Total quantity of ash to be disposed in Ash pond				4.027

Ash pond area requirement will be 64 ha, considering 30% area under bunds, supernatant collection lagoon and green belt. Height of ash dyke has been considered as 9.0 mtr.

Hazardous Solid Waste Management

Hazardous solid waste in the form of waste oil, spent ion exchange material and water pre treatment clarifier sludge will be generated from the power plant. The oil will be collected in MS drums and will be sold to the recycler registered with GPCB / Central Pollution Control Board. Sludge will be dried on solar drying bed, bagged and sent for land filling. Spent Ion exchange material will also be sent for land filling.

Social Environment

The proposed project is expected to contribute towards up-liftment of local people quality of life and it shall generate inputs for industrial/economic development in the region. Following guidelines are given to proponents for protection of workmen likely to be engaged from the nearby villages, as also a discussion towards the end covering community benefits. KPGL should take adequate steps to get local people into confidence so as to avoid any misconceptions amongst the people in future. The following measures are suggested for minimizing the adverse impacts on Socio-Economic & Human interest:

- Communication with the local community should be institutionalized as done on regular basis by the project authorities to provide an opportunity for mutual discussion
- Social welfare activities may be undertaken by the project authorities in collaboration with local administration, gram panchayat, block development office etc. for better co-ordination.

9.6 GRIEVANCE MECHANISM

A grievance Mechanism Cell will be set-up by the project proponent with the following objectives:

- To Conduct participatory social assessment of ethnic minority villages in project surrounding area
- The main objectives of the grievance Mechanism Cell is to implement project successfully so that the affected persons are compensated and assisted to restore their livelihood, improve their quality of life and educate the PAPs on their rights to entitlements and obligations.
- Conflict resolution and grievance readdress mechanisms will be developed in culturally appropriate ways by retaining the existing social structure
- To ensure that the population within impact zone are given their full entitlements as due to them as per the existing Entitlement Policy.
- To provide support and information to population within impact zone for income restoration, assist in counseling and co-ordination with the local authorities, in reducing their grievances (through the grievance redressal System), impart information to all the population within impact zone about the functional aspects of the various level committees set up by the project Authority and assist them in benefiting from such institutional mechanism.
- To assist the Project Implementation Unit (PIUs) in ensuring social responsibilities of the Project, such as compliance with the labour laws, prohibition of child labour and gender issues.
- To collect data and submit progress reports on monthly basis as well as quarterly basis to monitor the grievances raised during the counseling
- To encourage, promote and assist voluntary action for the enhancement of population within impact zone prosperity, strengthen and promote the communal harmonies between different ethnic groups and project proponent
- To raise income level and extend employment opportunities of the weaker sections of the society, particularly of those living below the poverty line and belonging to indigenous community
- To involve population within impact zone in the planning, implementation and maintenance activities envisaged, creating practical solutions through community participation and mobilization.
- To assist population within impact zone in the redress of grievance through the system implemented as a part grievance redressal system
- To ensure the participation of people in maintaining the environmental balance by educating and training them.
- Local NGOs may also take part in grievance mechanism system with other local agencies

9.6.1 Grievance Monitoring and Redressal Procedure

The grievance Mechanism Cell will have one day a week to receive complaints; the Chairperson of the above will be responsible for settling complaints and the fatherland front and citizens will also be responsible for supervising the process. In addition, affected

communities will be able to bring complaints to the executing agency after having gone through the official channels.

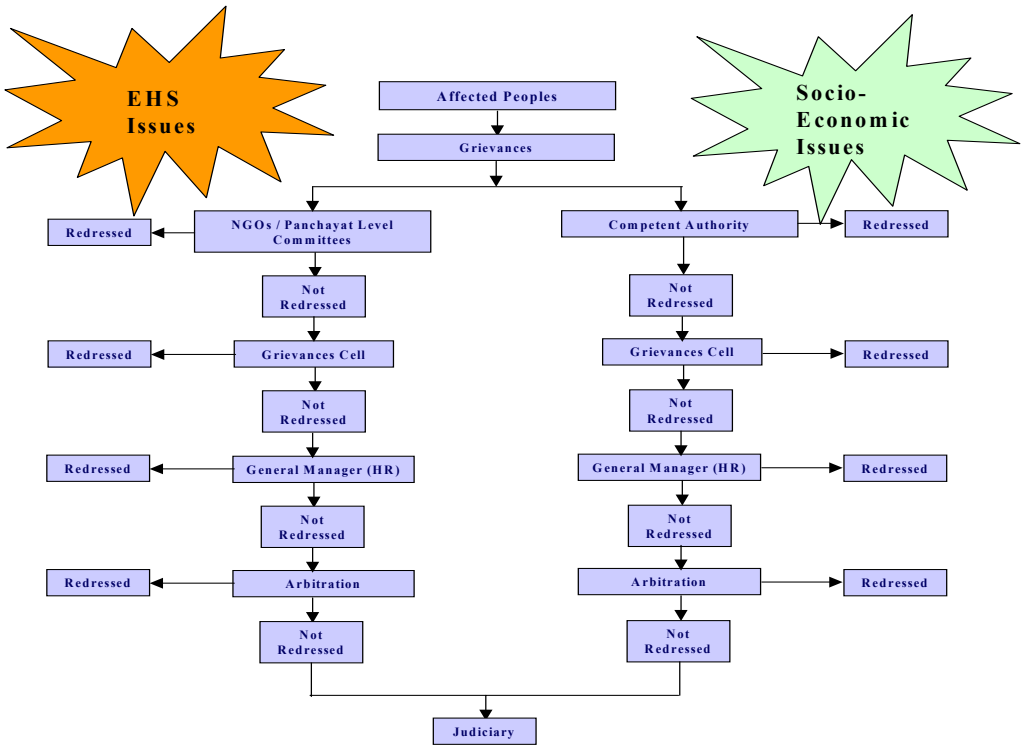


Figure 9.3 – Steps for Grievance Redressal

1.1 INDIGENEOUS PEOPLE

For the proposed Project no land has been acquired, which involves Rehabilitation and Resettlement issue. So, there will be no impact on the indigenous people due to land acquisition. However, the Scheduled Castes and Scheduled Tribes communities constitute 12.86% and 5.77% respectively of the total population of study area (10 km radius from the site) as per 2001 Census. The Indian Constitution provides for comprehensive framework for the socio-economic development of Scheduled Castes and Scheduled Tribes.

The KPGL will prepare a separate Tribal Development Planning (TDP) cell under the overall supervision of General Manager, HR with the following activities:

- The TDP cell will establish an ongoing relationship with the affected communities of Indigenous Peoples from as early as possible in the project planning, construction and throughout the life of the operation of the project.
- In projects with adverse impacts on affected communities of Indigenous Peoples, the TDP cell will ensure their free, prior, and informed consultation and facilitate their informed participation on matters that affect them directly, such as proposed mitigation measures, the sharing of development benefits and opportunities, and implementation issues.

- The process of community engagement will be culturally appropriate and commensurate with the risks and potential impacts to the Indigenous Peoples. In particular, the process will include the following steps:

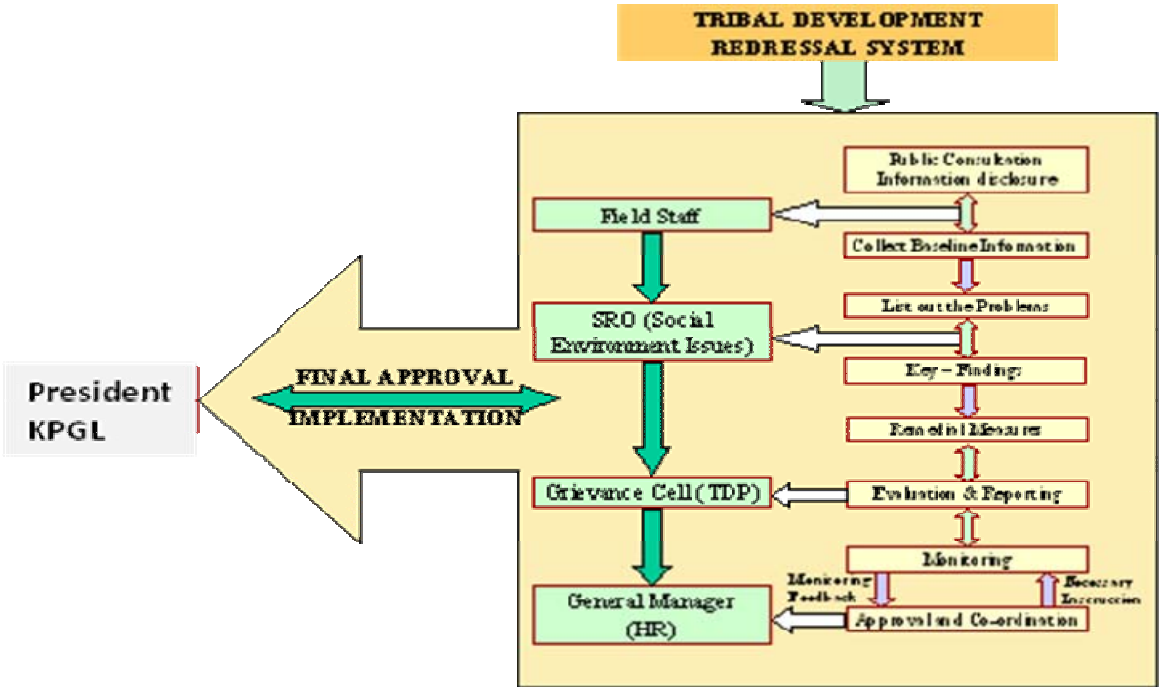


Figure 9.4 – Tribal development redressal system.

1. Involve Indigenous Peoples' representative bodies (for example, councils of elders or village councils, among others)
2. Be inclusive of both women and men and of various age groups in a culturally appropriate manner
3. Provide sufficient time for Indigenous Peoples' collective decision-making processes
4. Facilitate the Indigenous Peoples' expression of their views, concerns, and proposals in the language of their choice, without external manipulation, interference, or coercion, and without intimidation

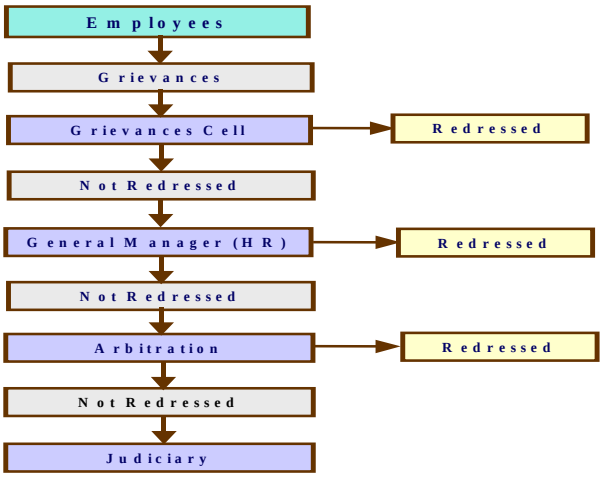
- Monitoring, documentation and implementation of Annual Plan.
- Monitoring and documentation of health infrastructure established in ST and SC areas will be carried out through Half Yearly/Annual Reports.
- Monitoring and documentation of health infrastructure, health manpower, stock of medicines/drugs etc. in extremely backward Scheduled Tribes areas

9.7.1 Responsibility of the Functions

Function	Responsibilities
President KPGL	Final Approval for implementation and ensuring the

	funding
General Manager (HR)	Approval and Overall responsibility for Tribal Development Plan, Monitoring and timely Implementation
Grievance Cell (TDP)	Implementation, Monitoring, Evaluation, Suggestion for remedial Measures
Senior Officer (SRO) – Social Environment Issues)	List out the problems, Key findings and arrange Public Consultation & Monitor the Progress
Field staff	Public Consultation, Interaction with the ethnic communities and Prepare reports

9.8 LABOUR AND WORKING CONDITION



For any business, the workforce is a valuable asset and sound worker-management relationship is a key ingredient to the sustainability of the enterprise. Through a constructive worker-management relationship, and by treating the worker fairly and providing them with safe and healthy conditions, clients may create tangible benefits, such as enhancement of the efficiency and productivity of their operations. The basic objectives is to ensure following.

- To establish, maintain and improve the worker-management relationship
- To promote fair treatment, non-discrimination and equal opportunity to all workers, and compliance with national labor and employment laws
- To protect the workforce by addressing child labor and forced labor
- To promote safe and healthy working conditions, and to protect and promote the health of workers by evolving safe working practices.

In order to achieve these objectives, some rules are required to be framed by enacting certain laws. Therefore, all the workmen of the company require to be governed by the relevant Indian Labour laws, which are stated in **Chapter 2**.

All the important features of these acts or laws are described below.

Working Relationship

The project proponent will document and communicate to all employees and workers directly contracted by the proponent in respect of their working conditions and terms of employment, including their entitlement to wages and any other benefits.

Workers Organizations

The project proponent will not discourage workers from forming or joining workers organization of their choosing or from bargaining collectively and will not discriminate or retaliate against worker, who participate or seek to participate in such organisations and bargain collectively.

Equal Opportunities

The proponent will base the employment relationship on these principal of equal opportunities and fare treatment and will not discriminate with respect to aspects of the employment relationship including recruitments and hiring, compensation, working conditions and terms of employment, access to training, promotion, termination of employment or retirement and discipline.

Grievance Mechanism

M/s KPGL will provide a grievance mechanism system for workers and their organization, where they are able to raise reasonable work place concerns. M/s KPGL will inform the workers about the grievance mechanism at the time of hire, and make it easily accessible to them. The mechanism shall involve appropriate level of management and address concerns promptly, using understandable and transparent process that provides feedback to those concerns without any retribution. The mechanism will not impede access other judicial or administrative remedies that might be available under law or through existing arbitration procedure, or substitute for grievance mechanism through collective agreements.

Child Labour

M/s KPGL will not employ children in manner i.e. economically exploitative or is likely to be hazardous or to interfere with the child education or to be harmful to the child's health or physical, mental, spiritual, moral or social development. Children below the age of 18 years will not be employed in dangerous work.

Occupational Health and Safety

KPGL will provide the workers with a safe and healthy work environment taking into account inherent risks in its particular sector and specific classes of hazards in the works premises, including physical, chemical and biological hazards. KPGL will take steps to prevent accidents, injuries and disease arising from, associated with or occurring in the course of work by minimizing so far as reasonably practicable the causes of hazards.

Non-Employee Workers (Contracted Labours)

They will comply with National Legal Requirement covering such matters as minimum wages, hours of work, overtime payments health and safety conditions, contribution to health insurance and pension schedules and other legally mandated employment terms with regard to all directly contracted Non-employee workers.

1.1 GREEN BELT DEVELOPMENT

With a view to attenuate air pollutants, to absorb noise and to care of uptake of water pollutants, it is recommended to develop a greenbelt on 30% of the total acquired area, all around the boundary and at several locations within the power plant premises.

Criteria used for selection of species for greenbelt

The plant species suitable for greenbelt development need to be selected based on the following criteria:

- Fast growing
- Thick canopy cover
- Perennial and evergreen
- Large leaf area index
- High sink potential
- Efficient in absorbing pollutants without significantly affecting their growth
- Suitable for the local seasons
- Native Species, No alien species would be planted

A concept of three tier green belt development viz. rows of permanent trees in say 20m width, followed by avenue trees with medium canopy in a width of approx. 10m may be planted along the periphery of the plant, thereby developing approximately 50m wide green belt all along the plant boundary. Concept of 2500 trees/ha will be followed.

The various services/utility areas within the plant would be suitably graded to different elevations. Natural features of the plant site would be retained as far as possible to

integrate with the buildings to form a harmonious/pleasant environment. Areas in front of various buildings and the entrance of power plant would be landscaped with ground cover, plants, trees based on factors like climate, adaptability etc. The green belt would consist of native perennial green and fast growing trees. Trees would also be planted around the coal stockpile area and ash disposal area to minimize the dust pollution.

The plant species that may be useful for development of thick green cover keeping in view the nature of pollutants expected from power plant and pollution attenuation coefficient of plants, the following native plants species with not less than 2500 trees per ha are short listed for plantation.

Areas to be developed as green belt are 95.0 hectares. Action plan for the development of Green belt is given below:

Sl. No.	Year	Area (Ha.)	No. of saplings	Budget (In Rs.)
1	1st	15	37,500	9.0 Lakhs
2	2nd	30	75,000	18.0 Lakhs
3	3rd	50	1,00,000	24.0 Lakhs

After 3 years, annual maintenance budget is provided at Rs. 5.0 Lakhs/year. Spacing of plantation to be made in 2mx2m.

Table 9.4: Species Recommended For Green Belt Plantation

Sl. No.	Indian Name	Botanical Name
1	Amaltas/Sonalu	*Cassia fistula*
2	Amlaki	*Phyllanthus emblica*
3	Andrakini	*Bischofia javanica*
4	Aparajita	*Clitoria turnatea*
5	Arjun	*Terminalia arjuna*
6	Ashok	*Saraca indica*
7	Babla	*Acacia nilotica*
8	Bakful	*Sesbania grandiflora*
9	Bakul	*Mimosops elangi*
10	Barun	*Cratseva narvala*
11	Bat	*Ficus bengalensia*
12	Bell tree, Scarlet bell	*Spathodea campanulate*
13	Blue gold mohar	*Jacaranda mimosaefolia*
14	Bottle brush	*Callistemon viminalia*
15	Cazliewnut	*Ancardium occidentale*
16	Champ	*Michelia champaca*
17	Chandramalika	*Chrysanthemum coronarium*
18	Chhatim	*Alstonia scholaris*
19	Chimul	*Bombax ceiba*
20	China-champa	*Michhelia Dear Dear Dpaji, chucho, bodmash*

Sl. No.	Indian Name	Botanical Name
21	Cock's comb	*Celosia cristate*
22	Drooping debdru	*Polyalthia lougifolia var pendula*
23	Dulee-champa	*Magnolia grandiflora*
24	Duranta-manta	*Duranta repene*
25	Eucalyptus var	*Fucalyptus hybrid*
26	Eucalyptus	*Eucalyptus*
27	False acacia	*Robinia acacia*
28	Gamar	*Gmelina arborea*
29	Ghora neem	*Melia azedarach*
30	Gliricidia	*Gliricidia maculate*
31	Glory of the garden	*Bougainvillea spectabilis*
32	Golpata	*Nipe fruticans*
33	Guava	*Psidium guava*
34	Hasanhana	*Cestrum nocturnum*
35	Horse cassia	*Cassia grandia*
36	Indian coral tree (Mandar)	*Erythrina indica*
37	Indian rosewood (Sitsal)	*Dalbergia latifolia*
38	Jajnya dumur	*Ficus glomerate*
39	Jamun	*Syzygium cumini*
40	Jarul	*Lagerstroemia speciosa*
41	Jerujalem thorn	*Parkinsonia aculeate*
42	Jhau/saru	*Casuarinas equisetifolia*
43	Kachnar	*Bauhinia variegate*
44	Kadam	*Anthocephalus cadamba*
45	Kamini	*Marrya exotica*
46	Kanak champa	*Pterospermum acerefolium*
47	Kanchan	*Bauhinia purpurea*
48	Kanthal	*Artocarpas integifolia*
49	Karanja	*Pongamia plnnata*
50	Katgolap	*p. rubra*
51	Krishnachura/Gulmohar	*Delonix regia*
52	Lichu	*Nephelium litchi*
53	Madar	*Brythrina indica*
54	mahogani	*Swietenia mahagani*
55	Mandar	*E. Variegata*
56	Mango	*Mangifera indica*
57	Minjirl	*Cassia siamea*
58	Muktajhuri	*Acalypha tricolour*
59	Nagkesher	*Meana ferrea*
60	Narkel/coconut	*Cocos nucifera*

Sl. No.	Indian Name	Botanical Name
61	Nayantara	*Vinca rose*
62	Neem/Maha Neem	*Azadirachta indica*
63	Night shade	*Solanum macranthum*
64	Nilkantha	*Ecbolium linnaenum*
65	Noon flower	*Pentapetee phcenicea*
66	Palas	*Butea monospermal*
67	Paper tree	*Schinus molle*
68	Pink cassia	*Cassia javanica*
69	Pink White cassia	*Cassia renigera*
70	Pogada tree (Katgolap)	*Plumeria acutifolia*
71	Putranji	*Putranjiva roxburghii*
72	Radhachura	*Peltophorum ferrugineum*
73	Rain tree	*Pithecolobium saman*
74	Ranjan	*Ixora sp*
75	Red cassia	*Cassia marginata*
76	Red sandal wood	*Pterocarpus santalinus*
77	Rupasi	*Melojeuca lenocodendron*
78	Safed siris	*Albizzia procera*
79	Sal	*Shoria robustae*
80	Safalika	*Nyctanthes arbor-tristis*
81	Shiris	*Albizzia odoratissima*
82	Silver oak	*Grevillea robusta*
83	Sisam / Sisoo	*Dalberrgia sisoo*
84	Sonajhuri / akashmani	*Acacia auriculiformis*
85	Sunflower	*Helianthes annue*
86	Swarnabriksha	*Ailsnthus excelsa*
87	Tagar	*Ervatamis coroneris*
88	Teak	*Tectona grandis*
89	Tetul	*Tamarindus indica*
90	Yellow cleander	*Jhevetia nertifolia*
91	Yellow shimul	*Cochla spurmum Gussipium*

9.10 RAIN WATER HARVESTING

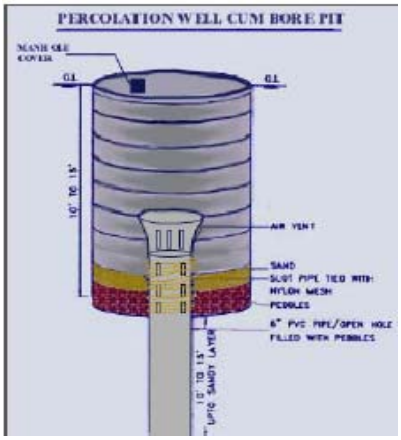
Rainwater Harvesting will be implemented at proposed Bhadreswar Thermal Power Project Site to conserve storm water. Rain Water harvesting typically has two different approaches namely:

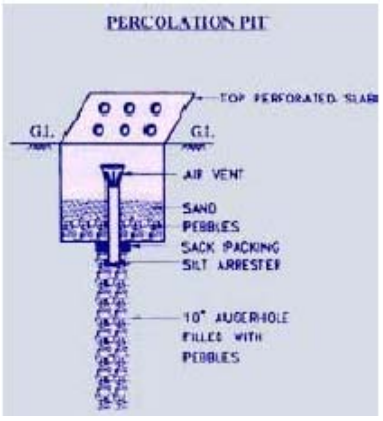
- Collection and storage of rainwater.
- Channeling surface run-offs to ground water recharging structure.

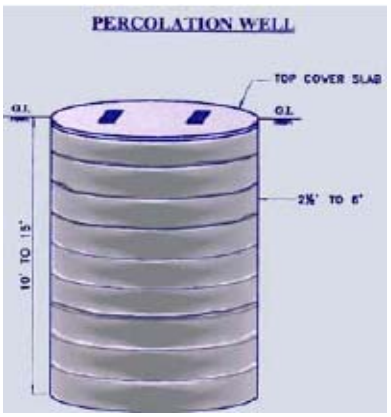
In the first approach, rainwater collected from roofs, pavements and roads after rain will be diverted to a collecting underground tank(s). Sand or pebbles will be provided depending on the end use of the water i.e. whether it will be used for sanitary purpose, horticulture/landscape gardening etc. System will be designed based on quantity of rainwater collected from well-defined surface areas and for the rainfall data applicable to the site. Oil filters will be put in all drain heads to ensure that no oil and grease from the surface gets mixed with the percolated water.

In the second approach, rain water from surface run-off will be directed towards recharging the ground water aquifer directly through the various types of structures such as, percolation pits, Dug cum Bore wells and Mini Artificial Aquifer, etc. The type of structure suitable for a site will be depending on the topography, lithology of the site and depth at which the ground water aquifer exists.

Some indicative sketches of Percolation Pit and Well are given in the figures below. However, during detailed designing of the plant suitable structure will be planned for rainwater harvesting.







9.11 IMPACT IDENTIFICATION AND RESPONSIBILITIES MATRIX

Table 9.5: Responsibilities Matrix

S. N.	Project Activities / Aspects	Associated Impacts	Mitigation – Action Plans	Audit / Monitoring Frequency	Responsibility
A	**Pre-Construction and Construction Phase**				
A.1	Land Acquisition for the project	Loss of land, livelihood, assets etc. broader socio-economic impacts	• Compensation for Land and assets negotiated as per the guidance district administration	• Land Acquisition Completed in 2003-04	KPGL
			• No Physical displacement of people	• No R&R is involved. • Govt. owned waste land	KPGL
			• Community Development Programme for the project	• Grievance redressal system will be set-up • Adani foundation is already working in the field for community development	KPGL & Adani Foundation
	Influx of Labour Force in the area	Potential disturbance to the social and cultural fabric of the affected nearby villages due to migratory labour	• Labour camps will be within the plant site	• Camps will be made for the construction laboures	KPGL
			• KPGL stipulates in its labour contracts that preference will be given for hiring local labourers first and then to outside labourers	• As far as possible Local labour will be contracted	KPGL
			• Regular check to control interference of labour force with local people	• Proper HR policy will be made for construction labour.	KPGL
		Potential Adverse sanitation conditions due to influx of migratory labour	• Proper sanitation facilities will be provided	• Provision of septic tanks for construction workers. • Sewage Treatment Plant will be set-up during construction phase. • Awareness programmes on various communicable disease, hygiene etc.	Contractors& KPGL
	Water Supply	Water Quality Degradation and Water borne disease	• Sea water will be used for construction purpose	• RO system will be established	KPGL
	Establishment of building, Storage facilities, workshop for maintenance of vehicles	Landuse Change of the Site Area	• Govt. waste Land	• Proper measure will be adopted to minimize the landuse disturbance	KPGL
		Soil Quality degradation	• The topsoil removed for the purpose of construction will be stored properly	• Stored Top Soil will be reused later for green-belt development.	Contractors & KPGL

S. N.	Project Activities / Aspects	Associated Impacts	Mitigation – Action Plans	Audit / Monitoring Frequency	Responsibility
	and Machinery / Equipment	Use of toxic substances such as paints, solvents, wood preservatives, pesticides and sealants will be used	• The wastes generated will be stored in sealed containers and labeled. • Efforts will be made to use less of hazardous chemicals during rainy seasons and special care will be taken to store these materials.	• Appropriate disposed plan will be established as required by the Hazardous Waste Storage, Handling and Transportation Rules of Environment Protection Act 1989. • Employees and contractors will be educated to handle hazardous wastes and materials.	Contractors and KPGL
		Effluent discharge	• Waste water through fabrication of concrete and related water usage	• Care will be taken to avoid water pollution problems during rainy season due to washout of waste material from dumpsite	Contractors and KPGL
		Fugitive dust emission	• Regular water sprinkling	• Suitable steps will be taken to ensure regular water sprinlling	Contractors and KPGL
	Vegetation Clearance	Bio diversity Loss	• The site consist only thorny bushes		KPGL
		Soil erosion	• New green belt will be developed	• Native species will be introduced	KPGL
	Transportation / Vehicular Movement	Congestion on road may cause public inconvenience	• Subsidiary roads shall be constructed as appropriate, so that the existing roads are not significantly congested • Instruct drivers of trucks / dumpers to give way to passenger buses, cars etc. • Transport of construction materials and machinery shall be carried out during lean traffic period of the day or during night	• Proper Traffic Management Plan will be introduced	KPGL
	Construction Equipment Operation	Noise generation	• Provision of acoustic cover on construction machinery	• Regular Maintenance	Contractors and KPGL
B	**Operation Phase**				

S. N.	Project Activities / Aspects	Associated Impacts	Mitigation – Action Plans	Audit / Monitoring Frequency	Responsibility
B.1	Project Process	Air Pollution	• Electrostatic Precipitators • Low NOx burners • Space Provision for FGD if required • Imported coal will be used containing low ash and high calorific value • 50m Green belt is proposed	• Five sites within the Impact area, including power plant site will be monitored on regular bases • Stack emission will be monitored on regular species	Environment Cell
		Water Pollution	• Intake through open channel of concrete lining • Disposal through marine diffuser system suggested by NIO	• 4 Surface and 5 ground water (including ash pond area) will be checked on regular basis	Environment Cell
		Solid Waste	• Fly ash will be utilized for cement manufacturers • Bottom ash will be used as a filler material for low lying area	• KPGL will set up its own cement plant for fly ash utilization • MoU will be signed with other prospective cement manufacturers	Environment Cell
		Noise	• Acoustic enclosure will be provided • 50 m wide green belt to attenuate the noise	• Proper Maintenance of equipment is proposed	KPGL management
		Social - Issue	• Public consultation • Medical Facility • Education Facility • Community Development	• Grievance redressal system • Tribal Development Cell	Adani Foundation and KPGL
B.2	Use of Hazardous Materials	Safety and Security Issue	• Workers shall be provided with proper PPE • Accidents and Diseases monitoring • Monitoring Ambient Conditions in the Work Place • Welfare Facilities • First Aid Facilities • Training Programme	• Grievance redressal Cell • Training Cell	KPGL

9.12 CORPORATE SOCIAL RESPONSIBILITIES

Adani Foundation, a social wing of the group responsible for CSR plan and community development. Need assessment study of local community has been carried out for

Infrastructure development, Education, Health and Livelihood programmes. The CSR report by Adani Foundation for need assessment study is enclosed as **Annexure-III.**

10. CLEAN DEVELOPMENT MECHANISM

10. CLEAN DEVELOPMENT MECHANISM

10.1 INTRODUCTION

The Clean Development Mechanism (CDM) is an arrangement under the Kyoto Protocol allowing industrialized countries with a greenhouse gas reduction commitment to invest in emission reducing projects in developing countries as an alternative to what is generally considered more costly emission reductions in their own countries. The CDM is supervised by the CDM Executive Board (CDM EB) and is under the guidance of the Conference of the Parties (COP/MOP) of the United Nations Framework Convention on Climate Change (UNFCCC).

The current modalities and procedures for the CDM focus on activities that reduce emissions. A CDM project activity might involve, for example, a rural electrification project using solar panels or the installation of more energy efficient boilers.

India has high potential for CDM projects, particularly in the Power Sector. The Baseline Carbon Dioxide Emissions from power sector have been worked out by CEA based on detailed authenticated information obtained from all the operating power stations in the country. The Baseline would benefit all prospective CDM project developers to estimate the amount of Certified Emission Reduction (CERs) from any CDM project activity.

India has a strong commitment to reduce its emissions of greenhouse gases. Ministry of Power has accorded high priority to the CDM projects in the power sector.

10.2 KYOTO PROTOCOL

The convention established the Conference of Parties (COP) as its supreme body. During COP3 in Kyoto, Japan, the Parties agreed to a legally binding set of obligations for 38 industrialized countries and 11 countries in Central and Eastern Europe, to return their emission of GHGs to an average of approximately 5.2% below their 1990 levels over the commitment period 2008-2012. This is called the Kyoto Protocol to the convention. The Protocol entered into force on February 16, 2005 and targets six main greenhouse gases:

carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydro fluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur Hexafluoride Recognizing that relying on domestic measures alone to meet the emission targets could be difficult, the Kyoto Protocol offers considerable flexibility through following three mechanisms:

- *Joint Implementation (JI)* which allows countries to claim credit for emission reduction that arise from investment in other industrialized countries, which result in a transfer of 'emission reduction units' between countries;
- *Emission Trading (ET)* which permits countries to transfer parts of their 'allowed emissions' (assigned amount units); and
- *Clean Development mechanism (CDM)* through which industrialized countries can finance mitigation projects in developing countries contributing to their sustainable development.

At COP-7 in Marrakech, Morocco in 2001, the Parties agreed to a comprehensive rulebook "Marrakech Accords" on how to implement the Kyoto Protocol. The Accords set out the rules for CDM projects. It also intends to provide Parties with sufficient clarity to consider ratification.

10.3 OUTLINE OF THE PROJECT PROCESS

An industrialized country that wishes to get credits from a CDM project must obtain the consent of the developing country hosting the project that it will contribute to sustainable development. Then, using methodologies approved by the CDM Executive Board (EB), the applicant (the industrialized country in our case) must make the case that the project would not have happened anyway (establishing additionally), and must establish a baseline estimating the future emissions in absence of the registered project. The case is then validated by a third party agency, a so-called Designated Operational Entity (DOE) to ensure the project results in real, measurable, and long-term emission reductions. The EB then decides whether or not to register (approve) the project. If a project is registered and implemented, the EB issues credits, so-called Certified Emission Reductions; CERs (one CER being equivalent to one metric tons of CO2 reduction), to project participants based on the monitored difference between the baseline and the actual emissions, verified by an external party called a DOE.

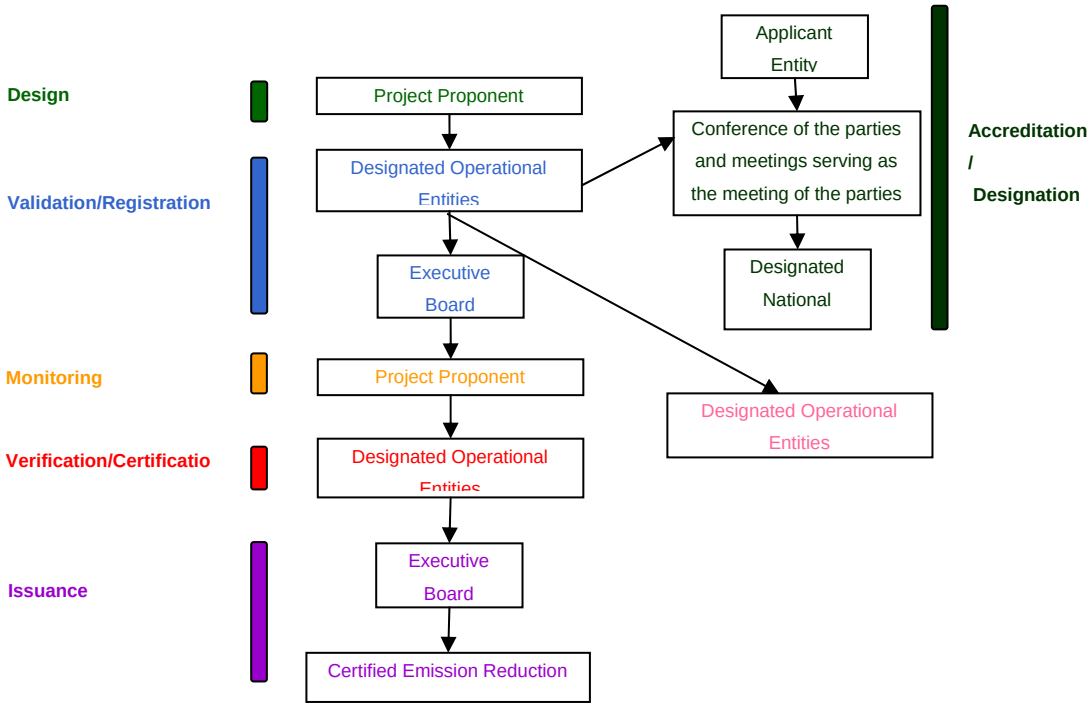


Figure 10.1: Project Process

10.4 PROJECT

The project activity aims at reducing Green House Gas (GHG) emission by expansion of the Proposed unit 5 x 660 MW imported coal based thermal Power Plant in District- Kutchh, State – Gujarat. The project activity will reduce the GHG emissions by using fuel-efficient technology.

10.5 CALCULATION OF CO2 EMISSION

Calculation Approach – Station Level

CO_2 emission of thermal stations was calculated using the formula below:

$$\text{Abs } CO_2 \text{ (station) } y = \sum_{i=1}^{2} \text{Fuel Coni,y x GCVi,y x EFi x Oxidi}$$

Where:

Abs CO2,y	Absolute CO2 emission of the station in the given fiscal year 'Y'
Fuel Coni,y	Amount of fuel of type I consumed in the fiscal year 'Y'

GCVi,y	Gross calorific value of the fuel I in the fiscal year 'Y'
EFi	CO2 emission factor of the fuel I based on GCV
Oxidi	Oxidation factor of the fuel i

The emission factors for coal and lignite are based on the value provided in India's initial National Communication under the UNFCCC (Ministry of Environment & Forests, 2004).

Specific CO_2 emission of Stations (Spec CO2,y) were computed by dividing the absolute emissions estimated above by the station's net generation (Net Geny):

Spec CO_2 (Station) y = Abs Abs CO_2 (station) y/ Net Gen (Station) y

Emission Reduction:

Imported Coal

Station Heat rate		2150 Kcal/ Kwh
Calorific Value of Coal		5200 Kcal/Kg
Specific Fuel Consumption		0.4135 Kg/Kwh
CO_2 intensity of the power plant	=	(44/12) x Specific Fuel Consumption X Percentage of Carbon in the Respective fuel (Kg/Kwh)
	=	(44/12) x 0.4135 x 41 Kg/Kwh
	=	0.6216 kg/kwh
		Where,
		0.4135 = Specific Coal Consumption of proposed 5 x 660 MW unit
		41 = Percentage of carbon in the coal
Net Generation of the plant	=	3300 MW x PLF x Operating Hours
	=	3300 x 1000 kW x 0.85 x 8760
	=	24572 Gwh
Average for the Western Grid	=	0.88 kg/kwh
Plant Carbon Intensity	=	0.6216 kg/kwh
Therefore Gross reduction in CO_2 emission	=	Net Generation x Difference between Average and Plant intensity
	=	24571800000 X 0.2584
	=	63493531.2 tons/year

Indigenous coal

Station Heat rate		2150 Kcal/ Kwh
Calorific Value of Coal		4000 Kcal/Kg
Specific Fuel Consumption		0.5375 Kg/Kwh
CO_2 intensity of the power plant	=	(44/12) x Specific Fuel Consumption X Percentage of Carbon in the Respective fuel (Kg/Kwh)
	=	(44/12) x 0.5375 x 45 Kg/Kwh
	=	0.8868 kg/kwh
		Where,
		0.5375 = Specific Coal Consumption of proposed 5 x 660 MW unit
		45 = Percentage of carbon in the coal
Net Generation of the plant	=	3300 MW x PLF x Operating Hours
	=	3300 x 1000 kW x 0.85 x 8760
	=	24572 Gwh
Average for the Western Grid	=	0.88 kg/kwh
Plant Carbon Intensity	=	0.5375 kg/kwh
Therefore Gross reduction in CO_2 emission	=	Net Generation x Difference between Average and Plant intensity
	=	24571800000X 0.3425
	=	84158415 tons/year