KAYAMKULAM CCPP
(400 MW)

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VOL. 2

ENVIRONMENTAL IMPACT ASSESSMENT
VOLUME I

MARCH 1996

NATIONAL THERMAL POWER CORPORATION LTD

NEW DELHI

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(400 MW)

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CHAPTER I

1.0 INTRODUCTION:

The National Thermal Power Corporation (NTPC) proposes to construct and operate a Combined Cycle Power Plant (CCPP) of capacity 400 MW (nominal), near Kayamkulam district Alleppey.

1.1 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK:

The principal Environmental Regulatory Agency in India is the Ministry of Environment & Forests (MOEF). MOEF formulates environmental policies and accords environmental clearance for the projects.

As per the notification from the Ministry of Env. & Forests (MOEF) dt. 27.1.1994, (Annexure 1.1.1) and Amendment dtd. 4.5.1994 (Annexure 1.1.2) expansion or moderanisation of any activity shall not be undertaken in any part of India unless it has been accorded environmental clearance by the Central Govt. in accordance with the procedures specified in this notification. As per the procedure, any person who desires to undertake any project in any part of India or expansion or moderanisation of any existing industry, a detailed project report which shall interalia include an Environmental Impact Assessment (EIA) report needs to be submitted. Accordingly, the EIA report for the proposed Kayamkulam CCPP was submitted to MOEF based on which the environmental clearance has been accorded by the Ministry of

Env. & Forests vide letter dt. 4.1.1995 (Annexure 1.1.3) Earlier MOEF has accorded Environmental Clearance for a coal based power project (Annexure 1.1.4). The Kerala State Pollution Control Board (KSPCB) has also issued a No Objection Certificate (NOC) for the CCPP proposal (Annexure 1.1.5). For the fuel unloading facilities at the Haripad Railway Station, no additional NOC is required from the KSPCB. A letter in this regard has been issued from KSPCB (Annexure 1.1.6).

The stipulations made by the MOEF along with the status of implementation is as under:

CONDITIONS	STATUS
1. Conditions contained in this Ministry's OM of even no. dt. 16.4.92 shall be implemented effectively.	Please refer Section 1.1(a).
2. It may also be pointed out that in case it is required to construct a jetty for unloading of the fuel which is said to be imported. NTPC shall examine the various environmental issues associated with it and shall submit an EIA Report for consideration of this Ministry before undertaking any activity in this direction.	It has been ascertained from the fuel companies that no additional infrastructure is required for unloading and storage of imported Naphtha at Cochin.

1.1 (a) CONDITIONS STIPULATED BY MOEF FOR COAL BASED POWER PLANT.

CONDITIONS STIPULATED BY MOEF	NTPC'S COMMENTS
2. i) A multifuel boiler should be installed in which coal or gas or oil may be used in any proportions.	The proposal envisages a combined cycle power plant (CCPP) with Naphtha as a fuel. Provision for firing natural gas has also been kept.
ii) A single stack having bi-flues of height not less than 220 m should be provided for both the units.	Not applicable for CCPP. Stack of 70 m is proposed.
iii) Electrostatic Precipitators (ESP) with operational efficiency of not less than 99.5% should be provided. The particulate emissions from the stacks should not exceed the prescribed standard of 150 mg/Nm3 and in the event of emissions exceeding the prescribed limit, the plant will have to be shut down.	Not Applicable for CCPP.
iv) A minimum of 100 meters of distance must be left on the front side from the Kayal and on the remaining three sides, the distance equivalent to the width of the Kayal should also be left as per the provisions of the Coastal Regulation Zone. The stipulation and restrictions as per the Coastal Regulation Zone should be complied with strictly in respect of the above stretches of land coming under the proposed project site. The area so left all around the Kayal should not be used for any other purposes except for raising green belt.	This will be complied with.
v) In the first instance, all efforts should be made to acquire fill material from outside such as by transporting fly ash from the nearby places, excavation of soil, dredging of sea etc. If it is not feasible,	The fill material will be generated through dredging of kayal. The permission of State Irrigation Deptt. has been obtained in this regard. Regarding areas to be filled up, the modified conditions will be complied with.

dredging of the Kayal could be undertaken in those stretches which are not involving nursery grounds for fishes and where the biological productivity and diversity are comparatively less. Dredging of the Kayal, if it has to be undertaken, should be completed in the shortest possible time not exceeding one year in any case and the fill material should be obtained for raising only that portion of the proposed site where Stage-I units are to be located. The remaining portion of the site required to be raised should be done at a later stage by using fly ash as the fill material after the Stage-I units are commissioned.

THIS CONDITION HAS BEEN MODIFIED AS FOLLOWS:

2(V): MOEF HAS NO OBJECTION IF IN ADDITION TO THE AREA REQUIRED FOR STAGE-I MAIN PLANT, THE AREAS OF STAGE-II WHICH WILL SERVE AS A COMMON FACILITY FOR BOTH THESE STAGES, ARE FILLED UP TOGETHER, EXCLUDING THOSE AREAS WHICH ARE IDENTIFIED FOR FILLING UP AT A LATER STAGE.

vi) While dredging the Kayal, necessary precautionary measures should be taken to avoid occurrences of hydrostatic pressure imbalances and adverse effects likely to be caused on sustenance fisheries and inshore fisheries. A detailed environmental management plan dealing with the dredging of Kayal, the amount of fill material to be obtained, area of the site to be raised, point and non-point sources of pollution during the construction phase along with preventive measures etc. should be prepared and submitted to this Ministry for approval within a period of six months.

Environmental Management Plan (EMP) dealing with the dredging of kayal has been submitted to MOEF in February 96. The EMP for other issues was earlier submitted to MOEF.

vii) A plan for full utilisation of ash (starting with utilisation of atleast 25% of the ash) should be prepared in consultation with the State Government and submitted to this Ministry within six months.	Not applicable for CCPP.
viii) The requirement of land for ash disposal should be based on ash utilisation plan and not more than 350 acres of land should be acquired for emergency ash disposal purposes. **The ash pond should be lined to avoid any ground water contamination. Sea water should not be used for ash handling and disposal. Effluents from the ash pond should conform to the standards as laid down by the State Pollution Control Board.** **THIS CONDITION HAS BEEN MODIFIED AS FOLLOWS: 2(VIII): THE SEA WATER COULD BE USED FOR ASH DISPOSAL PROVIDED NECESSARY PRECAUTIONS ARE TAKEN FOR TREATMENT OF THE WATER BEFORE IT IS DISPOSED OFF SO AS TO ENSURE THAT THIS DOES NOT POLLUTE THE AGRICULTURAL FIELDS AND GROUND WATER. THE DECISION IN REGARD TO LINING OF ASH POND MAY BE TAKEN ON THE BASIS OF A SCIENTIFIC STUDY ON THE LIKELY IMPACTS OF LEACHATES.	Not applicable for CCPP.
ix) Affected families should be properly rehabilitated in consultation with the State Government.	Affected families will be rehabilitated in consultation with the State Govt.
x) Barest minimum area for the colony, ash disposal and for other purposes should be used to restrict the displacement of local people to the extent possible.	The land requirement for CCPP is significantly lower as compared to the coal based power plant.

There is a possibility that the vegetation in the area, especially the coconut trees, might be affected by SO2 and SPM concentration. In case this happens, compensation would have to be paid to the affected families.	A study on impact of SO2 and fly ash on coconut has already been awarded to M/s Environmental Resources Research Centre, Trivandrum. The study is in progress.
xi) The State Government should formulate a regional plan for the area to ensure that industrial and urban growth occurs in a planned manner, so that its environmental impacts are minimised.	The regional development plan has been formulated by the State Govt and is under approval. The plan after approval will be submitted to MOEF shortly.
xii) The NTPC should prepare a plan for the green belt and submit for approval within 3 months.	A green belt development plan has already been submitted to MOEF.
xiii) A base line health survey, especially for pulmonary functions should be done i the region, and this should be followed by periodic tests after the commissioning of the power station in order to monitor the impact, if any, on the health of the local inhabitants.	Will be complied with.
xiv) 'Zero discharge' concept with respect to liquid effluents should be followed to the extent possible. Liquid effluents should be treated to conform to the standards of SPCB before discharging in the water bodies. Treated liquid effluent should be used/recycled in the plant/irrigation of the green belt to the extent possible.	The zero discharge concept will be followed to the extent possible. The treated effluents will conform to regulatory standards.
xv) Adequate measures for control of noise should be taken so as to keep the noise levels below 85 db in the working environment.	Adequate measures will be taken so as to keep the noise level below 85 dBA from the individual equipment. In the operational areas, where it is not feasible to keep the noiselevel below 85 dBA, operating personnel will be provided suitable protective devices.
xvi) Atleast six air quality monitoring stations should be set in consultation with the State Pollution Control Board for estimation of SO2, NOx and SPM. The exact location of the monitoring station should be decided based on meteorological conditions,	Air quality monitoring stations would be set up in consultation with SPCB and NOx emission from stack would be monitored by providing automatic stack monitoring equipment. Monitoring data will be submitted to SPCB and MOEF at the frequency specified.

human settlements, vegetation etc. Stack emission should be monitored by Setting up of automatic stack monitoring units for SO2 and SPM. The data on stack emission and ambient air quality should be submitted to the State Pollution Control Board once in three months and to this Ministry once in six months alongwith the statistical analysis.	
xvii) Thermal discharge of effluents from the condensers should not be put in the Kayal; instead it should be discharged in the sea, the temperature of which should not exceed the standard of 5 C over and above the ambient temperature of the receiving water.	Blowdown from the cooling towers willbe from the cold side hence no thermal discharge.
xviii) Air and Water Quality standards as prescribed under the Environment (Protection) Act, 1986, the Air (Prevention and Control of Pollution) Act, 1981 and the Water (Prevention and Control of Pollution) Act, 1974 should be complied with including the revised standards that may be prescribed in future.	Air and water quality standards prescribed by various regulatory agencies will be complied with.
3. The condition stipulated may be varied or new conditions may be added or the clearance revoked, if necessary in the interest of environmental protection, and if there is any change in the project profile non-satisfactory implementation of the stipulated conditions, etc.	-
4. The stipulations will be implemented, among others, under the Water (Prevention & Control of Pollution) Act, 1974, the Air (Prevention and Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986, and the Public Liability Insurance Act, 1991.	Will be complied with.
5. Necessary funds should be provided in the project for the implementation of the above mentioned conditions and environmental safeguards. The funds earmarked for the environmental protection measures should not be diverted for other purposes and yearwise expenditure should be reported to this Ministry.	Necessary finance for the above measures is already an integral part of project construction, operation and maintenance. The funds earmarked for environmental protection measures will not be diverted for other purposes.

1.2 PROJECT DESCRIPTION:

1.2.1 Site and Surrounding:

The proposed site is located on the fringe of the backwaters of Kayamkulam Lake/Kayal at latitude $9^{o}14'$N and longitude $76^{o}26'$E. Arabian sea is approximately 2 kms west and National Highway NH-47 is about 5 kms east of the proposed site. The nearest railway station is at approximately 10 kms from the site on the Kottayam Quilon section of the Southern Railways. The site is about 110 kms. from Trivandrum and 90 kms. from Cochin. Both Trivandrum and Cochin are linked with the National Air Network.

The township is located east of the plant on the western side of the National Highway NH-47 near Chingoli and Cheppad villages.

The township would have 213 quarters for O&M personnel and 77 quarters for CISF along with matching non-residential facilities. Already about 72 quarters have been constructed for the construction staff which would form a part of the permanent township.

Sweet water requirement for the plant would be met from the Achankovil river located about 10 km. from the plant area with the fall back from the PIP canal. The water would be drawn into a desilting basin (located at river end) by gravi-

ty and would be transported through pipelines to the reservoir located adjacent to the plant site in an area of 33 acres.The land for the reservoir is already with NTPC and no additional acquestion is involved. A raw water pump house shall be provided near the reservoir for pumping the water to the plant site. Other details related to reservoir are described under Section 2.12. Facilities for storage of fuel at the plant site will be provided. It is envisaged to have 4 number of floating roof storage tanks each of capacity 10000 m3 each at the site and 2 floating roof tanks of capacity 5000 m3 each at the chepad siding. Manually operated medium velocity water spray system along with foam system shall be provided for Naphtha storage tanks.

Approach road to the plant site from National Highway - 47 shall be constructed which will be a double lane road having a width of 7 m with 2.5 m wide shoulders. The location of the project site, township, water corridor along with approach road etc. have been depicted in Fig. 1.2.1

1.2.2 **Power Plant Components:**

1.2.2.1 <u>Land:</u>

The total land requirement for plant, township and associated facilities like intake water structure, water

pipe corridor, fuel storage facility near Haripad Station is as follows:

a)	Main Plant	100 Acres.
b)	Township	60 Acres.
c)	Labour Colony	6 Acres.
d)	Resettlement colony	20 Acres.
e)	Green Belt	40 Acres.
f)	Approach road, sweet water corridor etc.	38 Acres.
g)	Pump, desilting basin & intake structures.	6 Acres
h)	Main reservoir at plant site	33 Acres
i)	Fuel storage facility near Haripad station.	10 Acres
	Total	313.0 acres

An area of 180 acres required for the main plant, green belt and labour colony and reservoir earlier owned by the State Agricultural Department has now been taken over by NTPC. The balance 133 acres land is primarily private owned land out of which 60 acres required for township and 20 acres required for ressettlement colony is already in the possession of NTPC. About 53 acres required for water corridor, pump, desilting basin and water intake structures, approach road and fuel storage facility is yet to be acquired.

The land use of the surroundings have been described in Section 3.1. The land use pattern is based on interpretation of satellite imagery data. Details of Irrigated and non-irrigated land, waste land with scanty vegetation, agricul-

tural lands, dense plantation and build up areas based on satellite imageries are presented in Fig. 3.1.1 and Fig. 3.1.2.

It is to clarify that dredging would be carried out in the outer kayal near the plant site for which acquisition of land would not be necessary.

The ground level of plant varies from RL (-) 1.5M to RL (-) 2.0M. To protect the plant area against flooding and facilitate storm water drainage by gravity, the plant area is proposed to be filled up to a formation level of RL +2.0M. Site levelling shall entirely be in the form of filling. Since no burrow areas are available in the vicinity of the plant site, which can meet the full requirement, the levelling is proposed to be achieved by dredging and hydraulic filling with bed material obtained from outer Kayal. Permission to dredge the bed of outer Kayal has been obtained from the State Authorities.

As the land for plant site is below sea level, it remains water logged during monsoon months. However, it remains dry during summer seasons. Thus the plant site does not fall under the category of wetland and there will be no loss of wetland due to site elevation. The site is actually a reclaimed land and was earlier used for grass farming by Kerala State Agricultural Department. This has also been

highlighted in the EIA report prepared for Kerala State Electricity Board for location of coal based power station at the same location.

1.2.2.2 Risk Potential due to Maximum Storm Events:

Depressions and storms occur in the Bay of Bengal and Arabian sea during the premonsoon and post-monsoon seasons. As per the Atlas of Tracks and storms published by the India Meteorological Department, none of these storms has crossed over the project area during 1877-1970. However, associated marginal influence on the weather is observed in the wake of the passage of major storms over the sub-continent.

The proposed plant site is surrounded all round by the backwaters (known as kayals). The water level in the adjoining backwaters undergoes tidal variation and maximum and minimum water level as observed is stated to be RL (+) 0.81m & RL (+) 0.05 m respectively. A strip of land about 500 m wide between the outer kayal the Arabian sea, protects it from direct exposure to sea. Accordingly, the maximum water level in Kayal has been considered for fixing the plant formation level. Tidal levels for the Arabian sea are available at Alleppey and Quilon from admirality charts. The MHHW (Mean Higher High Water) and MSL (Mean Sea Level) are stated to be (+) 0.91 m and (+) 0.55 m, respectively for Alleppey

and (+) 0.91 m and (+) 0.67 m, respectively for Quilon. These levels are with respect to chart datum. Considering these tidal levels, the proposed formation level of RL (+) 2.0 m for the plant can be considered to be safe.

The high water level of (+) 1.2m in 1991 was not because of storm or typhoon. It was due to delay in clearance of bar formation at the confluence of Kayal with sea approximately 10 kms. south of plant site which is done annually in a routine way. It is to be noted that for most part of the year, the Kayal waters are open to sea at the confluence. However, in summer months before the monsoon when inflows to the Kayal from upstream water bodies is low, generally a sand bar form at the confluence point. In extreme conditions, as happened in 1991, the sand bar is normally cleared as a routine exercise by local state authorities at the onset of monsoon, so that the increased flows in Kayal during the monsoon can flow out into the sea. In case this sand bar clearance is delayed, as was stated to be the case in 1991, the Kayal water levels may rise. However, the possibility of Kayal water levels exceeding (+) 1.2 m is not anticipated, because if the Kayal water level rises and even before it reaches (+) 1.2 m, it tends to flood the adjoining land areas which are occupied by local people. The sand bar is, therefore, necessarily to be cleared as is done each year before it floods the occupied areas.

The storm water from the plant area envisaged to be drained by gravity through suitably sized open lined drains which will finally discharge into the adjoining outer kayal. With proposed formation level of RL (+) 2.0m and suitable drainge arrangements for rain water, plant site is protected against flooding.

1.2.2.3 Transmission Lines:

The necessary transmission system for evacuation of power would be implemented by the Power Grid Corporation of India Limited (Power Grid). It has been decided by Power Grid to retain the transmission system earlier identified with the Kayamkulam Thermal Power Project i.e.,

i) Kayamkulam-Pallam 220 KV D/C 65 Kms.

ii) Kayamkulam-Edamon 220 KV D/C 55 Kms.

iii) Establishment of a 220 KV switchyard at Kayamkulam CCPP.

iv) Extension of 220 KV Sub-stations at Pallam and Edamon of Kerala SEB.

Clearance from Central Electricity Authority (CEA) has been obtained for the proposed transmission system. It has also been confirmed by Power Grid that the proposal has the clearance of the Ministry of Environment & Forests.

As the switchyard would be located in the land in possession of NTPC adjacent to the main plant area, no land for this purpose is proposed to be acquired by Power Grid. For the transmission corridors, no land is proposed to be acquired and only right of way would be obtained. As far as extension of sub-stations is concerned, the same would be implemented where space is available for termination of transmission lines.

In view of the fact that no land acquisition is involved for the transmission lines, switchyard and substations, no resettlement or rehabilitation is envisaged. It has also been confirmed by Forest Authorities that the proposed transmission line does not pass through reserve forests.

1.2.2.4 Fuel:

Naphtha has been considered as the basic fuel and no gas supply line is currently proposed. The estimated requirement of Naphtha for running a 400 MW combined cycle gas plant is 0.45 MMTA considering 6000 hrs. of operation per year. As Naphtha at present is a decanalised item, no restriction is envisaged in directly importing the same. For handling imported naphtha at Cochin, construction of a new port is not required. The existing facility would meet the increased requirement. Therefore, Govt. of India's clearance is not required in this regard. Accordingly, no region-

al impact is contemplated due to fuel import at Cochin. Confirmation on availability of 0.6 MMTA of indigenous Naphtha has been obtained from two of the prospective Indian fuel suppliers. Confirmation letters in this regard are presented as Annexure-1.2.2.4 (i) & 1.2.2.4.(ii).

1.2.2.5 Fire Fighting System:

Adequate fire protection system will be installed at all the fire prone areas including naphtha storage and handling area. The details of fire protection system are as follows:

a) Hydrant system covering the entire power station including all important auxiliaries and buildings. The system shall be complete with piping, valves, instrumentation, hoses, nozzles, and hydrants valves etc.

b) A fire water storage tank of 2000 m3 capacity is provided for power plant. Two nos. (one working + one standby) 410 m3/hr hydrant pumps and 2 nos. (one working + one standby) 410 m3/hr spray water pumps are envisaged.

In accordance with TAC Rules, water is required for 2 hours for Hydrant System and for HVW spray system, water is required for 40 minutes.

The water quantities required are:

a) Hydrant System : 820 m3

b) HVW Spray System : 273 m3

Therefore, the highest water quantity required in

a + b = 1093 m3

Hence keeping adequate margin, a fire water storage tank of 2000 m3 has been envisaged. In case of emergency, the kayal water could also be utilized for fire fighting.

Further, a dedicated fire water storage tank is also provided for Naphtha handling area and capacity of the same will be as per Oil Industry Safety Directions (OISD) norms. The fire water storage tanks will be located in the existing plant area.

c) Automatic/manual high velocity water spray system shall be provided for all transformers located in transformer yard and those of rating 25 MVA and above located within the boundary line of the plant, turbine oil tank, ST bearing, purifier, seal oil system, fuel oil transfer pump house.

d) Sprinkler system for cable galleries/vaults/ spreader room etc.

e) Modular type, CO_2 panel injection fire extinguishing system for control equipment room, computer room, cable space below control room, control equipment room, etc.

and other unmanned electrical and electronic equipment room.

f) Manually operated medium velocity water spray system along withfoam system shall be provided for Naphtha storage tanks.

g) Portable extinguishers such as pressurized water type, carbon-di-oxide type and foam type will be located at strategic location throughout the plant.

h) Fire Alarm System:

A computerized addressible analog type early warning system shall be provided throughout the power plant. Following type of fire detection system would be employed.

a)	Control room, control equipment room etc.	Ionization and photo electric type smoke detectors
b)	Cable areas	Ionization and photo electric smoke detectors, linear heat sensing cables.

The above systems shall be designed as per the recommendations of Tariff Advisory Committee (TAC) of Insurance Companies of India or wherever TAC rules are not existing, relevant NFPA-USA, FOC-UK rules shall be followed.

Adequate number of electric motor driven and diesel engine operated hydrant and spray pumps with automatic starting shall be provided. The fire water pumps will draw water from the fire water reservoir to be created in the plant area. Fire water reservoir would be filled using sweet water

through a tapoff from sweet water pipeline from raw water reservoir and kayal water for filling fire water reservoir as an alternative.

1.2.2.6 Management of Hazardous Chemicals:

During storage and handling of hazardous chemicals like chlorine, caustic and acids, all precautions will be taken to avoid spillage of chemical. All these chemicals will be stored in well ventilated areas. Chlorine detectors (auto sensing type with alarm system) and neutralisation pit will be provided in chlorine storage areas. Sealing kit for plugging leaks in the storage cylinders will deal with any leakage. Personal protective equipment will also be provided at the work place. Acid/alkali will be stored in specially constructed tanks and loading and unloading will be through pumps. One empty storage tank containing HCl will be provided so that a leaking tank can be transferred to the empty one through unloading pumps. Dykes shall be provided around the storage area which will be connected to the neutralisation pit. In case of any accidental spillage, the chemical will flow into the pit.

1.2.2.7 Water:

Sweet water requirement for the plant (1015 m3/hr) would be met from Achankovil river, with a fall back from PIP canal system (Fig. 1.2.2.7). The water would be drawn into a desilting basin (located at river end) by gravity.

The desilting basin is proposed to be constructed in 8 acres of land. A commitment for supply of 3200 m3/hr. of fresh water has been accorded by the State Govt. vide letter dated 30.1.89 (Annexure 1.2.2.7 (i)) whereas the requirement for CCPP is only about 1015 m3/hr. The availability of water has been reconfirmed by State Govt. vide letter dt. 6.1.95 (Annexure 1.2.2.7 (ii)). During the period of low flow in the river, the water requirement for the project would be met from the Haripad branch of the Pampa Irrigation Project canal close to the project site. It is understood that an existing natural drain shall be suitably remodelled to form the link channel between the PIP system and Achenkovil river.

1.2.2.8 <u>Manpower Requirement:</u>

The manpower requirements during construction and operation of the project have been estimated. These are as follows:

During Construction:

a) Contract Labour:

- Skilled	270
- Unskilled	2430

b) NTPC's employees:

- Skilled	31
- Semi-skilled	10
- Unskilled	26

During Operation:

a) Contract Labour:

- Skilled	33
- Unskilled	297

b) NTPC's employees:

- Skilled	88
- Semi-skilled	47
- Unskilled	211

1.2.2.9 Labour Welfare Module:

The contractor has to provide following facilities to construction work force:

1. First Aid: At work place, first aid facilities shall be maintained at a readily accessible place where necessary appliances including sterilized cotton wool etc. shall be available. Ambulance facilities shall be kept readily available at workplace to take injured person to the nearest hospital.

2. Potable Water: Sufficient supply of cold water fit for drinking shall be provided at suitable places.

3. Sanitary Facility: Within the precinct of every work place, latrines and urinals shall be provided at accessible place. These shall be cleaned at least twice during working

hours and kept in a sanitary condition. The contractor shall conform to sanitary requirement of local medical and health authorities at all times.

4. Canteen: A canteen on a moderate scale shall be provided for the benefit of workers.

5. Security: NTPC shall provide necessary security to work force in coordination with State authorities.

6. Facilities for Women: Facilities as per Factor Rules of the State Govt. shall be provided to the women working force. Separate latrine and urinals for women shall be provided and marked in a vernacular in conspicuous letters 'For Women only'. A poster showing the figure of a man and woman shall also be exhibited at the entrance to toilets. If the number of women worker is 20 or more, at least one creche shall be provided for use of children under the age of 6 years belonging to such women. The size of creche shall vary according to the number of women worker. Creche shall be provided with sufficient openings for light and ventilation. The contractor shall provide at least one lady attendant to look after the children. There shall be adequate provision for sweepers to keep the place clean and hygenic. Creche shall be properly maintained and necessary equipment like toys etc. shall be provided.

1.2.3 ENVIRONMENTAL ASPECTS:

The following environmental protection systems have been proposed to be installed at the plant:

1.2.3.1 Air Pollution Control:

1. 70 meters tall stacks to ensure wider dispersion of pollutants. The stack height has been computed based on the requirement of MOEF as indicated in the notification dt. 19.5.93 (Annexure 1.2.3.1).
2. Appropriate system to control NOx emission to 100 ppm.
3. Green belt development and afforestation in and around the plant and township area.

1.2.3.2 Water Pollution Control:

1. Minimise quantity of effluents through reuse to the extent feasible.
2. Provision of cooling towers to avoid thermal discharge.
3. Treatment of DM Plant waste through neutralisation.
4. Biological treatment for domestic waste.
5. Provision of oil separators followed with rotating drum type oil skimmer having oilofil resin for

removal of oil from effluents. The drum skimmer consists of a cylinder covered with an oleophilic skin. The device, continuously rotating on the surface of the water, allows to pick up selectively the hydrocarbons which are then recovered by a stationery scraper in the collecting trough. The quantity of recovered oil depends on the drum rotation speed as well as nature of the oil. The operation, performance and advantages of Rotating Oil Skimmer with olephilic resin is presented at Annexure 1.2.3.2.

6. All the treated waste water will be collected in a Central Monitoring Basin to minimise the outlet points and discharged through a single point.

This treated and diluted waste water will meet stipulated standards prescribed by Ministry of Env. & Forests and State Pollution Control Board.

1.2.3.3 Sanitary Solid Waste Disposal:

An extended aeration system will be provided for treatment of sewage. A disinfection unit will be added to the Sanitary Waste Water System for disinfection of sewage. This system will have sludge drying beds. The solid waste thus generated from the treatment process will be dried on drying beds and disinfected with bleaching power to prevent the formation and spreading of pathogenic organisms. Thus

spreading of any disease through vector will be eliminated.

The dried sludge would be sold in the market in the manure. However, in the absence of market demand, it sould be appropriately disposed off as landfills at suitable selected locations. A suitable Solid Waste Management Plan for the township and plant will be formulated and implemented. The principle of Solid Waste Management Plan is detailed in Environment Mitigation Plan under Section 5.2.2.

1.3 REHABILITATION:

Land required for the project, ancilliary facilities and township (1103 acres) has already been acquired. A balance of 53 acres required for approach road, make up water system and fuel handling and transit storage is still to be acquired. About 902 acres of land out of the 1103 acres of land already acquired is Govt land and the balance is private land. The 53 acres yet to be acquired is also private land. Of the 201 acres of private land already acquired60 acres would be utilised for township and about 20 acres for construction of the resettlement colony for the project affected families.

1.3.1 Earlier Socio-economic Survey:

A socio-economic survey for the project affected families due to land acquisition for the earlier proposed coal based power plant at Kayamkulam was undertaken in 1990 through Loyola College of Social Sciences, Trivandrum in accordance with earlier R&R Policy.

1.3.2 Complementary Survey:

In view of the reduction in the requirement of land, the time gap between the completion of the Demographic and Socio-economic studies by Loyola College of Social Sciences,

Trivandrum, and the implementation of RAP and also due to the fact that the NTPCs R&R Policy had undergone a major change, a complementary Demography and Socio-economic study has been awarded also to Loyola College of Social Sciences, Trivandrum in January 1995. The study envisages detailed discussions with the PAPs in order to assess their land, homestead holdings, their opinion within the framework of the R&R policy and their views in the finalisation of RAP. The study has since been completed.

1.3.3 Findings of the complementary survey of Affected Population in land already acquired:

Of the 1103 acres land already acquired, 902 acres belonged to the State Govt. and the balance 201 acres was privately owned. The Govt. land was transferred to NTPC in 1989. 827 labourers working on this land were retrenched by the State Govt. after paying all retrenchment benefits. Acquisition of 201 acres of private land affected 604 families. This includes 50 owners who have lost both land and homesteads. The compensation paid per acre ranged from Rs. 89,000/- to Rs. 3,50,000/-. In addition, solatium and interest were also paid. Of the 604 affected families only 562 land and/house award cases could be located. The remaining 42 land owners had either migrated elsewhere or their residence had changed. Inspite of all efforts, these 42 families could not be contacted. Out of the 827 retrenched labourers, the surveyors could contact 806 and the balance 21 could not

be located. Other than the directly affected, 20 persons have been identified as indirectly affected. These people are mainly traders and belong to the affluent section of the society and do not expect any rehabilitation assistance from NTPC. They are expecting that their business will flourish once again on implementation of the project. In addition to the above indirectly affected persons, few traditional fishermen numbering 226 will be affected by the dredging of the Kayal for filling of the land acquired for the main plant. The number of families coming in this category of indirectly affected persons has been assessed, in the case of traditional fishermen through the representative body of traditional fishermen. These people will be extended the benefits of Income Generation Schemes (IGCs).

1.3.4 Additional Land Acquisition:

Survey for identifying the project affected persons due to acquisition of additional 53 acres of private land also formed a part of the study awarded to Loyola College, Trivandrum as mentioned above. The study has been completed and the findings are given below:

1.3.5 Findings of Complementary Survey of Affected Population in Land yet to be Acquired:

As per the survey 373 land owners would be affected due to land acquisition out of which 16 owners who loose their

homesteads. However, only 219 land owners could be located during the survey out of which 17 land owners refused to answer. There are no indirectly affected people due to this land acquisition. The persons are generally not interested in any economic rehabilitation measures but are interested in liberal cash assistance and/or permanent employment in NTPC. The compensation expected to be paid would on an average Rs. 5 lakhs per acre.

Category of PAPs, their numbers and entitlements are enclosed in Table 1.3.6.

1.3.6) Rehabilitation Action Plan:

Based on the discussion with various Government Organisations, general preference of local people towards various income generating schemes which has been agreed to by the VDAC in principle, local/traditional skills etc., the following schemes are found viable for the area. However, in case of preference by PAP for any other skill, the same shall be considered after examination. The VDACs, (Village Development Advisory Committees) functioning in these villages will be the focal point in making the Economic Rehabilitation successful.

Because of very limited requirement of manpower in a combined cycle gas based project, employment in NTPC has not been kept as a rehabilitation option and was not indicat-

TABLE1.3.6 CATEGORY OF PAPs, THEIR NUMBERS AND ENTITLEMENTS

CAT.	DESCRIPTION	NO. OF PAP	ENTITLEMENT AS PER NTPC POLICY	OPTION OFFERED
A	Persons losing entire land	Nil	Land for land, or self employment, or shop or award of petty contract, or job(after accounting for compensation legally due under Land Acquisition Act) (Set A)	Nil
B	Persons left with land not economically viable.	910	Land for land, or self employment, or shop or award of petty contract, or job(after accounting for compensation legally due under Land Acquisition Act) (Set A)	Only IGSs.
C	Persons whose homestead is acquired.	Nil	Alternate house site measuring 50'x40' along with community infrastructure facilities and relocation, and other rehabilitation assistance (SET B)	Nil
D	Persons whose homestead and land is acquired.	66	Set A + Set B	Housing plots as per NTPC policy, Govt. and IGSs.
E	Person (tenant tiller) in actual possession of land	Nil	Set A when no claim made by original landlord; or Set C in case original landlord claims compensation under LA Act and Set A option.	Nil.
F	A person (agriculture labourer) who does not have legal title to the land which is acquired but earns his living principally through manual labour on that land.	Nil	Self employment or shop or award of petty contract or job (Set C)	Nil

G	A tribal residing or deriving livelyhood from the forest land which is acquired.	Nil	Set C and Set D. Tribals will receive special attention to restore their income.	Nil
H	A landless person cultivating on the Govt. land which is acquired.	813	Set C	IGSs.
I	Persons dependent upon the land either directly or indirectly, and having a client relationship with the displaced community.	Nil	Assistance to establish the type of facilities lost on account of land acquisition. Assessment in such cases will be separately carried out by NTPC and/or the State Adm. and in consultation with PAPs (Set D).	Nil
J	In a joint family or joint holding, a person (major) who has a share in the land or homestead.	218	Set B	IGSs.
K	A permanent resident of the area which is acquired but not defined above.	Nil	Set D	Nil
L	A person (absentee land owner or absentee homestead owner) who is not in actual possession of land or homestead for 5 years prior to notification under LA Act.	13	No entitlement under RAP.	Nil

M	Traditional Fishermen deriving their livelihood from the Kayal to be dredged and persons engaged in grass cutting etc. (not covered in NTPC R&R Policy).	226	Not covered in NTPC R&R policy, but proposed extension of Set-D. (Assistance to establish the type of facilities lost on account of land acquisition. Assessment in such cases will be separately carried out by NTPC and State Administration and in consultation with PAPs).	IGSs.
	TOTAL PAPs	2246		

ed in the questionnaire used in the socio-economic survey. Further, the Kerala State Govt. has informed that land will not be available for using the same as option for rehabilitation. Moreover, as explained earlier, and also seen from the survey report findings, land has not been the main source of income for land owners, the option for land for land as rehabilitation is not considered in the RAP.

Considering the above, the main option/alternative vialble and available for rehabilitation would be the income generation schemes (IGS)/Self employment schemes.

It is important to ensure proper utilisation of compensation and entitled rehabilitation assistance by individual PAPs. It largely depends on the attitude of the PAPs and their occupational and economic background. The land oustee PAP as well as the others like the Kayal Farm labourers, the fishermen and grass cutter community PAPs are accepting IGS as an alternate for rehabilitation on appropriate education and counselling.

Self employment/income generation schemes like coconut plantation, fish farming, coir products, etc. will help such PAPs who have the skill and/or inclination for such activities. Eligible PAPs will also be assisted under various development programmes of Govt. Dovetailing State sponsored schemes will help to accelerate the economic rehabilitation of the PAPs.

BUDGET SUMMARY AND EMPLOYMENT

Scheme	No. of person covered	Total cost of scheme (Rs. in lakhs)
Coconut farming	50	60.00
Fish farming	500	70.00
Coir	400	720.00
Labour Cooperative	500	79.00
Shrimp feed	300	33.00
Poultry Farm	100	30.00
Dairy Farm	100	26.00
Self employment	300	45.00
TOTAL	2250	1063.00

1.3.7 Public Awareness on the Proposed Project:

During the complementary study, the views of the people regarding the Kayamkulam CCPP were ascertained. Of the families surveyed 93.5% opined that the Kayamkulam CCPP is the need of State since Kerala is industrially backward. Other reasons were that the availability of power will create job opportunities, which in turn will reduce unemployment problem in general and educated unemployment problem in particular. Among those who are unfavourably disposed,

include 4.62 per cent of families who are concerned about the delay in executing the project and acquisition of private cultivable land for the project. The balance 1.78 per cent were neutral.

Regarding land already acquired for the project, 91.81 per cent of the respondents opined that the land acquired is in order as any developmental work needs such facilities, and they are willing to cooperate with the Govt. in that aspect. But 8.18 per cent members were against the acquisition of their land because their main source of income was from the land acquired and the compensation was not sufficient and the land acquired by NTPC is not yet utilised and the place look almost deserted which was prime cultivable land earlier.

Regarding land being acquired, 50.17 per cent of the families felt that for the development of the State and for the well being, some sacrifices have to be made, 12.45 per cent of the families felt that though the place is one of the good sites, their land was not an urgent requirement for the project. The objection of these people were mainly on the ground that there is a time lag in executing the project.

1.3.8 **Section 29 Notification:**

Notification under Section 29 of the Electricity (Supply) Act, as is required under the law in the country has already been issued in the Official State Gazette and several

local newspapers in January 1995 (copy enclosed as Annexure 1.3.8 (i)) informing on the intent of implementing the project at the proposed location. This notification ensures that the people in the area are well aware of the implementation proposal and any objections in this regard are invited so that satisfactory clarifications could be furnished to such objections. It is further interesting to note that an opinion survey has been conducted by **MALAYALAM MANORAMA**, (Annexure - 1.3.8 (ii)), a local newspaper in July 1993 to assess the views of the population of the State as to which development projects in their opinion should be implemented on priority in Kerala. The survey indicated that about 81.5% of the respondents favoured the implementation of the Kayamkulam power project.

1.3.9 **Public Information Centre:**

In order to bridge the communication gap and distance between the local people/PAPs and the project authorities and with a view to establish a regular dialogue between the project and the local population, particularly the project affected persons, it is proposed to develop a formal mechanism of sharing information with the public. Accordingly, a PIC has been established at the project (copy enclosed as Annexure 1.3.9). Details of PIC is outlined below:

a) OBJECTIVES:

1. To initiate formal open dialogue with the local population, particularly PAPs.

2. To share the relevant information, reports, plans and other documents with public.

3. To address the representations, complaints, grievances and suggestions of the public quickly.

4. To be easily accessible to the public.

5. To act as single window for addressing all issues pertaining to PAPs.

b) LOCATION:

The PIC is located at the site office in the Plant area. After the construction of the Resettlement Colony is completed, it will be shifted to a more convenient place in the resettlement colony.

c) OPERATIONAL DETAILS:

1. The PIC is equipped with relevant reports, plans and other documents like R&R policy, RAP, Socio-economic reports, reports of various studies conducted, schedules of various activities proposed, land and compensation details, etc.

2. A letter box has been kept for receiving representations, complaints, grievances and suggestions. A register is

being maintained indicating the date of receipt of letters, the contents, from whom received, to whom addressed, and date of reply.

3. A separate register is maintained for recording the name and address of the person who has visited the PIC and referred the documents.

4. A visitor book is also kept.

The PIC is functioning regularly and is attended to by Head of the R&R Cell. An executive of the R&R Cell will be specifically designated In-charge of PIC.

5. A quarterly progress report will be sent to Corporate Centre.

1.3.10 Organisation and Staffing:

NTPC has identified resettlement and rehabilitation as one of its primary concerns. Therefore, in accordance with the priority accorded to the R&R activities, a separate Cell has been created in the Kayamkulam Power Station.

The Cell to be headed by a Manager, will be a part of the Personnel & Admn. Department of the Power Station.

The Cell will be sufficiently strengthened and will consist of three personnel. The Manager heading the R&R Cell, will report to the Chief Personnel Manager (Organisation Structure enclosed). The R&R Cell will be

assisted by the Land Acquisition Cell for close coordination.

The R&R Cell will have the responsibility of formulating and implementing the Rehabilitation Action Plan, in close coordination with the various State Agencies, Financial Institutions, Opinion Groups and the PAPs themselves.

1.3.11 Public Consultation:

Public consultation process was initiated soon after the Land Acquisition activities commenced at the site through meetings with interested groups, individuals, etc.

- Elaborate discussions with majority of the land owners giving land to NTPC and the retrenched Kayal Farm labourers were held during the socio-economic and demographic survey. The same is video recorded and is available at site.

- All decisions affecting the PAPs and the population in the neighbourhood of the project are taken only by consultative mechanism. For instance:

- a) The dispute of communication facility to traditional fishermen was resolved in 1990, by mutual discussions along with representatives of Govt. of Kerala, in the presence of Hon'ble Ministers of Govt. of Kerala.

- b) Recently when the approach road to the plant site was to be formed, the road had to cross the inner Kayal water route used by the traditional fishermen. The details of the crossing were finalised by the tripartite consultative committee chaired by the District Collector. Minutes dtd. 29.4.95 is enclosed as Annexure 1.3.11.1.

- c) Any issue raised by any group or individual is discussed in PIC and whenever detailed discussions are specifically required, the same is carried out until the matter is resolved finally. A meeting was held on 25.8.95 with representatives of Traditional Fishermen at the office of R&R Cell. (copy of the letter inviting the representatives is enclosed as Annexure 1.3.11.2).

Village Development Advisory Committee (VDAC) constituted in four affected villages. The constitution of VDAC is as follows:

Chairman	-	Dy.Collector, Alleppey
Member	-	2 from Land/Homestead oustees/ traditional fishermen.
		1 from NTPC
		1 from the Village Panchayat (either Panchayat President or a member).

The draft RAP was discussed in the VDAC Meeting held on 14.10.95 and 17.10.95. Further, after freezing of the

number of PAP's the same was again discussed in the VADC meeting held on 01.12.1995 and 02.12.1995. The approval of the VADC was obtained for the RAP.

As mentioned earlier, a register has been maintained in the Public Information Centre. The residents in the area have been regularly recording their views in this register. Some of the salient views recorded in the register are as follows:

- The progress of the project has been explained by the Manager. We want a power station to be commissioned here which will improve the power shortage in the area together with job opportunities.

- We want proper rehabilitation and employment.

- We have surrendered our land only for a solution of power shortage.

- We have surrendered our land for the project because we understand that the commissioning of such a power plant will lead to some solution for power shortage and unemployment problem. But the activities of Govt. in this regard is disappointing. It is still on the part of Govt. to make clear whether the project will materialise or not.

- We have surrendered our land with the belief that NTPC will start off power station here. We have even lost our "Tuition Centre" located in the land which was our main bread earlier.

Even after all these NTPC has not yet started this project seriously. Therefore, it is requested to start the project work and contribute to the power development and employment opportunities.

- This Information Centre has provided details of the project and its benefit to the public especially the people from Kerala. Kerala being a electric energy deficient state, early implementation of the project is urgently needed. Though the number of displaced families are very low compared to other projects, the R&R programme planned by NTPC is appreciable.

- This project is to be implemented immediately as this will give more employment facilities to the local residents. I am told that this power project is on Naphtha based and as such it will be environment friendly.

A copy of the extracts of register wherein the above comments have been recorded is enclosed as Annexure - 1.3.11.3.

1.3.12**Monitoring & Evaluation:**

Monitoring & evaluation has been established as a permanent, continuous responsibility. Monitoring will be done by the R&R Unit established in the Kayamkulam project. Evaluation will also be carried out by Corporate R&R Group on annual basis till the measures provided in the plan are implemented. Head of the project will take a monthly review on the progress of the R&R plan.

To ensure proper implementation of RAP Quarterly review meeting will be held at the Regional Executive Director level.

CHAPTER II

2.0 PROJECT DESCRIPTION

2.1 EXTERNAL APPEARANCE:

The Combined Cycle Power Project (CCPP) would be located on the bank of Kayamkulam Kayal. The plant site is surrounded on all sides by the backwater. On eastern side, the plant site is separated from the main land by a narrow inner kayal. A narrow strip of land to the west separates the outer kayal and Arabian sea.

The proposal envisages installation of a CCPP of 400 MW capacity. The CCPP will have a configuration of 2 GT + 2 WHRB + 1 ST. Each gas turbine will have a capacity of 130 MW whereas the steam turbine will have a capacity of 140 MW. The switchyard is located towards the north of the site, adjoining the main plant. However, the switchyard which is under the scope of POWERGRID will be separated by a permanent boundary wall and shall be provided with independent approach. The layout plan is presented in Fig. 2.1.

The CW pumphouse and induced draft cooling towers would be located on the south of the main plant. The water treatment plant is envisaged to the west of main plant area. Liquid fuel storage and transportation facilities are proposed on western side close to the approach to the plant. Space provision has also been made for providing gas terminal facilities of the gas supplier, which may be required in future.

The layout of the plant has been formulated with an effort to blend functional requirement as well as aesthetics. Considerable emphasis will be given to plantation of trees within and around the plant area. The planned arboriculture will act as a partial visual barrier and will considerably reduce any adverse aesthetic impact due to the plant.

2.2 LAND DEVELOPMENT AND SITE PREPARATION:

The proposed plant site is surrounded all around by the back waters (known as kayals) of the Arabian sea. The existing site is protected on its periphery by an earthern bund with its top generally at RL (+) 1.3m. The bund on western side is also protected by stone dumpings. In plant area the existing ground level varies from RL (-) 1.5m to RL (-) 2.0m.

To protect the plant facilities against flooding, storm water will be drained by gravity. However, drainage from the adjoining low level areas shall be through existing pumping arrangements.

Site levelling shall entirely be through filling. Since no burrow areas are available in the vicinity of the plant site, which can meet the fill quantity requirements, it is proposed that levelling to proposed level shall be achieved by dredging & hydraulic filling with bed material (which is predominantly sand and suitable for the purpose)

obtained from outer kayal. Permission to dredge the bed of outer kayal has been obtained from the state authorities. The dredging activity will be completed within a year.

The water level in the adjoining back waters undergoes tidal variation and maximum and minimum water level as observed is stated to be RL (+) 0.81m & RL (+) 0.05m respectively. However, in June 1991, the water level in back waters is reported to have reached a maximum level of RL (+) 1.2m.

2.3 DREDGING OF KAYAL :

As the proposed site of the thermal plant is a low lying, it is estimated that a total quantity of 1.8 million cubic metres of filling material would be required to raise the plant area to the required level. The Govt. of Kerala, vide G.O. dtd. 28.6.90 have cleared the proposal to dredge the kayal basin for a distance of about 12 km. and for a depth of about 7 metres, leaving a clear width of 75 metres on the sides of the kayal for ensuring stability of the kayal banks (Annexure 2.3).

2.3.1 Dredging Technique:

It is proposed that the bed of outer kayal which is adjoining the plant area will be dredged and the dredged material will be directly pumped to the filling site. From the borelog investigation in the outer kayal, it is seen that the soil in the bed of outer kayal adjoining plant area

generally consists of very loose to loose, fine to medium sand upto a depth of 10 m and is quite suitable for dredging and hydraulic filling. The hydraulic filling is the best recommended method for filling of sand to achieve high compaction of fill material. However, no major equipments/ structures are planned to be supported directly on this fill material and these are envisaged to be supported on pile foundations of adequate capacity and length. For minor equipments/highly loaded structures, depending upon the loads, suitable ground improvements or pile foundations are envisaged for support. The pumped material which generally will contain 15-20% solids, will be allowed to get hydraulically compacted and the excess water will be drained back into the outer kayal. For containing the fill material at the filling site, earthen bunds all round the filling areas shall be made with earth burrowed within the filling site or with dredged material. The bunds shall be made in stages as per the requirement as the filling progresses. Necessary drainage arrangements like temporary weirs shall be provided to drain out the excess water.

The available draft in the outer kayal is about 1.5 m only. Accordingly, it is proposed that portable cutter suction dredger(s) shall be deployed for the dredging. Total fill in material required for plant area is estimated to be 1.8 million cu.m. and it is proposed to be completed within a period of 12 months. The capacity and number of dredgers shall accordingly be decided by the turnkey contractor

depending on availability of dredgers. Suitable floating pipeline shall be used for transport of dredged material across the water.

It is envisaged to dredge only a length of about 1700 m of the kayal bordering the proposed project site to extract the required filling material. The dredging is proposed to be undertaken by Cutter Suction Dredgers which would pump the dredged material approximately 80:20 at water-sediment ratio.

Dredging shall be restricted to a depth of 7 m leaving a clear width of 75 m on the sides of the kayal for ensuring the stability of structures on the banks of the kayal, as per the requirements of state authority.

A clear width of 75 m shall be left on either side of Kayal while dredging for ensuring the stability of banks of the Kayal. The dredging is generally undertaken to a slope of IV:5H to IV:6H which itself is a stable slope for the sandy bed material of kayal and will ensure stability of bank in the dredged portion. In view of above and dredging being restricted to a maximum depth of 7.0 m only, no potential threat to the stability of the land strip between the kayal and the sea is envisaged.

2.3.2 **Impact of Dredging:**

The principal and the most conspicuous impact of dredging would be the creation of an extremely turbid condition in the kayal and the impact on the benthic organisms of the

kayal basin. One redeeming feature of the present proposal is that it is only a one-time activity and very much limited in coverage. As soon as the dredging activity is over, the kayal would begin to recover. Water would become clear. The uprooted organisms in the lake bed would recolonise the basin once again. The kayal would eventually recover its habitat characteristics.

The kayals of Kerala are unique. They receive huge monsoonal river discharges every year. The rivers deposit huge quantities of sediments in the kayal basin every season and this has been the principal process by which the coastal land tracts have been formed in the State. The deposits have been so enormous in quantity that most of the kayals in Kerala have lost their depth and became shallow lagoons today. Huge quantities of these kayal sediments are already being extracted by the local people for agricultural and land reclamation purposes.

The kayal sediments are renewable resources brought in by river discharges during the monsoon periods. The sediments taken out during one season are replenished during the succeeding seasons. This has so far not caused any major ecological problem in the kayals of Kerala.

The proposed dredging in the Kayamkulam kayal adjacent to the project site would creat a deep kayal basin with a

depth of seven metres for a length of 1700 m and a width of 300-400 metres. Taking into consideration, the natural forces at work, it can be presumed that the dredged area would get naturally filled up with the sediment brought in by land drainage in the Kayamkulam area. As no data is available regarding the annual input of sediment in the kayal basin, the period required for this natural filling cannot be predicted.

2.3.3.1 SCIENTIFIC STUDIES RELATED TO DREDGING:

To understand the impact of dredging on the Kayal, following two scientific studies had been carried out:

(i)**First Study:**

"Hydrological Studies for the proposed gas based power project at Kayamkulam", carried out by National Institute of Hydrology, Roorkee, a premier National Institute in the field of hydrological institute.

The objective of this study was to assess the impact of dredging of the Kayal on the prevailing hydrostatic conditions in Kayal and to suggest the possible remedial measures and to analyse the chemical characteristics of the Kayal water. The findings of the study are as follows:

a) Slope stability analysis for the transverse dredged slope of 1V : 5H has been carried out and found to be stable.

This analysis has also been carried out accounting for the possible scour at the transverse slope end. It is found that even after the realignment, the bank slope would be safe.

b) The trench created at the central part of the Kayal due to the dredging operation does not adversely affect the stability of the land strip separating the Kayal and the sea. Further, the possible deepening of the trench due to the degradation of the kayal bed also does not result in any adverse effect on the stability of the land strip.

c) The exit gradient has been computed for various depths of the proposed trench and found that it is well within the limits and hence there will not be any slope failure due to ground water movement.

d) It is found that water gets well mixed in the kayal trench portion and hence there is no vertical density variation for longer periods.

(ii)**Second Study :**

"Studies on the impact of the Kayamkulam Super Thermal Power Project on the Kayamkulam Kayal and adjacent Sea with special reference to living resources" carried out by Deptt. of Aquatic Biology and Fisheries, Kerala University.

The report brings out the following in respect of impact of dredging:

"The dredging activity is stated to be a one time activity covering largely, the area of the kayal adjacent to the proposed plant, If this is so, the impact would be minimal. Flood waters of the Pamba and the Achenkoil rivers joining the kayal at its northern extremity through a net work of canals would be depositing huge quantities of land borne sediments in the dredged area and would replenish the sediment extracted from the basin'.

"The benthic fauna in the sediments may suffer a temporary destruction but would eventually recolonise the basin once the dredging activity is over". The report has suggested the following:

1. The area proposed for dredging may be limited to a maximum length of 6 kms. covering areas adjacent to the project site.

2. The dredging should be completed within the shortest time possible.

3. All measures may be taken to ensure the stability of the land strip between the sea and the kayal.

2.3.4 ENVIRONMENTAL MANAGEMENT DURING DREDGING:

Based upon the results of aforesaid two scientific studies, following environmental and engineering measures will be adopted during dredging activity:

1. Dredging will be restricted to a length of 1700 m of kayal.

2. Dredging will be done upto a depth of 7 m only leaving a clear width of 75 m on both sides of Kayal.

3. Dredging activity will be completed within a year period.

4. Temporary bunds will be constructed in the area to be filled in order to contain the dredged material and to allow excess water to flow back into kayal.

2.4 PLANT FORMATION LEVEL:

The proposed plant site is surrounded all round by the backwaters (known as kayals). The water level in the adjoining backwaters undergoes tidal variation and maximum and minimum water level as observed is stated to be RL (+) 0.81 m and RL (+) 0.05 m respectively. A land strip of about 500 m wide between the outer kayal the Arabian sea, protects it from direct exposure to sea. Accordingly, the maximum water level in Kayal has been considered for fixing the plant formation level. Tidal levels for the Arabian sea are available at Alleppey and Quilon from admirality charts. The MHHW (Mean Higher High Water) and MSL (Mean Sea Level) are stated to be (+) 0.91 m and RL (+) 0.55 m respectively for Alleppey and (+) 0.91 m and (+) 0.67 m respectively for Quilon. These levels are with respect to Chart datum. Considering these

tidal levels, the proposed formation level of RL (+) 2.0 m for the plant can be considered to be safe.

A high water level of (+) 1.2m was recorded in 1991. This level was not due to any storm or typhoon. It was due to delay in clearance of bar formation at the confluence of Kayal with sea approximately 10 kms. south of plant site which is done annually in a routine way. It is to be noted that for most part of the year, the Kayal waters are open to sea at the confluence. However, in summer months before the monsoon when inflows to the Kayal from upstream water bodies is low, generally a sand bar form at the confluence point. The sand bar is normally cleared as a routine exercise by local state authorities at the onset of monsoon, so that the increased flows in Kayal during the monsoon can flow out into the sea. In case this sand bar clearance is delayed, as was stated to be the case in 1991, the Kayal water levels may rise. However, the possibility of Kayal water levels exceeding (+) 1.2 m is not anticipated, because if the Kayal water level rises, even before it reaches (+) 1.2 m, it tends to flood the adjoining land areas which are occupied by local people. The sand bar is, therefore, necessarily to be cleared as is done each year before it floods the occupied areas.

2.5 LAND UNDER COASTAL REGULATION ZONE:

Ministry of Env. & Forests, Govt. of India, have stipu-

lated certain guidelines for the protection of coastal area (copy enclosed as Annexure 2.5)

Ministry of Environment & Forests in the environmental clearance for coal based thermal power project have stipulated that a minimum of 100 m of distance must be left on the front side from the Kayal and on the remaining three sides, the distance equivalent to the width of the Kayal should also be left as per the provisions of the Coastal Regulation Zone. The area so left all around the Kayal should not be used for any other purposes except for raising green belt". Filling operation in CRZ zones is not prohibited. This will be complied with.

2.6 LABOUR COLONY:

Six acres of land will be demarcated for contractor labour colony. The land will be well developed and all essential facilities will be provided in the colony by the Contractor. The facilities include first-aid, potable water supply, sanitary facilities, security, etc. Separate toilet facilities will be provided for women. If the number of women is more than 20, separate facility as per Labour Law would be provided. The details have been given in Section 1.2.2.9.

2.7 SERVICE TOWNSHIP :

For construction staff, 72 quarters have been constructed which would later form part of permanent township.

2.8 PERMANENT TOWNSHIP:

The township is located east of the plant on the western side of the National Highway NH-47 near Chingoli and Cheppad villages.

The township would have 213 quarters for O&M presently and 77 quarters for CISF along with matching non-residential facilities.

2.9 FUEL:

2.9.1 Liquid Fuel:

Naphtha has been considered as basic fuel. The estimated quantity of Naphtha for operating a 400 MW combined cycle power plant is 0.45 MMTA for 6000 hours of operation per year. As Naphtha at present is a decanalised item, no restriction is envisaged in directly importing the same. A confirmation on the availability of 0.6 MMTA of indigenous naphtha is also available from two Indian fuel suppliers.

.9.1.1 Fuel Transportation and Risk Assessment:

Naphtha is to be transported from BPCL storage terminal at Irumpanam near Cochin to storage facilities at Kayamkulam plant. A study has been undertaken to identify the most optimum mode of transportation considering both the techno-economic as well as environmental aspects. Various possible mode of fuel transport were considered. Based on detailed analysis, the following two options were considered for indepth study.

1. Rail option
2. Marine option

Rail Option:

The following three rail options have been considered:

Option-I : Direct by rail upto Haripad and thereafter to Kayamkulam site by rail.

Option-II: Unloading near Haripad station transit stroage and transfer to Kayamkulam by pipline.

Option-III: Unloading near Cheppad station transit stroage and transfer to Kayamkulam by pipeline.

A comparison between three options has been presented in Table - 2.9.1.1(a) and 2.9.1.1 (b).

Option-I involves road overbridge over National Highway, acquisition in developed and populated area and long construction time at a substantial cost and therefore not recommended.

Option-III involves transit storage near Cheppad with suitable siding for unloading. To cater to the requirements, some modifications at the station, platform and upgradatation of some of the railway crossing etc. will be required, but it will be of lesser scale as compared to the Option-II and acquisition would also be on a lesser scale as compared to the other options due to the convenient layout of the siding arrangements.

It is, therefore, evident that Option-III i.e. unloading at Cheppad and transportation to site through pipeline is the optimum rail option, considering the basic aspects of feasibility, ease of implementation, operation, safety and implementation schedule.

Marine Options:

The various alternate marine options are as follows:

a) Open-sea mooring of ships with submarine and onshore pipline. This alternative is further sub divided into two:

1. Single point mooring
2. Multibuoy mooring

b) Jetty with pipline running on approach trestle/ road.

c) Jetty inside lagoon near plant site.

As no port/off-shore facility is available near kayamkulam coast to handle the envisaged traffic, a port and marine facilities are to be developed afresh. Various alternatives on such port/offshore facility for fresh development are as following:

a) Creation of a new harbour for a protected jetty;

b) Jetty inside lagoon;

c) Multi-buoy mooring;

d) Single point mooring.

The study reveals that multi-buoy mooring is the optimum marine option.

The rail option enjoys in having an existing rail from Cochin to Cheppad on which only marginally additional cost is to be spent to make the system suitable for fuel transportation. The marine option, thus, for obvious reasons become costlier.

Both on account of capital cost and NPV, the rail option via Cheppad is cheaper and lower compared to even the least cost marine option.

Even for the future additional 400 MW power generation, it has been established that the present rail has adequate capacity to handle the required quantity of naphtha. The additional expenditure that will be required to be made is limited to the transit storage terminal at Cheppad and the total cost still remains lower than the marine option.

2.9.1.2**Risk Analysis:**

The risk analysis study has been carried out on the rail option-III of rail options which has been brought out as the least cost option.

A study of Indian Rail transport practices indicate that transport by rail of hydrocarbon products of all classifications is common and the safety regulations adopted by Indian Railways ensure safe transport of such products.

As per Ministry of Railways, only BTPN (Bogie Tank for Petroleum New) wagons will be used in this route to transport naphtha from Ernakulam to Cheppad. BTPN wagons (eight wheeled) are more stable on rail track in comparison to conventional wagons (four wheeled). Therefore, the probabilities of accidents like derailment are less likely.

The wagons used for POL transport in India are manufactured as per RDSO (Research, Design and Standard Organisation) of Indian Railways standards. The specification laid

down for ISO containers are more liberal than the Indian Railway Standards. Therefore, as per Ministry of Railways, the possibility of leakage or puncture on the wagon in case of accidents like derailment is negligible.

Based on the above information and available Indian Railways accident data, frequency analysis was carried out for Naphtha transportation by rail from Ernakulam to Cheppad. Frequency analysis was also carried out based on Netherlands accident data. The Individual risk based on the Indian data has been found to be lower.

The risk of outage, which may occur due to possible accident in the areas of operation like loading/unloading and storage, has been found to be quite low by itself in rail option.

The separation distances provided in Kayamkulam plant site and Cheppad transit depot site between storage tanks and other facilities are found to be adequate except for the fire water storage tank and pump house for liquid fuel storage area at Kayamkulam. Such facilities lie within 4.5 kw/m2 of radiation intensity from tank fire. This may affect manual operation of the fire water pumps and hence may be shifted beyond this zone. The separation distance from the plant operations area and the plant boundary are also found to be adequate and hence no impact on adjoining habitation and facilities is expected.

Considering the above aspects and other risk analysis study results, safety on rail option may be considered adequate.

Conclusion:

1. The rail option via Cheppad is the most cost effective option.

2. It can meet the requirements of handling required quantities of naphtha both for Stage-I and expansion stage of the power plant.

3. Under regulations of Indian railways, rail transport of naphtha is permissible.

4. The rail option via Cheppad can be adopted for implementation.

Study reports on the mode of transportation and risk analysis have been submitted to the Bank separately. The recommendations made in the reports will be implemented by NTPC.

2.9.1.3 Naphtha stroage:

It is envisaged to have 4 floating roof storage tanks, each 10,000 m3 at this plant and 2 floating roof stroage tanks of 5000 m3 each at the Cheppad siding . The dyke wall and floor of the storage area shall be made impermeable by suitable concrete construction to avoid any seepage, in case of storage tank failure. For fire fighting, manually operated medium velocity water spray system along with foam system shall be provided for Naphtha storage tanks.

2.9.2 Natural Gas:

Provision shall also be kept for firing natural gas as and when gas is available. However, presently facility for Naphtha terminal will be provided.

2.9.3 Fuel Characteristics:

The characteristics of naphtha are presented in Table 2.9.3.1. Sulphur content is 0.1% by volume. Lead is present in traces (100 ppb). The concentration of lead in the fuel is an important factor for the health of turbine and permissible value (maximum) for lead in fuel is 0.5 ppm (Table 2.9.3.2)

2.10 HEAT DISSIPATION SYSTEM:

A closed cycle cooling system with cooling towers will be adopted to comply with the regulatory standards for hot water discharge.

2.11 PLANT WATER REQUIREMENT:

Sweet water requirement for the plant (1015 m3/hr) would be met from Achankovil river, with a fall back from PIP canal system (Fig. 1.2.2.8). The water would be drawn into a desilting basin in an area of 6 acres (located at river end) by gravity. A reservoir is proposed to be constructed in 33 acres of land adjacent to the plant site. The land for reseroir is already in possion of NTPC and no acquestion is involved. A commitment for supply of 3200 m3/hr of fresh water has been accorded by the State Govt. vide letter dt. 30.1.89 whereas the requirement for CCPP is only about 1015 m3/hr. The availability of water has been reconfirmed by State Govt. vide letter dt. 6.1.95. During the period of low flow in the river, the water requirement for the project would be met from the Haripad branch of the Pampa Irrigation Project canal close to the project site. The eventuality of water not being available in river Achankovil during certain part of the year was also considered. During this period, the water shall be supplied by Irrigation Deptt. from PIP canal systems upto the Achankovil river near our intake point, through a gravity channel.

2.11.1 Desilting Basin:

Intake point on Achankovil river for sweet water drawal is located about 10 km. from the plant area. A weir shall be constructed in Achankovil river to maintain minimum water level in river. An intake structure of RCC shall be constructed upstream of the weir. Water shall be drawn through intake structure into an open RCC channel leading to desilting basin. One raw water pumphouse shall be provided after the desilting basin for pumping the water through pipelines to the reservoir at the plant site. There shall be another make up water pump at the reservoir to pump water to clarifiers located in plant area. The reservoir is proposed to have 5 days storage capacity which would act as a contingency measaure in case of non-availability of water from the river.

Replacing the desilting basin by sand filters is not being considered in view of the following facts:

a) A certain minimum water quality is to be ensured for effective use of sand filters without choking. Generally clarified water limiting turbidity to 30 ppm is supplied to sand filters. In case raw water from the river source is directly treated through sand filters, there is every possibility of sand filters getting choked especially during the monsoon months when the turbidity of river water is expected to be quite high.

b) There is no significant reduction in land requirements for the same. The land requirement for sand filters is estimated to be 2-6 acres depending on the type of sand filters.

A commitment to supply make up water for the plant is available from the state irrigation authorities. As per the information available, the anticipated minimum flow downstream of the weir would be of the order 600,000 m3/day. About 2000 people depend upon the river water downstream with an average consumption of 75 litres only. The total requirement, therefore, would be 150 m3/day and hence there would be absolutely no impact on availability of water down stream due to construction of weir.

Presently, it is proposed that a submerged weir will be constructed on the river to ensure minimum water depth for drawal of water. A cross section diagram of the weir across the river Achankovil river is given as Annexure 2.11.1. It may be noted that no dam is proposed to be constructed to raise the water level upstream. Due to submerged type of weir, the water level in the reservoir will not exceed HFL.

The water supply for the project is envisaged from a single intake point on river Achenkovil. Commitment of water supply from state irrigation authorities is also for drawal from a single point on river Achenkovil. Accordingly, all

land requirements related to drawal arrangements from this single intake point to plant are included in the project report. No separate water drawal arrangement from PIP canal system to plant is envisaged by NTPC. However, the state irrigation authorities have proposed to link the PIP canal system with Achenkovil river upstream of intake point on the river, to augment the water supplies in the event of water flow in Achenkovil river being inadequate to meet the commitments downstream. It is understood that an existing natural drain shall be suitably remodelled to form the link channel between the PIP system and intake point near Achenkovil river.

As clarified earlier, augmentation from PIP canal system is supposed to be from surplus supplies after meeting the irrigation and domestic requirements.

2.11.2 Condenser and Auxiliary Cooling:

Recirculating type C.W. system with cooling towers is proposed for the project. The circulating water requirement is estimated to be about 30,000 m3/hr. The system would require about 765 m3/hr as make up.

2.11.3 Demineralised Water:

The demineralised water requirement for the plant would be 35 m3/hr for boiler make up and 120 m3/hr for NOx control.

2.11.4 Potable Water:

Potable water requirement for plant and colony would be 60 m3/hr.

2.11.5 Miscellaneous Use:

The water requirement for service water, floor cleaning and regular maintenance would be 10 m3/hr. For air conditioning and ventilation, about 10 m3/hr of water would be required. Water required for fire fighting system would be drawn from the cooling tower blow down.

2.12 LIQUID WASTE:

2.12.1 Cooling Water:

A recirculating type CW system with cooling towers has been envisaged for the project with blowdown from the cold side. Therefore, there would not be any hot water discharge.

2.12.2 Demineralisation Plant Regeneration Waste:

The plant demineralisation system will be regenerated periodically. The regeneration waste would be about 15 m3/hr. In the regeneration waste, the concentration of various parameters are expected to be higher in comparison

to the pretreated water. In addition, increase in the concentrations of sodium and sulphates and wide variations in the pH of the waste water are expected.

2.12.3 Treatment plant waste:

Clariflocculator and filter employed for clarification of water will produce 50 m3/hr of waste water. This water would contain mainly the flocculated chemicals and suspended solids.

2.12.4 Sanitary Effluents:

Domestic water for colony and plant would generate about 60 m3/hr of sanitary waste. This waste would contain suspended solids and organic matter.

2.12.5 Miscellaneous Waste:

Service water used for regular maintenance and floor cleaning will produce about 5 m3/hr.

2.13 WASTE WATER TREATMENT FACILITIES:

All effluents such as sludge from clarifiers, DM plant waste, main plant drains, oily wastes, etc. would be treated in the respective local treatment systems and all the treated effluents would be fed to Central Monitoring Basin (CMB) prior to final disposal.

Sludge from clarifiers would be stored in local sludge sumps. P.T. plant clarifier sludge would be treated using solid liquid separators.

Oily waste would be treated using oil separator followed with drum type oil skimmer having oilofin resin. The details of the oil skimmer have been given in Section 1.2.3.2. Oil separators would be designed for treating the run off water in the oil facility area during rainy season. Clear water would be led to CMB.

Service wastewater would be treated for reducing TSS by using tube settler.

DM plant regeneration waste after neutralisation would be led to CMB.

Cooling tower blowdown from the cold side would be led to the Central Monitoring Basin from where all treated effluents would be pumped for the final disposal. The treated effluent will conform to the regulatory standards.

Flow integrators would be provided both at the plant intake and discharge point at Central Monitoring Basin.

2.14 STACK EMISSIONS:

The combustion gases would be discharged through WHRB stack/bypass stack of 70 m. The NOx emission shall be controlled to 100 ppm by providing either low NOx burners or by injection of steam/water depending upon manufacturers experience. DM Plant will be sized to meet the water requirement for NOx control.

2.15 FUGITIVE EMISSIONS:

Fugitive dust emissions from combined cycle power project would be insignificant due to absence of coal stack yard, coal handling plant, ash handling plant and ash disposal area. Besides, Kerala receives a good amount of monsoonic rain and dry spell is not dominant, and consequently the general fugitive emission in the area is extremely low. In addition, extensive afforestation will be undertaken in all the vacant spaces besides developing green belt in the land earmarked under the provision of CRZ which would help in further minimising the fugitive dust emission.

2.16 INSTITUTIONAL NEEDS:

The Environmental Engineering Group was created at the Corporate headquarter in 1981 with a view to inter alia

formulate policies, carryout environmental impact assessments for new projects and coordinate with Govt. of India on all environmental matters.

Subsequently, NTPC has recently formed an Environmental Management Group under the Director of Operations. This group is charged with broad responsibilities of overseeing of environmental affairs including collection, compiling and analysis of environmental monitoring and compliance data. At all the NTPC stations a separate Environmental Management Group has been established headed by Manager/Sr. Manager to oversee the environmental functions and interact with the operation and maintenance group in environment related mat ters.

A dedicated group has been established at the Corporate Centre to coordinate the company's R&R and community development activities. Senior Manager (R&R & Administration) has been delegated the responsibility of planning the formulation of policies on implementation of the R&R programmes at the different stations.

At the stations, a separate group to ensure implementation of R&R programme have also been established under the administrative control of the P&A Department.

CHAPTER III

3.0 BASELINE ENVIRONMENTAL CONDITIONS:

The baseline conditions presented in the EIA report are based on data collected for EIA of coal based project. Although the data is about five years old, the scenerio in the area has not undergone drastic change with respect to various environmental components including land use, water quality, soil, meteorology, air quality, terrstrial ecology, aquatic ecology, noise because no major development work has taken place in this area. Therefore, description on major components of the environment like water quality, air quality, ecology, water use are comparable to five year back condition. The biological data presented in the EIA report are based on actual field study and survey. To understand the biological diversity of the kayal, a special study was undertaken through Deptt. of Aquatic Biology and Fisheries, University of Kerala. The main findings are presented in Section 3.10.1.

However, to assess the status of environmental conditions, monitoring of main environmental domains like air, water, ecology, will be undertaken during the operational phase of the plant.

3.1 LAND USE

The land use pattern was primarily assessed through interpretation of satellite imageries for the period of 1973

and 1988. Ground truth verification was also undertaken. Census data was also analysed. The land use classes derived from interpretation of Satelite imageries for the year 1973 and 1988 are presented in figure 3.1.1 and 3.1.2.

The distribution of land for various uses is presented in Table 3.1.1. The table indicates that among the four districts, Kottayam has the maximum percentage of (83.64%) under net shown area. Pathanamthitta district has the maximum percentage of area under forest land (57.76%), followed by Quilon (32.34%) and Kottayam (3.71%), while Alleppey district does not have any forest land. On the other hand Allepey district has the maximum potential for bringing in additional land under cultivation (3.25%), followed by Kottayam (2.03%), Quilon (0.98%) and Pathanamthitta (0.66%).

The change in distribution of cultivable area remaining uncultivated between the years 1976-77 and 1986-87 is as follows:

Percentage Distribution of Cultivable Area Remaining Uncultivated in 1976-77 and 1986-87

District	Cultivable uncultivated area as %age of Cultivated area of the District	
	1976-77	1986-87
Alleppey	1.98	2.99
Quilon	1.59	1.40
Pathanamthitta	NA	1.28
Kottayam	2.42	2.10

Source : KSLUB, 1989.

It is evident that more land has been brought under cultivation over the years in all the districts except Alleppey.

3.1.1 Cropping Intensity:

Alleppey district has the distinction of having the maximum cropping intensity in Kerala State. The cropping intensity during the period 1986-87 was as follows :

Cropping intensity in the districts during 1986-87

(Area in Ha)

District	Net Sown Area	Area Sown More than Once	Gross Cropped	Cropping Intensity Area%
Alleppey	101832	63770	165602	163*
Quilon	144581	75536	220117	152
Pathanamthitta	101992	6295	108287	106**
Kottayam	183638	60542	244180	133
Total	532043	206143	738186	139

* Highest in Kerala State

** Lowest in Kerala State

Source : KSLUB, 1980.

3.1.2. Irrigated and Non-irrigated Land:

The distribution of irrigated and non-irrigated land is presented in Table 3.1.2. The table indicates that about 60% of the total area is irrigated land while about 40% is non-irrigated land.

3.2 DEMOGRAPHY AND SOCIO-ECONOMICS

In order to understand the socio-economic and demographic characteristics of the people in this area data were compiled from census reports, various statistical data published by the Kerala State Government and other related reports. A socio-economic survey of sample households was also undertaken. The sample survey included demographic characteristics, migration pattern, occupational structure, economic opportunities, income levels, environmental conditions etc. **In addition, a separate detailed Demographic and Socio-economic census study for project affected people was undertaken through Loyala College of Social Sciences, Trivendrum.**

3.2.1. Complementary Survey:

In view of the reduction in the requirement of land, the time gap between the completion of the Demographic and Socio-economic studies by Loyola College of Social Sciences, Trivandrum, and the implementation of RAP and also due to the fact that the NTPCs **R&R Policy had undergone a major change,**

a complementary Demography and Socio-economic study has been awarded also to Loyola College of Social Sciences, Trivandrum in January 1995. The study involved detailed discussions with the PAPs in order to assess their land, homestead holdings, their opinion within the framework of the R&R policy and their views in the finalisation of RAP and has been completed . The study also provides for identification of suitable local NGOs who could be associated in the preparation/implementation of the RAP.

3.2.2 Family Size and Age-Sex Ratios:

The rural average family size is found to be 4.92 persons (urban 4.88 persons). On an average, there are 855 females per 1000 males. The average sex ratios for the rural areas is 876 while it is 809 for the urban areas.

3.2.3 Migration Pattern:

Analysis of data of sample socio-economic survey indicates that in-migration in this area is very rare. Out-migration is quite prevalent, almost one-fourth of the households have migrated out of the villages. In the households surveyed it is found that 26-28% of the rural, and around 13-16% of the urban respondents have migrated outside their settlements. A notable feature about the out-migra-

tion pattern is that there is a greater migration from the rural areas than the urban areas. This may be explained by the fact that people from rural areas generally migrate to urban areas in search of employment.

Out of the households surveyed in the core area, 4% had migrated to places within the district, 12% went outside the district and 50% had moved out of Kerala State. In case of general study area, the corresponding figures were 15%, 7% and 35%, respectively.

Essentially a large section of migrants (35% in core and 42% in general study area) went to seek better avenues and income earning opportunities outside the country - mainly to the Gulf countries. In fact almost 85-90% of the migration was found to be for economic reasons while the remainder had gone out for educational purposes.

3.2.4 Economic Opportunities and Income Generation:

A brief review of the economic opportunities available to the inhabitants in this region is given below:

(a) <u>Agriculture:</u>

Agriculture is the main avenue of employment, the major crops being paddy, coconut, vegetables, tapioca, bananas and sugarcane. Single cropping is the main practice though double

cropping is also observed in some areas. Agricultural lands are mostly observed adjoining the houses. 30% of the agriculturists own the land they cultivate. The average size of the holding is 0.30 ha.

Irrigation facilities in the region comprise canals and wells although most of the cultivators are still dependent on rainfall. During the rainy season, water-logging is a common problem and water has to be pumped out to the low-lying areas and canals.

(b) Household Industry:

In the coastal areas, coconut is the main crop. Yields of 80 to 100 coconuts per tree provide a steady income. Coconut trees have given rise to an important household industry in the coastal villages, viz. coir industry. although it is not very remunerative.

(c) Fishing:

Fishing is another important occupation in Alathupuzha, Ambalapuzha, Purrakkad and Thrikunapuzha Panchayat of the coastal belt. Country boats and engine-powered rowing boats are used by the fishermen. There are no large fishing trawlers. In fact, it is found that the trawlers in the region are owned by large industrial units. Consequently, the benefits accruing from big catch of fish are drained out of the region

to outsiders, who in turn are able to process and market the output to the larger market outside the area. Although, fishermen's cooperatives exist, due to their unorganised nature, income from fishing is very low. The catch consists mostly of fish, which fetches little remuneration as compared to prawns.

A characteristic of the occupational pattern in the region is the prevalence of seasonal unemployment especially in agriculture and fishing due to dependance on seasonality in cropping and fish breeding.

(d) Industries:

There is no major industry in this area. However, certain small scale and household industries, generally non-polluting in nature are in operation.

3.2.5 Housing:

i) Ownership

In the rural area, houses are predominantly owner occu pied (94-97%).

ii) Structural Type

Housing structures in the region can be classified as Temporary, Kutcha, Semi-pucca, and Pucca houses. Kutcha structures are defined as those structures with mud walls and

floors and thatched roofs; semi-pucca are those with brick and stone walls and tiled roofs, generally inclined; and pucca structures are brick and concrete structures, usually with flat roofs.

Despite low income levels in the region, remittances from abroad are invested mostly in housing. Consequently, semi-pucca structures are predominant in both rural as well as urban areas .

3.2.6 **Infrastructure Facilities:**

The basic infrastructural facilities like water supply and sanitary available in the area have been surveyed.

Water Supply:

Taps, tubewells, handpumps, wells, rivers, canals and ponds constitute the various sources of drinking water supply. The predominant source of water supply in the region is shallow wells with generally sweet water, however, quality varies from place to place. Almost 45% in the rural, and 71% of urban households are supplied by this source. Piped water supply is available in about 41% households which is a reasonably good standard as compared to the national average and has been achieved primarily by the efforts of Kerala Water Authority's aim to provide piped water supply to all.

The quality of water supply available is reasonably good. Most of the households surveyed (over 90%) both in urban and rural areas, reported soft water availability for domestic purposes.

Sanitary Facilities:

Sanitary facilities in the area were found to be fairly poor. Flush toilets with septic tanks were not available everywhere. Of the households surveyed, about one-third of the dwelling units had no regular toilet facilities.

Overall Situation:

The area as discussed above has a high density of population and has been experiencing a high growth rate as compared to the average growth rate of Alleppey district. The economy being predominantly agricultural is also reflected in the urban areas, which exhibit semi-urban characteristics with substantial dependency on primary activities. Although about 84% of the area is under cultivation, workers in agricultural activities comprise about 49% of the work force. The scope of bringing more land under agriculture is limited.

Also, the high levels of migration from the region owing to economic reasons is a sharp pointer to the paucity of employment opportunities.

3.3 HYDROLOGY:

The data on hydrology have been collected from Irrigation Design & Research Board, Trivandrum.

3.3.1 Surface Water Hydrology:

The Pamba is the main river controlling the drainage of the area. Achankovil river joins the Pamba from the south in the western part of Kerala. The river Pamba finally drains into the Vembanad lake through several distributories. Manimala, the other important river in that region, also drains into the same lake.

The river Pamba, Achankovil and Manimala are in the youthful stage and all of them are fast flowing perennial rivers. The banks of the rivers are steep and high in the eastern part of the state but on approaching the coast, these features becomes considerably subdued and the river and its distributaries have a gentle gradient near their confluence with backwaters or lakes.

The coastal plains of Pamba basin where the Kayamkulam combined cycle power plant is to be located lie on the coast of Lakshadweep sea and have a width ranging from 25 km in the north near Alleppey to 18 km in the south at Nurnad. The

general elevation of the plains ranges from 1m to 5m above m.s.l. At places the level of the ground surface is below sea level and gets inundated during the rainy season and remains water-logged till January.

The proposed combined cycle power plant is located on the fringe of the Kayamkulam Kayal (backwater). The Kayal is connected to the Arabian sea through a bar mouth which cuts off the Kayal from the sea by formation of a sand bar from January to May. During monsoon season, the fresh water flowing from the land flushes out the Kayal by forced opening of the bar mouth and the Kayal experiences tidal effect as well as heavy fresh water inflow. The sediments carried by the fresh water flow causes the sand bar to form again after the monsoon.

The mean annual rainfall for the period 1901-1980 in the Pamba river basin is 3218 mm. Out of this the major rainfall contribution (about 61%) is during the south west monsoon season i.e. June to September; 20% of the rainfall occurs during the period October to December; 17% during March to May and 2% during the remaining period of January and February. The highest annual rainfall of 4508 mm was recorded in 1933 and the lowest annual rainfall of 1146 mm in 1967.

3.3.2 Fresh Water Potential:

Gauging stations on Pamba basin for which discharge data were available are presented in Fig. 3.3.2.

The available annual discharge data for the period 1966 to 1986 at Erapuzha and Kollakadavu gauging stations on Pamba and Achankovil rivers are presented in Tables 3.3.2.1 and 3.3.2.2, respectively. Data for monthly flows (1982-86) showing monthly average and minimum flow are presented in Tables 3.3.2.3 and 3.3.2.4. Both of the above mentioned gauging stations are upstream of the proposed river water intake point of the CCPP.

From the results of the rainfall run-off correlation carried out in a previous study, it is seen that a minimum of 44.7 MCM rainfall is required to create a run-off. This is supported by a good percentage of low-lying lands in the catchment area and an appreciable ground percolation due to predominantly permeable soil.

The mean annual run-off at Erapuzha gauging station on Pamba is 3892.5 MCM (1970-86). The same for Kollakadavu gauging station on Achankovil river is 1735.0 MCM.

3.3.3 Hydrogeology around the Project Area:

Hydrogeologically, the Kayamkulam area is rather complex and aquifer system is multi-layered. Due to a flat terrain, there seems to be an active exchange of water between the upper aquifer with open estuary channels and drainage system. The uppermost aquifer in the area comprises sands, clayey sands and silt. A layer of lateritic clayey material sometimes overlies these sands due to which the direct recharge into the upper aquifers seems to be rather slow. However, the upper aquifer layers are able to support large number of dug wells in the area to meet the domestic needs.

Fluctuations in water table in thirteen open/dug wells tapping the shallow (unconfined) aquifer around the project area have been observed during the course of the field study. The data are presented in Table 3.3.3. It is observed that the depth of water table is shallow and ranged from 1.53 m below ground level at location no. 12 near plant area (Chullatheravu) to 4.20 m below ground level at location no. 4.

The deeper, confined and semiconfined aquifers in the Kayamkulam area have been tapped by over 40 tubewells ranging in depth from 85 m to 200 m . Out of three tubewells within Karthikapally Panchayat area, which include the project area, are reported to be self-flowing. The average yield of the tubewells in the project area is rather high and varies in

the range of 1.00 to 2.00 lakh litres/day, with average pumping duration varying from 8 - 10 hours/day. The range of discharge in the tubewells varies from 7000 L/h to 10,000 L/h. In Cheppad area, to the north east of the power plant site, the clay content in the aquifers seems to increase, resulting in significant reduction in well discharges.

3.3.4 Ground Water Potential:

From the available data about the Groundwater potential of the Kayamkulam plant area, an idea can be obtained about the overall groundwater balance of the Pamba basin totalling 4337 km^2. Out of the total rainfall of 5246 MCM, about 740 MCM (14.1%) percolates as groundwater recharge in the area. The total ground water resources in the upper aquifers are of the order of 864 MCM out of which 75 MCM is withdrawn through different wells and shallow tubewells.

3.4 WATER QUALITY:

3.4.1 Methodology of Baseline Survey:

The locations of the monitoring stations are presented in Fig. 3.4.1. In order to establish the present state of water quality of surface and ground water and to identify critical parameters, if any, an extensive water quality

monitoring programme was undertaken. The monitoring locations were selected with a view to obtain an overall spatial and annual water quality profile.

Water samples were drawn on a composite basis (24 hours) each month from each monitoring point. For all surface water samples, depth integrated samples are drawn.

Use of appropriate preservatives, containers and storage duration have been maintained in accordance with Standard Methods for the Examination of Water and Wastewater (16th ed., 1985) by APHA et al.

In-situ tests for pH, D.O., temperature and conductivity, have been carried out using a portable combined Water Quality Analyser. Other tests have been performed at various places such as CES site laboratory at Kayamkulam; Centre for Earth Science Studies, Trivandrum; Superintendence & Co. Ltd.; Calcutta, Government Analytical Laboratory, Trivandrum and Centreal Inland Capture Fisheries Research Institute, Barrackpore (near Calcutta).

Parameters monitored and frequency of monitoring are as follows:

a) Monitoring of heavy metals, arsenic, selenium, cyanide, phenolic compounds, anionic detergents, mineral oils and polynuclear aromatic hydrocarbons (PAH) have been undertaken quarterly (four times a year) for all the samples.

b) Radio-activity analysis was undertaken twice a year for two sea water and one groundwater sample.

c) Pesticides have been monitored twice a year for all the samples.

d) Bacteriological tests i.e. total coliform (MPN) and presence of Salmonella, Shigella and Vibri Cholerae have been undertaken on a monthly basis for all the samples.

3.4.2 **Results and Observations:**

The results of water quality analysis for seven locations on monthly basis are presented in Tables 3.4.2(i) to 3.4.2.4. (ii)

3.4.2.1 **Sea Water:**

The monthly monitoring results of sea water are presented in tables 3.4.2.1(i) and 3.4.2.1(ii) Dissolved oxygen (DO) levels vary from 4.95 to 7.91 mg/L with an average of 6.32 mg/L which is good enough to sustain aquatic life. pH varies from 7.5 to 8.4 at WSS 1 while it varies from 7.3 to 8.4 at Kayal mouth/bar mouth. BOD levels are very low indicating no major wastewater input. This is further supported by undetectable nitrate/nitrite level.

Alkali earth metal concentrations show normal values for sea water (Sodium 7500-13000 mg/L, Calcium 371-465 mg/L, Magnesium 767-1668 mg/L). Near barmouth heavy metal concentrations are also within normal range except that of Nickel which show slightly higher concentration.

Bacteriological quality does not indicate any gross pollution. No presence of pathogens is indicated.

In general it can be concluded that the quality of sea water is quite satisfactory and does not indicate any appreciable pollution or contamination.

3.4.2.2 Backwater Quality (Kayamkulam Kayal):

The monthly monitoring results of backwater are given in Table 3.4.2.2. The backwater quality varies greatly with fresh water inflow. Since the Kayal is connected to both rivers and the sea (through the barmouth which opens in monsoon and closes in winter naturally) the salinity distribution varies widely. Generally speaking, in late May or early July, the water becomes brackish but in August it is generally constituted of fresh water, while both the EC and chloride content rise appreciably as run-off reduces. At the end of monsoon, the salinity level is of the order 11% whereas in April/May, the level increases to about 30% which is almost equal to normal sea water. The quality aspects corre-

sponding to alkali earth metals and hardness show similar trend. Average DO level is 5.9 mg/L and pH varies from 6.6 to 7.3.

As far as presence of heavy metals is concerned, their levels are quite low and a marked decrease is noted in almost all metal concentrations between July and August, generally due to heavy fresh water inflow.

Toxic substances like Arsenic, Cyanide, Selenium are all below detectable limit. Phenolic compound level is also low.

In general it can be concluded that the quality of backwater is dependent on fresh water inflow, it's mixing as well as ingress of sea water. However, there is no indication of any appreciable pollution or contamination.

3.4.2.3 **Fresh Water Quality:**

Two surface water sources have been monitored: WSF_1 on Danapadi canal and WSF_2 on on River Achankovil. The monitored data are in Tables 3.4.2.3(i) and 3.4.2.3(ii).

Electrical Conductivity (EC) and chloride values in the river varied over a smaller range whereas the variation is high in the canal water. In general, the river water has

lesser TDS than the canal water. This could be due to the influx of tidal water into the Kayal particularly in summer months. Similar trend is observed in the hardness values.

As far as sulphates and phosphates are concerned the values are well within typical fresh water range but phosphate concentrations increased in July-August in both the cases indicating increased agricultural run-off.

Alkali earth metal concentrations are observed to be in normal range but Potassium concentrations are higher as compared to Sodium in river water (July). Heavy metal concentrations are well within normal range and also show a marked decrease probably due to increased run-off from July to August. However, lead concentrations have shown proportionately higher value in the river water (0.15 - 0.12 mg/L). Chromium (both hexavalent and total) was not recorded.

3.4.2.4 **Groundwater Quality:**

The analyses of two groundwater samples both tapping Warkalai formation are presented in Tables 3.4.2.4(i) and 3.4.2.4(ii).

Normal taste and colour (5.0 on Pt-Co scale) and a pH varying from 7.1 tp 7.9, was observed. EC values range from 290 to 500 umhos/cm. Hardness varied from 143 to 198 mg/L as $CaCO_3$ which is considered moderately hard considering domestic use.

Maximum BOD was 2.4 mg/L but generally negligible. Nitrates/Nitrites are either in traces or absent indicating absence of pollution.

As far as radio-activity is concerned, WG_2 registered a very low level of both aplha and beta activity which are well below the permissible limits for drinking water. Concentration at WG_2 showed presence of very low levels of pesticides. This could be possibly either due to slight leakage through the tubewell casing pipe or due to recharge via upper shallow aquifer which receives the run-off containing non-point pollution. However, since WG_2 is a flowing well from a semi-confined aquifer, the second reason could be more plausible.

Alkali earth metal concentrations are within normal limits. However, the Sodium/Potassium ratio is somewhat different from normal range. Heavy metals are generally of low concentration except Nickel and Lead. Toxic substances like Arsenic, Selenium, Cyanides and Phenolic compounds are either absent or below detectable limits. With respect to Bacteriological parameter, water quality is good.

In general, it can be concluded that groundwater is good and there is no evidence of contamination. There are no major industries within the plant area. The existing industries are either minor agro-based or household e.g. coir and allied industries, candle making, ice-plants, safety matches etc. None of these require substantial quantity of water,

therefore, do not contribute much to pollution by industrial waste water.

3.5 SEDIMENTS:

Since the sediments are derived from erosion of rocks the metal concentration in the sediments inherit the composition of the parent rocks. In addition, certain minerals in sediments take up metals from the surrounding aquatic environment and therefore may often reflect the metal composition of the depositional environment itself. However, there is no worldwide acceptability on the composition of unpolluted vis-a-vis the polluted sediments. It is, therefore, often a practice to compare the metal composition of sediments with the average composition of metals in crust rocks. In this area, Hg and Ni concentration in sediments are much lower than that of the crust rocks. The copper concentration is not consistent and shows wide variation without any spatial distribution. In crust the average concentration is about 70 mg/kg. Though in most cases, the concentration in sediments of the area exhibit a lower value than the reference, higher values in the range of about 130 mg/kg have also been reported. Pb also exhibits a marginally higher value. However, it needs be mentioned that most of the Pb present in sediments are generally associated with organic matter as chelates and are fixed in the sediment matrix. Due to such fixation tendency, they are not leachable.

Fe in the sediments are rather high. Most of the sediments of Kerala coast are weathered products of charnokites and pegmatites are therefore do contain significant amount of Fe even in unpolluted environment.

In general, the sediments of Kayamkulam area do not reflect any abnormal deviation of metal concentration from the natural sediments of the Kerala coast.

3.6 SOIL:

The data in this section is based on scientific literature survey and soil sample analysis in the laboratory following standard analytical procedures.

3.6.1 Classification and Properties of Soils:

The major part of the Alleppey district is covered with laterites, greyish Onattukara and riverine alluvial soils. The lateritic and greyish Onattukara soil is interspersed in patches of brown hydromorphic saline soils. The coastal areas are covered with coastal alluvium soils. Riverine alluvium soils lie along the courses of rivers Pamba and Achankovil and their tributaries, whereas acid saline soils are observed to be concentrated in the vicinity of Vembanad lake.

In the Alleppey district sandy soils cover Karthikapally, Mavelikara and Ambalapuzha taluks while clay loam with much acidity is found in Kuttanad taluk. Chengannur and part of Mavelikara taluk is covered with laterites and so is the Kunnathur taluk of Quilon district, part of Changanacherry of Kottayam district and Thiruvalla, Mallappally, Kozhencherry and Adoor taluks of Pathanamthitta district. Karunagapally taluk of Quilon district is covered with sandy soil. The panel diagram of soil of Quilon-Kayamkulam area is presented at Fig. 3.6.1.

3.6.2 **Characteristics of Soil around the Plant Site:**

The plant site and the surrounding area consist of 4 major soil series.

1. Kavur series (Dry land series of coastal area).
2. Ariyad series (Soils of Kayamkulam Kayal area).
3. Champakulam series (Wet land series of Karipuzha Punja which is distributed in the low-lying areas).
4. Mannar series (Dry land series consisting of soils west of Karipuzha Punja and east of Kayal farm, i.e. plant site).

The land is flat with no crops except a few of salt tolerant variety of grass. The section of the dug pit profile did not show clear differentiation indicating the recent origin of the sand deposit. However, following three layers could be faintly observed:

Horizon	Depth (cm)	Description
1	0-15	Coarse sand somewhat compacted with grass roots light grey in colour.
2	15-65	Light grey with bleached appearance.
3	> 65	Dark grey sand, red streaks appearance
Drainage		Well drained
Permeability		Very high
Use & Vegetation		Agricultural with some salt tolerant grass growing.

The soil is predominantly sandy in nature with low to medium silt and clay fraction (Table 3.6.1). The CEC and NPK (Nitrogen-Phosphorous-Potassium) values are low indicating poor fertility.

3.7 METEOROLOGY:

For the purpose of study of base line meteorological conditions, a surface meteorological observatory was operated near the plant site in order to record the following meteorological parameters :-

a) Temperature

b) Humidity

c) Rainfall

d) Wind

In addition, data from the nearest full-fledged Meteorological Station maintained by IMD at Cochin were also collected. These data are used to compare the one year field data generated near the plant site for meteorological observations.

3.7.1 Interpretation of Past Data:

Cochin is located at a distance of about 80 km NNW of the project site. A brief description of the data related to temperature, humidity, barometric pressure, rainfall, wind patterns and occurrences of inversions are described in the subsequent paragraphs.

(a) Temperature:

Generally March and April are the hottest and December and January are the coldest months. The mean of daily maximum temperature is 29.8 ^{o}C and that of minimum temperature is 24.4 ^{o}C.

(b) Humidity:

At morning hours, the relative humidity is high. During June to September, air is more moist and the relative humidity is still higher. The relative humidity is low during January and February (68% to 72%). During the evening hours, the relative humidity is less compared to morning hours.

(c) Rainfall:

Based on 1901-80 data, it is reported that the coastal plains recorded 2909 mm, the uplands recorded 3073 mm and the hill ranges recorded 3197 mm of normal annual rainfall. The south-west monsoon contributes the major part of the rainfall as compared to the north-east monsoon. The mean annual rainfall at Cochin is 3099.1 mm.

(d) Wind:

Monthly wind rose diagrams of Cochin averaged over a decade are presented in Fig. 3.7.1 and 3.7.2 for 08-30 IST and 17-30 IST respectively. During January and February, the prevalent wind direction is from E or NE in the morning hours, whereas the direction reverses in the evening hours. This reversal of direction due to land and sea breeze is evident almost all over the year except during the SW monsoon (June-September). During this period, the morning wind rose shows a pattern of gusty wind but the wind direction in the evening shows a distinct pattern with prevalent wind from NW or W. The percentage of calm is also high during this season varying from 19% to 30% in the morning hours. However, the percentage of calm is quite low in the evening hours during this period. During October to December, while the percentage of calm shows a similar pattern of high frequencies in the morning and low in the evening, the prevailing wind direction blows from E or NE in the morning and from W or NW in the evening. The most prevalent wind speeds fall in the range 12-

19 km/h during evening hours, whereas those in the morning hours are in the range of 6-11 km/h. Higher wind speed (>19 km/h) usually occurs in the evening hours particularly in the winter and also early part of summer.

3.7.2 Meteorological Observation at Site:

A surface meteorological observatory was operated near the plant site in order to observe meteorological parameters such as temperature, humidity, rainfall, and wind.

The above mentioned meteorological parameters were observed in the field over a period of 12 months. The brief description of the parameters is given in the following paragraphs:

(a) Temperature:

The mean monthly maximum temperature ranges from 24.2 ^{o}C to 32.6 ^{o}C and the mean monthly minimum temperature ranges from 23.5 ^{o}C to 29.7 ^{o}C. The annual mean maximum and minimum temperature is found to be 30.04 ^{o}C and 25.23 ^{o}C respectively.

(b) Humidity:

The percentage of relative humidity during morning hours is observed to be higher than that during evening hours. The relative humidity in the morning hours ranges from 91.8% to 93.9% during June to September and 90.8% to 93.7% during October to December.

(c) Rainfall:

The total annual rainfall recorded in the project site is 2085.25 mm, out of which 1507.00 mm (72.26%) is contributed by SW monsoon and 555.00 mm (26.61%) by NE monsoon.

It may be noted that the total rainfall of 2085 mm observed is substantially less than long term average of 3099 mm at Cochin. This is corroborated by the fact that the rainfall near the plant area is usually less (2500-2000 mm) compared to that of Cochin.

(d) Wind:

The seasonal wind rose diagrams have been prepared and presented in Figs. 3.7.3 to 3.7.6. In the evening the prevalent wind direction is towards the land side and is considered important for the transport of air pollutants. The annual wind rose diagrams are also presented both for morning and evening hours in Fig.3.7.7. On an annual basis, the percentage of calm is about 20% in the morning and about 14% in the evening with evening wind speed also registering higher speed ranges as compared to those in the morning hours.

3.8 AIR QUALITY:

3.8.1 Monitoring Schedule:

A 24 hours sampling programme with 8 hours of cycle was undertaken using High Volume Sampler. Sampling frequency was twice a month for one year.The sampling locations are presented in Figure 3.4.1.

Particulate Matters: This was measured as the concentration of all solids and liquid particles averaged over a period of 24 hours by blowing known volume of air through Whatman Fibreglass Filter papers and then taking its difference in weight (BIS 1973).

Sulphur Dioxide: Sulphur dioxide present in a known quantity of air was absorbed in a solution of hydrogen peroxide at about pH-4 and the resulting increase in acidity which is proportional to SO2 absorbed was determined by titration with sodium hydroxide solution (BIS 1969).

Nitrogen Oxides: A known quantity of air contaminated with nitorgen oxides was bubbled through a solution of sodium hydroxide forming a stable solution of sodium nitrate whose concentration was then measured colorimetrically by the reaction of an exposed absorbing agent with phosphoric acid, sulfanilamide, and NEDA (BIS 1975).

3.8.2 Results and Discussions:

The results of the ambient air quality monitoring are summarised in Table 3.8.1.

The annual average level of SPM around the project area (i.e. average of all the three sampling stations) is 47.31 ug/m^3. However, the SPM varied in the range of 13.83 ug/m^3 at Station A_1 in the month of September to 88.12 ug/m^3 at location A1 in the month of January. The average SPM concentration is low and is well within the prescribed limits.

The region has limited industrial and constructional activity and is covered with green vegetation. This associated with intermittent precipitation may be the probable reason for low SPM levels in the region.

The Annual average level of NO_x in the area varies from 26.10 ug/m^3 to 41.14 ug/m^3. The NO_x levels can be attributed due to traffic. The baseline SO2 levels in the area are below detectable limit.

3.9 TERRESTRIAL ECOLOGY:

The floristic and faunal composition of the core and general areas have been evaluated based on the available literature and field survey carried out in the area and

satellite imageries data. Further, no ecologically sensitive area exists. No forest falls within the 30 km. 'general area' of study.

3.9.1 Flora:

In fact, the land covered with water for more than six months in a year and the extreme saline conditions have deprived forest growth in the core area. The area enjoys both south-west monsoon (June to September) and north-east monsoon (October to November).

The tropical conditions in Kerala support luxurious vegetation with a great diversity of species. Changes in the vegetation of the area stem mainly from either conversion into agricultural lands or due to monoculture practices. For convenience of field study, core area was divided into two main radials - Northern and Southern, with the Kayamkulam (Plant Site) as a central point.

3.9.1.1 Vegetation Pattern:

During the field studies, a total of 267 species were identified. Among these, the herbs account for 61%, shrubs (16%), trees (14%) and grasses (9%).

The main floristic composition is a mix of grasses, herbs, shrubs and trees. The low lying plant area is covered mostly by grasses and herbaceous species, while on

the banks, by coconut plantations. Apart from the plant site, the Northern and Southern radials also exhibit similar floristic composition. Some of the fruit yielding plants like mango and jack trees were found infested with 'epiphytes'. A total of 21 species of grasses; 164 species of herbs; 44 species of shrubs; and 38 species of trees were recorded in the core area (10 km. radius) as listed in Table 3.9.1.

3.9.1.2 Extension of Cultivable Area:

Some of the areas adjacent to plantations were under cultivation with a few commercially important plantations like banana, papaya,castor and a few field crops like, lemon and pineapple. These are in low proportions as substitute crops in tapioca fields and in coconut gardens. Eucalyptus and casuarina plantations have also been developed in some areas.

3.9.1.3 Agriculture and Agronomy:

The agriculture sector of this area has a number of distinctive features. It seems that agriculture is more commercialised in this area. The technical setup of the agricultural system is unique leading to formation of "HOMESTEAD CULTIVATION" (also known as "INTEGRATED CULTIVATION" which combines association of food and commercial crops, rearing of livestock and fisheries.

There are two major cropping patterns : (a) Food & Commercial crops, (b) Plantations of commercial trees. Higher proportions of the area is under cultivation of commercial plantations (43.5%), followed by food crops (33.5%). The important commercial field crops are condiments and spices (12.5%).

Paddy is the most important field crop. Next to paddy is Tapioca. The important crops grown are pepper, coconut, and cardamum etc. Other field crops like ginger, sesamum, and betel are occasionally raised as garden crops.

The plant area is waterlogged practically throughout the monsoon season. The agro-system which could be categorised into coconut base farming, upland rice farming and homestead farming has a direct bearing on the soil characteristics of the area. Aquatic species such as Nymphea- Eicchornia and certain other weeds prosper during monsoon season in the watterlogged conditions.

3.9.2 **Fauna:**

Unfortunately, human activities and increased farming have consistently disrupted the delicate ecosystem on which animals depend for their survival.

The wild animals include Lutra vulgaris (otter) in the backwaters, Mus rattus (Indian rat), and Mus musculus (mouse) in the paddy fields. The domesticated animals comprise of cattle, buffalo, goat, cat, dog etc. as in the other surroundings. The fowls and ducks are quite common.

At plant site dominant vertebrate fauna is mainly of bird species. The avian fauna is in greatest abundance and variety is usually associated with aquatic bodies. The names of amphibians, reptiles,birds and mammals observed in the study area are presented in Table 3.9.2.

3.10 AQUATIC ECOLOGY:

The proposed power plant is located on the fringe of the backwaters of Kayamkulam lake. It has three interconnected major water bodies - the fresh water, the brackish water and marine. Consequently, the eco-systems together exhibit a high level of diversity. Within the study area, Kayamkulam Kayal and the rivers Pamba and Achankovil are of importance in addition to coastal waters.

3.10.1 Biological Characteristics of Kayal:

The distribution of micro and macro flora and fauna in the lake closely follows the pattern of salinity gradient. The monsoon influx is associated with a predominance of fresh water forms and the eruyhaline species whereas

the dry season shows a conspicuous dominance of the salt water varieties. The distribution of species within the lake at a given time too shows strong affinity to the salinity gradient. The lake is, however, generally dominated by the euryhaline brackishwater inhabitants.

The important diatoms observed in the kayal are Rhizosolenia, Chaetcoceros, Pleurosigma, Pinnularia, Thallassiosira, Concinodiscus, Biddulphia. and Blue Green Algae are Microcystis, Spirulina, Oscillatoria.

Among fauna four groups viz. Protozoa, Coelenterates, Annelids and Arthropodes are recorded out of which Arthropodes is the most dominant. Zooplankton distribution in the backwaters is well associated with the salinity distribution, exhibiting a positive correlation. The abundance of planktonic fishes, invertebrates, and their young ones have a direct bearing on the concentration of zooplankton.

3.10.1.1 **Benthic Fauna:**

The bottom fauna in the backwaters are mainly composed of ilogochaetes, polychaetes, bivalves and crustaceans. The bottom fauna recorded are: Nimertinea, Gastrotraclia, OIigochaetes, Polychaetes, tanaid worms, isopods, amphipods, sipunculoids, gastropods, and bivalves.

3.10.1.2 Fish Fauna:

The chief fish and prawn varieties constituting the fishery are listed in Table 3.10.1.

3.10.2 Aquatic Ecology of Achankovil River:

The river Achankovil is one among the 41 west-flowing rivers of Kerala and originates at Western Ghats. It seldom exceeds 100 km. in length. Though the river is a perennial one, water remains shallow barring a few deep pools, during the non-monsoon season.

No detailed account of the limnological status of the river is available. A list of fishes caught from the river is listed in Table 3.10.2. The list has been prepared based on personal queries, since no organised fishing is practised in the locality.

3.10.3 Adjoining Marine Aquatic Ecosystem:

The south-west coast of India is one of the most productive marine zones and contribute substantially to the marine landings in India. Therefore, the aquatic ecosystem of the adjoining coast has been discussed here briefly.

3.10.3.1 Plankton and Productivity:

All along the west coast of India, the rate of primary production was of significantly high order (over 1.0 g C/m^2/day), especially during the S.W. monsoon. The standing crop of phytoplankton was high with maximum during July or August (200,000 - 29,000,000 cells/L). Nanonplankton constituted 30-85%, at times upto 96% of the total phytoplanktons.

3.10.3.2 Fisheries and Fish Landings:

Kerala ranks second among all the states of India in marine fish landings. In 1984-85, the total landings from Kerala amounted to 0.3775 million tonnes. The catch per hour of bull trawling was 10025 kg. With regard to the availability of prawns, the most productive zones lie in the inner half of the continental shelf adjoining river mouths and bar mouths of lakes. The lakes are known to be good nurseries for important penaeid prawns. Apart from the landings from the sea, the inshore waters also serve as good seed collection sites for penaeid prawns. Prawn farming is widely practised along backwaters of Kerala.

3.10.3.3 Mud Banks:

In the inshore waters of Alleppey region, extending upto Calicut, there is a vertical acceleration resulting in the lifting up of silt-ladden bottom waters. This silt is

kept in a state of suspension extending over wide region popularly known as mud banks. The area is store house of nutrients like phosphates promoting rich plankton production. The abundance of plankton attracts crustacean groups and shoals of pelagic fishes, such as prawns, sardines, mecker-els, soles, etc. This phenomenon at the south-west coast is a boon for fishermen giving them an opportunity for a bumper harvest. Mud banks are cyclic phenomena associated with the south-west monsoon.

3.11 NOISE:

3.11.1 Base Line Noise Study:

There exists no information on background or ambient noise levels either within the core area or the general area. A baseline noise monitoring survey was undertaken with due consideration to locational aspects, daily and seasonal variations and characterisation of noise environment. The sampling locations selected are presented in Fig. 3.4.1.

3.11.2 Base Line Noise Levels:

The equivalent continuous sound pressure level over 8 hour averaging period (L_{eq} - 8h) at each location for both day and night was calculated and is presented in Table 3.11.2.1. It is obvious that the overall noise level in and around the proposed project site at present is low. This is because there is no heavy industry and construction work in the area.

CHAPTER IV

4.0 ENVIRONMENTAL IMPACT

The proposed project would create impacts on the environment in two distinct phases:

i) During the construction phase which may be regarded as temporary or short term.

ii) During the operation phase which would have long term effects.

The environmental impacts in this study have, as such, been discussed separately for the construction phase and the operation stage.

The constructional and operational activities would affect the various domains of environment such as air, water, ecology, population etc.

4.1 CONSTRUCTION IMPACT

4.1.1 Demography and Socio-economics:

The manpower and workforce requirement during construction is given in Section 1.2.2.8. During construction, the contract labour would be about 2700 and NTPC employees would be 67.

The impact of the CCPP would begin to be felt with the start up of the construction activities.

a) The non-workers (including marginal workers) in the general study area constitute about 75% of the population. The agricultural labourers constitute more than 30% of the workforce, indicating availability of sizeable man-power required for the construction activity.

b) As the labourers are generally non-skilled the locals would get opportunities for employment during construction activities.

c) In addition to the opportunity of getting employment as construction labourers, the local population would also have employment opportunities in related service activities like petty commercial establishments, small contracts/sub-contracts and supply of construction materials for buildings and ancillary infrastructures, etc. Consequently, this may lead to economic upliftment of the area.

The sudden influx of a large number of people in search of job opportunities is likely to bring in the inherent problems of rapid urbanisation to the area. The social conflicts between the guest and host communities are expected in the initial stages of development. This is expected to get stabilized in a short period.

4.1.1.1 Population Expectations:

People in the locality generally welcome the project and willing to surrender their land, provided that the agency effect the compensation as early as possible.

Availability of land, such as, that of the land of Government and the flood affected areas limited the acquisition of fertile land. These are the reasons for the majority of the respondents favouring the decision in selecting the project site.

The effects of the low power generation, slow growth of industries and educated unemployment in the State forced the majority of the people to give a positive outlook towards the need of a thermal power plant in the state.

Considering the Rehabilitation option put forth by the respondents majority opted for cash compensation.

When the imapct of the project on various aspects of life of people are concerned, majoriity of the people expect for a positive change except in the field of agriculture.

NTPC would undertake suitable community development activities in the surrounding villages depending upon their needs and requirement. These may include construction of approach road, school, building, community hall, drinking

water and hospital etc.

4.1.2 **Soil:**

As the land is not rocky, no blasting is envisaged. The level of plant site will be raised to a formation level of RL (+) 2m. The fill material will be obtained through dredging the kayal. The details of dredging activity are presented at Section 2.3.

The construction activities will result in loss of vegetation and top soil to some extent in the plant as well as township areas. The gestation period of the combined cycle power project is, however, short. Apart from very localized construction impcts at the plant site and township, no significant adverse impact on soil in the surrounding area is anticipated.

4.1.3 Land Use:

The total land requirement for the project is 313 acres out of which 180 acres are Govt. land and balance 133 acres are private land. The land acquisition is in accordance with Land Acquisition Act, 1894.

The construction of Combined Cycle Power Plant would bring in certain immediate changes in the land use pattern of the proposed area as well as in the vicinity. The likely changes in the land use would be in the following areas :

a) Reduction in the net agricultural land because of acquisition for township.

b) The construction activities would attract a sizeable labour population and the influx of population is likely to be associated with construction of temporary hutments; leading to agricultural land getting converted to other uses. This, however, would be temporary especially in case of a combined cycle plant where the gestation period is short.

4.1.4 Air Quality:

During construction phase, suspended particulate matter will be the main pollutant which could be genrated from site development activities and vehicular movement on the road. However, concentration of NOx and CO may also slightly increase due to increased vehicular traffic movement. To mitigate these impacts, regular sprinkling of water will be done at the construction site. As Kerala has mostly wet climate condition, fugitive dust emission is expected to be low. The approach road will be black carpeted and vehicles will be kept in good order to minimise automobile exhaust.

The impact of such activities would be temporary and restricted to the construction phase. The impact will be confined within the project boundary and is expected to be negligible outside the plant boundaries. Proper upkeep and maintenance of vehicles, sprinkling of water on roads, pro-

viding sufficient buffer vegetation etc. are some of the measures that would greatly reduce the impacts during the construction phase.

4.1.5 Terrestrial Ecology:

The preparatory and construction activities at the site result in the land degradation, inward migration and intensive vehicular movement. The primary influence of such activities is seen in the loss of productive agricultural land. The agricultural system with the predominant cocunut and paddy cultivation would get disturbed to some extent. On the contrary, the damage to the wild vegetation relates to the elimination of herbaceous and shruby species. These impacts are, however, restricted to the early phase of construction.

The dust loadings on some common plants reported by Yunus et al. have been presented in Table 4.1.1. It is apparent from the table that various morphological features among the species are efficient in the trapping of particles in air. A few species such as Calotropis, Ipomea, Eucalyptus could serve well for the dust control during construction phase.

The construction activities concurrently promote inward migration of large labour force demanding fuel and temporary shelter. These evidently impart burden on the trees around.

In addition to the above impacts, intensive vehicular traffic disturb the natural floristic and faunal components.

The inevitable but negligible direct and indirect impacts of construction activities could be well substantiated through appropriate afforestation programmes. Such species adapt well not only to the dust nuisance but also serve often as sink for gaseous pollutants.

4.1.6 Aquatic Ecology:

Condenser cooling system is proposed to be based on cooling towers. It is relevant to note that the incoming cooling water would be chlorinated to prevent biological fouling of condenser tubes.

As the water will be drawn from Achankovil river which does not harbour aquatic species of importance, there will not be any significant impact due to intake of water. The impact due to dredging of the kayal during construction is discussed in Section 4.2.10.

4.1.7 Noise:

The major sources of noise during the construction phase are vehicular traffic, construction equipments like dozers, scrapers, concrete mixers, cranes, generators, pumps,

compressors, rock drills, pneumatic tools, saws, vibrators, etc. The operation of these equipments will generate noise ranging between 75-90 dB(A).

The predicted noise level due to operation of such equipments at a distance of 1000 m (far field) from the source is 40 dB(A). The ambient noise level recorded during field campaign in the nearby villages located approx. 1000 m from the site ranged between 14 to 46 dB(A). As the ambient noise levels are higher than the predicted noise levels, due to the masking effect, no increase in the ambient noise level during the construction phase is envisaged.

The noise generated during the construction phase from various equipments will have some adverse impact on the operators. Provision of ear plug/ear muffs/masks as the case may be to operators likely to be exposed to higher noise levels will minimise/eliminate such an adverse impact.

4.2 OPERATION IMAPCT

4.2.1 Demography and Socio-economics:

The manpower and workforce requirement during operation is given in section 1.2.2.8. During operation, the number of contract labour would be about 330 and NTPC employees would be 346.

a) Along with the new township, a service town is expected to come up with about one third population of the

project township. The principal characteristics of the township would be to cater to the service requirements of the project township and engagement in ancillary industries.

b) The present trend of out migration for employment is likely to reduce due to better economic opportunities available in the area.

c) With the establishment of the CCPP, the area would also experience a sectoral shift towards non primary activities which is likely to boost the economy considering the lower returns from poor quality of agricultural land in the area.

d) The dynamics of population growth once set in the area is likely to pick up with the establishment of ancillary industries and associated service activities.

e) With the commissioning of the plant, avenues would open up for the unskilled labour in the transportation sector and service industry catering to the township.

4.2.2 Soil:

Combined Cycle Power Project operates on clean fuel and there is no solid waste generated in the form of ash. The scale of operation is also much smaller as compared to coal based projects. Under these circumstances, the operation of the proposed project will have practically no impact on the soils of the area. Whatever marginal impact caused during the construction phase will get mitigated during operation

phase. Implementation of plantation programme during operation will further stabilize the soils to a great extent.

4.2.3 Land Use:

The changes that are likely to occur during operation would be related to the following:

a) Shift in occupation or sectoral changes would require more land for non primary activities. The forces of urban dynamics would put tremendous pressure on land especially near the permanent township and service township. The proximity of all these urban centres to each other would increase the pressure on the areas in between.

b) Ribbon developments for commercial and service industries are likely to take place along the national highway. Speculations on land would also contribute to the upsurge of these uses along the major arterials and around the existing urban centres.

c) Pressure on land would increase due to ancillary industries and other service activities.

4.2.4 Water Use:

It is envisaged that sweet water requirement for the plant and township will be met from Achankovil river. The requirement for the plant is only a minute fraction of the net availability (1654 MCM) of water resource in the area. Furthermore, there is no major user of fresh water from the

river Achankovil downstream of the proposed point of abstraction. This indicates that there would be no or little alteration of the situation of fresh water usage and availability downstream.

A commitment to supply make up water for the plant is available from the State Irrigation Authorities. As per the information available, the anticipated minimum flow downstream of the weir would be of the order 600,000 m3/day. About 2000 people depend upon the river water downstream with an average per capita consumption of 75 litres only. The total requirement, therefore, would be 150 m3/day and hence there would be absolutely no impact on availability due to construction of weir.

The water in the reservoir will not stagnate because of constant inflow and outflow and therefore may not create any health problem. The organic debris, if any would be regularly cleaned and thus there may not be any eutrophication of the reservoir water. However, if mosquitoes menace occurs, suitable measures would be applied to eradicate it.

4.2.5 Water Quality:

Impacts on water quality could be caused by disposal of waste water from cooling tower blowdown, wastewater from DM Plant, plant effluent and domestic wastewater. All these effluents will be treated in respective waste water treatment

units as detailed in Section 2.13. All the treated waste water will be discharged through Central Monitoring Basin (CMB). The discharged treated effluent will conform to standards prescribed by Ministry of Env. & Forests, Govt. of India.

4.2.5.1 Impact due to water effluents:

All the effluents will be treated to meet the regulatory standards. Therefore, adverse impact on receiving water body (Kayal) is not anticipated. However, it is proposed to monitor the status of biota of kayal once in two years to assess the impact of discharge of treated waste water on aquatic life.

4.2.5.2 Impact due to Domestic Wastewater:

The domestic wastewater will be biologically treated tc meet the statutory requirement and hence it is unlikely that there would be any adverse impact on receiving water.

4.2.6 Air Quality:

Naphtha is proposed as the main fuel, the combustion of which will not result in any particulate emission.

The short term incremental ground level concentration (glc) due to emissions of NOx and SO2 have been computed on a 24 hourly basis through a computer based mathematical model. The results of the prediction are presented in Table 4.2.6.1 & 4.2.6.2.

The pollutant dispersion is generally dependent on the direction and speed of wind prevailing over the area. The site meteorological data indicate that the most probable wind speed at the site is about 2m/sec.

The incremental ground level concentration of pollutants show a decreasing trend while moving from stability class A to F.

The maximum short term 24 hourly predicted incremental glc of NOx is 10.98 ug/m3 occurring at a distance of 2 km. This maximum value corresponds to the wind speed of 2 m/s in the stability category as determined by Pasquill stability classification. The maximum glc of SO2 under similar conditions is 2.78 ug/m3, at 2 km. distance.

The ambient levels of SO2 in the area remain below detectable limit. The incremental contribution of only 2.78 ug/m3 due to plant operation is not likely to deteriorate the existing air quality.

The average level of NOx on a 24 hourly basis in the ambient air is 34.40 ug/m3. The addition of only 10.98 ug/m3 to this background level will result in an ambient NOx level of 45.38 ug/m3 which is well within the stipulated limit of 120 ug/m3. Therefore, it can be concluded that the operation of the plant will not affect the air quality of the area.

4.2.7 Terrestrial Ecology:

The levels of NOx and SO2 in ambient air after operation of CCPP are expected to be within the levels stipulted by regulatory agencies and hence no active injury to the vegetation is expected.

It is proposed to include *Azadirachta indica*, *Ficus religiosa* and *Ficus recemosa* in the afforestation programmes as they serve as sink for gaseous emissions.

4.2.8 Aquatic Ecology:

All small organisms (phytoplankton, zooplankton, fish eggs and larvae) are entrainable and subject to passage through the power plant cooling system. The organisms experience a combination of thermal and mechanical stress. Due to operation of cooling water system with closed cycle cooling towers, the chances of survival of entrained organisms are, however, remote. The loss to the biota will, however, be limited since requirement of make up water is low. Since the cooling tower blowdown will be from the colder side of the cooling cycle, thermal pollution is totally avoided. Therefore, no impact on aquatic ecosystem of the kayal is envisaged due to cooling water discharge.

The cooling tower blowdown and other plant effluents will be collected in the Central Monitoring Basin after treatment and will be discharged into the Kayal. As discussed in Section 4.2.5, water quality of Kayal water will

not change significantly, hence no impact on the aquatic biota is expected.

4.2.9 Noise:

The major noise generating units in a combined cycle gas based power plant are turbines, turbo-generators, compressors, pumps, fans, etc. Noise is continuously generated from such sources. The design noise levels for different equipments are still to be finalised. However, a typical 90 dB(A) combined Leq level has been assumed during operation for computing the impacts.

For computing the noise levels at various distances with respect to the plant site in general and the turbo-generator bay in particular, noise propogation analysis was undertaken.

The noise computed at a farfield distance of about 1000 m is of the order of 40 dB(A) during the operation of the plant. The ambient noise level recorded in the nearby villages located at a distance of about 1000 m from the plant site ranges from 14 to 46 dB(A). As described earlier, due to the masking effect, the ambient noise level in the nearby villages will not increase during the operation of the plant. Hence, there would not be any adverse impact due to the operation of the plant on the residents in the nearby villages.

The operators, workers and other personnel within the plant, however, may be affected unless protective measures are taken. According to Occupational Safety and Health Administration (OSHA) Standards, the allowable noise level for the workers is 85 dB(A) for 8 hours exposure a day. It could be seen that in the plant premises many of the machineries/equipments generate noise levels above 85 dB(A) continuously. Therefore, adequate protective measures in the form of ear-muffs/ear plugs to the workers working in high noise areas need to be provided. In addition, reduction in noise levels in the high noise machinery areas could be achieved by adoption of suitable preventive measures such as suitable building layout in which the equipments are to be located, adding sound barriers, use of enclosures with suitable absorption material, etc.

4.2.10 Impact of dredging on Aquatic life of kayal:

The impact of dredging on Kayal aquatic life would be marginal. State Irrigation Department has clarified that State Govt. have taken into consideration the environmental aspect also while permitting NTPC to carry out dredging operation.

A study was also undertaken through Department of Aquatic Biology and Fisheries, University of Kerala, to assess the aquatic (biology) of the Kayal. The study also

covered the possible adverse impacts due to dredging on the aquatic eco-system of the Kayal. The findings of the study indicate that:

"The dredging activity is stated to be a one time activity covering largely, the area of the Kayal adjacent to the proposed plant. If this is so, the impact would be minimal. Flood waters of the Pamba and the Achankovil rivers joining the Kayal at its northern extremity through a net work of canals would be depositing huge quantities of land borne sediments in the dredged area and would replenish the sediment extracted from the basin.

The fauna of the Kayal sediments would be destroyed in the area proposed to be dredged. The life-cycle of benthic organisms would be able to resettle in the dredged basin once the dredging activity is over."

The report has suggested the following :

i) The area proposed for dredging may be limited to a maximum length of 6 Km covering area adjacent to the project site. However, NTPC is proposing to dredge only 1500 mtrs., therefore, the impact would be further minimised.

ii) The dredging activity should be completed within the shortest time possible. NTPC will complete the dredging activity within a period of one year.

All measures may be taken to ensure the stability of the land strip between the sea and the Kayal. The mitigative measures for the stability of the slope has been described at Section 2.3.

The following precautions would be taken while dredging:

i) Although Govt. order, permits dredging for 12 km. of the kayal, it may be limited to a maximum length of 1700 m.

ii) The dredging activity would be completed within the shortest time possible (one year), so as to minimise the period of disturbance in the kayal.

iii) The stability of the landstrip separating the kayal from the adjacent sea would be ensured while undertaking deeper dredging.

v) A programme to strengthen the kayal banks would be formulated, if necessary and implemented as a long term measure to guarantee the ecological balance of the area being dredged.

.3 ANALYSIS OF ALTERNATIVES

.3.1 Site Selection:

The site for the power station was selected by the erala State Electricity Board (KSEB) from amongst seven lternatives considered by them. Kerala State is densely opulation and Government land free from habitation is exremely scarce. The present site offers a distinct advantage hat the entire area for the power plant is Govt. owned land nvolving no displacement of persons. Some private land is, owever, required for the township and corridors for approach oad and sweet water make up line. Moreover, assured availbility of sweet water in the nearby vicinity makes this site he ideal choice from all considerations and was, therefore, inally selected for putting up the power project.

.3.2 Site Alternatives:

Following alternative sites were considered:

a) Brahmapuram Site: This site is near Ambalamugal in rnakulam District. It was not persued because of environental constraints in the area.

b) Alleppey Jetty Site: The site is located at a listance of 3 kms. from the proposed railway station. It was ejected as the area is densely populated and would pose roblems of displacement of persons.

c) Karinugapally Site: The site is located at a distance of approx. 15 kms. from Karunagapally Railway Station. It was found to be densely populated and hence not persued.

d) - Site near proposed fishing harbour at Kayamkulam: The site is approx. 12 kms. from Kayamkulam Railway Station and involves displacement of families as well as uncertainty regarding availability of land. The site was, therefore, not considered.

e) Nilambur site near Manjeri: The site is located at a distance of approx. 12 kms. from Nilambur Railway Station. The land belongs to private cultivators and could involve large displacement of persons.

f) Malampuza near Palghat: The site is located at a distance of approx. 3 kms. from Kanjivode Railway Station. It was rejected as no water was available for the plant and colony requirements.

- Kayamkulam site in Kayal Reclaimed area (selected site): This site is located at a distance of approx. 10 kms. from Kayamkulam Railway Station. The entire land for the plant area is govt. land which is readily available and involves no displacement of persons.

4.3.3 Justification for project:

4.3.3.1 DEMAND SUPPLY SCENERIO:

The power supply position for the southern region and for Kerala State during the period 1977-78 to 2001-02 (Nineth Plan) indicates that there would be considerable shortage both in terms of peak demand and energy requirement during the entire nineth plan during which the project is expected to progressively yield benefits. The peak load and energy deficit for the southern region by the year 2001-02 would be (-) 12.6% and (-) 6.9% respectively and for Kerala State, these projections are (-) 26.4% and (-) 34.8% respectively. The above scenerio is based on an installed capacity of 35723 MW for the southern region by the year 2001-02 which includes benefits from Kayamkulam Project (420 MW). Hence, the need for the project is fully justified. Moreover, Kerala State has already agreed to purchase the entire power from this station (if it is not considered as a regional station)) and a Power Purchase Agreement has been signed with them.

4.3.3.2 LOCATION OF PROJECT:

The State of Kerala is presently entirely dependent on hydro power and in the eventuality of failure of monsoons, the power supply position becomes very erratic and critical.

The present project would provide the required thermal back up in the State and stabilise the system.

It is also clarified that the Central Electricity Authority conducts long term generation expansion studies for determining the desirable/optimal options to be taken up for implementation from a set of power projects in a given time frame (say a five year plan) so as to meet the power demand in that period 1985-2000 (National Power Plan). Coal based Kayamkulam project (2x210 MW) had been included for implementation.

4.3.4 **Least Cost Options:**

In order to establish the economic viability of Kayamkulam CCPP, a least cost system study was conducted by CEA. The report has been submitted to the World Bank by NTPC. The study establishes that Kayamkulam CCPP fits in the least cost system expansion programme in the Southern region.

CHAPTER V

5.0 ENVIRONMENTAL MITIGATION/MANAGEMENT PLAN

a) SUMMARY OF ANTICIPATED ADVERSE ENVIRONEMNTAL IMPACTS AND MITIGATION

DISCIPLINE	POTENTIAL NEGATIVE IMPACTS	PROBABLE SOURCE	MITIGATIVE MEASURES	REMARKS
CONSTRUCTION IMPACT				
Water Quality	Incrase in suspended solids due to soil run off during heavy precipitation.	Soil Erosion.	Temporary sedimentation Tank.	-
Air Quality	Increase in dust concentration.	Heavy vehicular movement.	Regular sprinkling of water in the construction area.	The impact will be low as the main approach road is tarred.
Sediment	-	Dredging of the Kayal.	) No significant) impact.	-
Aquatic Life	-	Dredging of the Kayal.	))	-
Noise	Higher noise level.	Construction equipments.	Equipments will be kept in good condition to keep the noise level within 90 dB(A).	Workers will be provided necessary protective equipment e.g. ear plug, ear-muffs.
Socio-economics.	Population displacement.	Land Acquisition.	Proper R&R measures.	Refer Section 13 of the report.
OPERATIION IMPACT				
Water Quality	Deterioration of water quality of surface water.	Discharge of Main Plant, Cooling Tower, Water Treatment Plant waste, boiler blow down and Township Effluents.	Adequate treatment facilities like neutralisation pit, settling ponds, biological treatment system etc. will be	All effluents after accord treatment will be led to a central monitoring basin and finally discharge into the Kayal. Analysis

			provided so that the treated effluents conform to the regulatory standards.	of all relevant parameters on heavy metals in the effluent is included in the monitoring programme. STP effluents will be disinfected, if required.
	-	Condenser Cooling Water Discharge.	A closed cycle cooling system with cooling towers is proposed with blowdown from the cold side.	No temp. increase in discharge hence no impact on aquatic life anticipated.
	Coliform contamination of ground water in shallow aquifers.	Human settlements.	Adequate drainage and sanitation system in township and treatment for sanitary effluent shall be provided.	-
Air Quality.	Increase in NOx levels in ambient air.	Power Plant.	Gas turbines would be designed to keep the NOx emission level to 150 ppm. A 70 m stack would be provided to ensure wider dispersal of pollutants. Low NOx burners or steam/water injection will be used depending on the vendor chosen for the main plant. Maximum short term Ground Level Concentration (GLC) of NOx and SOx due to operation of CCPP would be of the order of 10 ug/m3 and 3 ug/m3 respectively.	-

			Superimposing the maximum background levels the total NOx and SOx levels in ambient air due to operation of CCPP will be about 89 ug/m3 and 26ug/m3 respectively which are well below the stipulated norms of 120 ug/m3.	
	Increased SPM in ambient air.	Vehicular traffic.	All motorable roads in the plant area will be paved to reduce dust emission.	-
			Afforestation programmes will be undertaken around the Plant and Township Areas.	-
Ecology:				
a) Terrestrial	Impact on plant species	Emissions from stack.	Emission will be controlled through appropriate design.	As emissions will be within limits, no active injury to the vegetation is expected.
b) Aquatic	Impact on kayal.	Waste water from CMB.	All the waste water will be provided adequate treatment.	As all the effluents will be treated to conform to prescribed limits, no significant impact on aquatic life of kayal is expected.
Noise	Increase in noise levels in the area.	Equipment in main plant and auxilliaries.	Equipment are being designed to conform to noise levels prescribed by regulatory agencies.	-
			Provision of green belt and plantation would further help in reducing noise.	-

Demography & Socio-economics	Strain on existing amenities like housing, water sources and sanitation, medical and infrastructure facilities.	Influx of people - NTPC's employees as well as contractor's employees/labourers.	NTPC proposes to built its own township equipped with all infrastructural facilities for its employees. Population in surrounding area will also be benefitted from some of these facilities like shopping complex, medical camps, etc.

5.0(b) DESCRIPTION AND TECHNICAL DETAILS OF MITIGATION MEASURES:

The summary of anticipated adverse environmental impacts and proposed mitigative measures are given at Table 5.0(a). The mitigative measures to be adopted during construction and operation of project is given below:

5.1 DURING CONSTRUCTION:

The impacts during the construction phase on the environment would be basically of transient nature and are expected to reduce gradually on completion of the construction activities.

In order to mitigate impacts, the following measures are proposed:

(i) Designation and demarcation of sites for construction camps and ensuring due provision of necessary infrastructural services.

(ii) Regular sprinklig of water around vulnerable areas of the construction sites, roads, etc.

(iii) The following recommendations made by Deptt. of Aquatic Biology and Fisheries, University of Kerala to minimise impacts of dredging on the Kayal will be implemented:

a) The area proposed for dredging may be limited to a maximum length of 6 kms. covering areas adjacent to the project site. However, NTPC is proposing to dredge only 1500 m of Kayal.

b) The dredging should be completed within the shortest time possible.

c) All measures may be taken to ensure the stability of the land strip between the sea and the kayal.

5.2 DURING OPERATION:

The main sources of air and water pollution during operation of the project would be:

a) Furnace: Flue gases containing SO2, NOx.

b) Cooling System: Hot Water Discharge.

c) Turbine Generator Bay: Service water effluent containing suspended solids, oil and grease.

d) Fuel handling and storage area: Waste containing

e) Water Treatment: Clarifier sludge, filter backwash, DM Plant regeneration waste

f) Township: Domestic sewage.

5.2.1 Proposed Pollution Control Systems:

The proposed waste management schemes are presented in Table 5.2.1.

TABLE 5.21

WASTE MANAGEMENT AT KAYAMKULAM CCPP

S.NO.	WASTE	SOURCE	ANNUAL QUANTITY	ANALYSIS	TREATMENT AND DISPOSAL
1.	Plant drains	Main plant area	265 m3/hr	Oil/grease/TSS	Oil seperation and treatment to less than 10 ppm. Oily sludge to be sold for recycling.
2.	Cooling tower blowdown	Cooling tower	240 m3/hr	Dissolved solids and chlorine.	Cl2 will be monitored to control excess chlorine
3.	DM Plant regeneration waste, filter backwash and clarifier sludge	Water treatment plant	65 m3/hr	Dissolved solids and pH variation	pH adjustment for regeneration waste and backwash sludge to be dried and disposed in an environmentally secure landfill.
4.	Boiler blowdown	Boiler		Alkalinity	Dilution
5.	Plant/township sewage	Township	50 m3/hr	BOD, suspended solids	Boilogical treatment sludge to be dried and provided to farmers for fertilizer or disposed in an environmentally secure landfill.
6.	Township/domestic solid waste	Township	91.25 ton/yr	Characteristic of solid waste	To be disposed in an environmentally secure sanitary landfill.

The following environmental protection systems will be installed at the plant:

5.2.1.1 **Air Pollution Control Systems:**

NOx is the main pollutant from a combined cycle power plant. The NOx emission from turbine unit shall be controlled to 100 ppm by providing either low NOx burners or by injection of steam/water depending upon manufacturer. DM Plant will be sized to meet the water requirement for NOx control. Height of WHRB and bypass stack will be 70 m. This 70m stack height has been arrived after taking into consideration the guideline of Ministry of Env. & Forests, Govt. of India, published in Gazettee notification dt. 19.5.93. The air pollution control measures proposed for the project are described below:

a) 70 meters tall stacks to ensure wider dispersion of pollutants. The 70 m stack height has been arrived using the formula stipulated by Ministry of Env. & Forests, Govt. of India.

b) Appropriate system to control NOx emission to 100 ppm.

c) Green belt development and afforestation in and around the plant and township area.

5.2.1.2 **Water Pollution Control Systems:**

Following effluent treatment and disposal systems are proposed to be installed:

a) Minimise quantity of effluents through reuse to the extent feasible.

b) Treatment of DM plant waste through neutralisation.

c) Biological treatment for domestic waste.

d) Provision of cooling towers to avoid thermal discharges.

e) Provision of oil seperators.

All effluents such as sludge from clarifiers, DM plant waste, main plant drains, oily wastes, etc. would be treated in the respective local treatment systems and all the treated effluents would be fed to Central Monitoring Basin (CMB) prior to final disposal.

Sludge from clarifiers would be stored in local sludge sumps. P.T. plant clarifier sludge would be treated using solid liquid separators.

Oily waste would be treated using oil separator followed with drum type oil skimmer having oilofin resin. Oil separators would be designed for treating the run off water in the oil facility area during rainy season. Clear water would be led to CMB.

Service wastewater would be treated for reducing TSS by using tube settler.

DM plant regeneration waste after neutralisation would be led to CMB.

Cooling tower blowdown from the cold side would be led to the Central Monitoring Basin from where all treated effluents would be pumped for the final disposal. The treated effluent will conform to the regulatory standards.

The township waste will be accorded biological treatment so as to conform to the standards prescribed by regulatory agencies. A disinfection unit will be added to the sanitary waste water treatment plan for disinfection and reduction of pathogens. In NTPC township, all city water effluent flow through sewerline and rain water is made to flow separately. If oil separator is employed before biological treatment unit, deposition of organic substnace in the separator would create problem of putreseibility. In addition, inorganic matter will also get deposited. However, oil

content in the domestic waste is very small and are below the permission limit of discharge of effluent with receiving water body.

Effluent monitoring instruments namely pH meter, flow meter, etc. would be provided in the effluent discharge line. Flow integrators would be provided both at the plant intake and discharge point at Central Monitoring Basin. Central monitoring basin would be of twin compartment having total capacity of 500 cu.m.

5.2.2 Solid Waste Management Plan:

Environmentally sound Solid Waste Management Plan (SWMP) dealing with the solid waste generated at the township will be framed. The main principles of the plan will include classification and quantification of various wastes and their collection, treatment and disposal practices. It is proposed to adopt sanitary landfill for the domestic waste and incinerator for the hospital wastes.

The suitable sanitary landfill area will be identified taking into consideration permeability of soil, distance from populated area etc. The collection, transport and disposal of solid wastes from different parts of the township to the disposal area through 'Sanitation Contract Package'. The contractors deployed by NTPC are required to follow certain norms with respect to tools and safety equipments.

The waste brought to the landfill site would be unloaded immediately over the working face of the landfill and would be evenly spread and compacted by bull dozers/loaders. The top surface and the slopes of the refuse dumped would be covered progressively with a layer of soil/civil debris or any other sealing material. It would be made flat and consolidated with a roller to mitigate disease vectors. A daily inspection will be made for rodent burrows or insect infestations and appropriate control measures shall be taken.

The generation at leachate from the landfill area will not be a common phenomenon under Indian conditions. The compaction and provision of proper slope would prevent stagnation of water inside the landfill area, thereby minimising leachates. In addition, a drainage system would be constructed around the landfill area. However, two monitoring wells be established near the landfill area. Water of these wells will be monitored at intervals to assess the status of ground water quality. The monitoring work shall be co-ordinated by Environment Management Group.

The sludge from the sewage treatment plant would be dried in drying bed and disinfected with bleaching powder to prevent the formation and spreading of pathogenic organisms.

The hospital waste would be stored and transported in covered bins to the incinerator. The quantity of these

wastes would be very small. The final selection of the tupe and design of incinerator will be done at the time of finalization of specification. However, in view of the low quantity of waste generated per daily, daily burning of waste is not considered for design of incinerator. The residue from the incinerator will be collected and disposed in the landfill area.

5.2.3 Afforestation:

Comprehensive afforestation would be undertaken in and around the project and township. The land demarcated under CRZ notification will be also afforested to serve as green belt. Local trees species adopted to salt and water logged conditions will be preferred for plantation. The edaphic and climatic conditions of the area support coconut trees. Therefore, coconut will be planted extensively. In addition, fast growing trees like Eucalyptus will also be planted which can grow in water logged condition. The afforesttion activities of the industrial region not only serve as foreground and background landscape features resulting in harmonising and amalgamating the physical structures of thermal power project with nature and the surrounding environment, but also contribute to the overall improvement in the environment.

5.3 INSTITUTIONAL ARRANGEMENTS:

5.3.1 Organisation at Site:

The organisational chart for plant site including functions in environment related areas and relations with corporate centre is given as Annexure 5.

The NTPC has a full fledged Environmental Engineering Department, consisting of a number of qualified scientists and engineers from various disciplines. This department is the nodal agency to coordinate and provide necessary services on environmental issues during planning, construction and operation of the project. This group is responsible for preparation of Environmental Impact Assessment report, interaction with the environmental regulatory agencies, reviewing draft policy, notification, framing environmental policy and planning for NTPC projects. This Deptt. interacts with Ministry of Env. & Forests (MOEF), Central Pollution Control Board (CPCB) and other environment regulatory agencies. Further, an R&D group at the Corporate Centre has been created which is responsible for field work related to air quality, water quality, soil etc.

NTPC has also established Environmental Management Group (EMG) in Operations Division at the corporate level. This Group has constituted in September 1991 with basic objectives of:

a) Co-ordinate with Stations, Regions, Corporate Centre Engg. Division on all environmental matters.

b) To carry out trend analysis of pollution monitoring data and prepare exception reports.

c) Providing operational feedback to Engg. for carrying out necessary modifications in existing/future systems.

d) Providing corporate support to stations.

The Environmental Management Group at site will be headed by a Manager/Sr. Manager with requisite supporting staff to oversee all environmental aspects including monitoring, interaction with the State Regulatory Agencies as well as the concerned environmental groups at the Corporate Centre. Information on data generated through monitoring and other environmental systems available for the plant will be regularly submitted to the plant Corporate EMG by the site EMG. Depending on the results thus submitted, in case any technical assistance is required to mitigate adverse impacts on environment, the matter will be referred to the Env. Engg. Deptt. for appropriate solutions for implementation at the project site. The EMG at site will also closely interact with the State Regulatory Agencies for obtaining consents for power plant operation, joint monitoring of the environmental parameters at regular intervals and submission of all data to the Pollution Control Boards. Head of the EMG will report to Dy. General Manager (Technical Services). Regular training

programmes for staff in the area of environment management are organised at NTPC with a view to provide wide ranging exposure in different disciplines of enviornmental pollution.

A separate group under Director (Personnel) has been established at the Corporate Centre to implement the Rehabilitation and Resettlement programme for people affected due to land acquisition. Separate groups at each project have also been established to address this matter and report to Head of Personnel.

NTPC has a safety group at Corporate Centre to manage, develop and administer safety policies of NTPC. At the project, a safety group with the requisite number of personnel would be constituted. The Safety Department of the project would provide routine training to the plant personnel to make them aware of safety needs. All Personnel will be involved in training and drills. The Safety Department would also be responsible to conduct safety audits and analysis of data relating to safety and health.

5.4 MONITORING & REPORTING PROCEDURE:

Regular monitoring of important and crucial environmental parameters is of immense importance to assess the status of environment during plant operation. With the knowledge of baseline conditions, the monitoring programme can serve as an indicator for any deterioration in environmental conditions

due to operation of the plant and suitable mitigatory steps could be taken in time to safeguard the environment. The following routine monitoring programme would therefore be implemented. The detailed programme for monitoring is presented in Table 5.4.

5.4.1 Air Quality:

Both ambient air quality and stack emissions would be monitored. Whereas it is proposed to undertake continuous monitoring of NO_x emissions, the ambient air would be monitored twice a week (in line with the directions from Central Pollution Control Board) at three locations to be finalised in consultation with the State Pollution Control Board.

5.4.2 Water Quality:

All the effluents emanating from the plant, township would be monitored monthly for physico-chemical characteristics. Heavy metals would be monitored on a quarterly basis. CT blowdown would be monitored for Cl_2 on a daily basis. It is proposed to monitor the physical, chemical and biological parameters in the effluents as per Table 5.4

The water quality of the Kayal at two locations would be monitored once a month.

5.4.3 Ecology:

Aquatic:

A monitoring programme of Kayal at two locations in the vicinity of project once in two years would be undertaken to evaluate any ecological change due to operation of KYCCPP.

The site EMG will co-ordinate all monitoring programmes at site and data thus generated will be regularly furnished to the State Regulatory Agencies as well as the Corporate EMG. The data thus submitted will be scrutinised by the Corporate EMG and if any deviation results from accepted standard norms, the matter would be referred to the Environmental Engineering Group for suggesting appropriate solutions for implementation at the project. This would ensure that problems, if any, are detected at an early stage and mitigated without undue delay.

5.5 COST ESTIMATES:

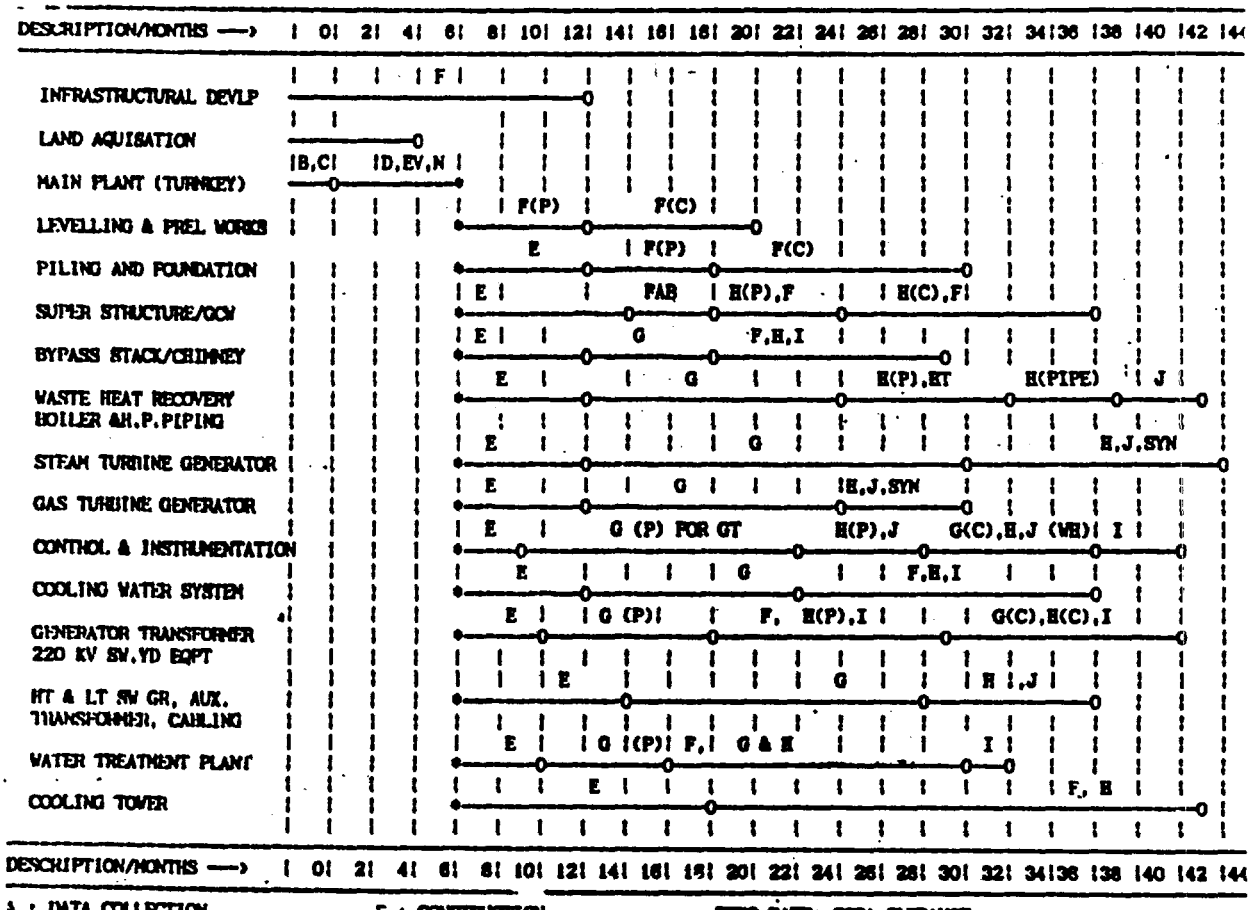
The cost provided for environmental protection measures in the project report are as under:

	Rs. in Crores
1. Chimney	1.70
2. Cooling Tower	5.30
3. DM Plant Waste Treatment	0.20
4. Control of Fire & Explosion	14.00
5. Sewerage Collection, Treatment & Disposal	0.50
6. Environment Lab Equipment	0.35
7. NOx Control	10.00
TOTAL	32.05

The source of funds for these measures will be the same as that of the total project cost. The expenses during project operation in the area of environmental protection will be funded from internal sources.

5.6

NATIONAL THERMAL POWER CORPORATION LTD.
IMPLEMENTATION SCHEDULE FOR KAYAMKULAM GAS POWER PROJECT STAGE-I(400MW NOMINAL)



A : DATA COLLECTION
B : ENGINEERING & SPECIFICATION
C : BANK REVIEW & NIT
D : BIDDING
O : CONTRACT AWARD
E : DETAILED ENGINEERING
P : PART

F : CONSTRUCTION
G : MANUFACTURING & DELIVERY
H : ERECTION
I : TESTING
J : PRE-COMMISSIONING
K : COMMISSIONING
(C): COMPLETION
SYN: SYNCHRONISATION

ZERO DATE: CCEA CLERANCE

SUBSEQUENT GAS UNITS ARE TO BE COMMISSIONED AT INTERVAL OF 2 MONTHS EACH. STEAM TURBINE UNIT WILL BE COMMISSIONED IN 42 MONTHS FROM ZERO DATE.

SW.YARD COVERED IN MAIN PLANT TURNKEY TO BE HANDED OVER TO POWERGRID AFTER COMMISSIONING.

CHAPTER VI

6.OOCCUPATIONAL HEALTH SAFETY AND EMERGENCY PLAN

Large industries, in general, and power plants in particular where multifarious activities are involved during construction, erection, testing, commissioning, operation & maintenance, the men, materials and machines are the basic inputs. Alongwith the boons, industrialisation generally bring several problems like occupational health and safety.

Chlorine detectors (auto sensing type with alarm system) and neutralisation pit will be provided in chlorine storage areas. Sealing kit for plugging leaks in the chlorine cylinders will be kept in chlorine storage area. Personal protective equipment will also be provided at the work place.

6.1 OCCUPATIONAL HEALTH:

Occupational health needs attention both during construction & erection and operation & maintenance phases. However, the problem varies both in magnitude and variety in the above phases.

6.1.1 Construction & Erection:

The occupational health problems envisaged at this stage can mainly be due to constructional accidents and noise.

To overcome these hazards, in addition to arrangements to reduce it within TLV's , personnel protective equipments shall also be supplied to workers.

6.1.2 Operation and Maintenance:

The problem of occupational health, in the operation and maintenance phase is due to noise hearing losses. Suitable personnel protective equipments will also be given to employees. Persons working in the fuel storage and handling area who could be exposed to the vapour of high aromatic content of the Naphtha will be provided suitable protective equipments.

The working personnel will be given the following appropriate personnel protective equipments.

- Industrial Safety Helmet
- Crash Helmets
- Face shield with replacement acrylic vision
- Zero power plain goggles with cut type
- filters on both ends.
- Zero power goggles with cut type filters on both sides and blue colour glasses.
- Welders equipment for eye & face protection.
- Cylinderical type earplug
- Ear muffs
- Cannister Gasmask
- Self contained breathing apparatus

- Leather appron
- Aluminised fibre glass fix proximity suit with hood and gloves.
- Boiler suit
- Safety belt/line man's safety belt
- Leather hand gloves
- Asbestos hand gloves
- Acid/Alkali proof rubberised hand gloves
- Canvas cum leather hand golves with leather palm
- Lead hand glove
- Electrically tested electrical resistance hand gloves
- Industrial safety shoes with steel tie
- Electrical safety shoes without steel tie
- Gum Boots

Full fledged hospital facilities will be available round the clock for attending emergency arising out of accidents, if any. All working personnel will be medically examined at least once every year and at the end of his term of employment. This is in addition to the pre-employment medical examination.

6.2 SAFETY AND EMERGENCY PLAN:

Safety of both men and materials during construction and operation phases is of concern . The preparedness of an industry for the occurrance of possible disasters is known as emergency plan. The disaster in power plant is possible due to leakage of hazardous chemicals like chlorine, collapse of structures and fire/explosion etc.

Keeping in view the safety requirement during construction, operation and maintenance phases NTPC has formulated safety policy with the following regulations:

- To allocate sufficient resources to 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, equipments 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 upto date knowledge.

- To provide appropriate facilities for first aid and prompt treatment of injuries and illness at work.

- To provide appropriate instruction, training, retraining and supervision to employees in health & safety, first aid and to ensure that adequate publicity is given to these matters.

- To ensure proper implementation of fire prevention methods 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 organise 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 types of occupation/processes involved in a project.

- To ensure regular safety inspection by a competent person at suitable intervals of all buildings, equipments, work places and operations.

In NTPC, it is imperative that contractors follow rules to ensure safety to all construction workers. For violation of Rules Rs. 5000/- per day is claimed. For a lapse leading to fatality, Rs.1,00,000/- is recovered from the contractor.

In operation, the safety guidelines have been framed in consultation with CEGB and were tested under their guidance. The same shall be implemented.

6.3 SAFETY ORGANISATION:

6.3.1 Construction & Erection Phase:

NTPC shall employ atleast two qualified and experienced safety officers. The responsibilities of these safety officers shall include identification of the hazardous conditions and unsafe acts of workers and advise on corrective actions, conduct safety audit, organise training programmes and provide professional expert advice on various issues related to occupational safety and health. He shall also ensure compliance of NTPC Safety Rules/Statutory Provisions .

In addition to employment of safety officers by NTPC, every contractor, who employs more than 250 workers, shall also employ one safety officer, in accordance with the conditions of contract.

6.3.2 Operation & Maintenance Phase:

When the construction is completed the posting of safety officers shall be in accordance with the requirement of Factories Act and their duties and responsibilities shall be as defined there of.

6.4 SAFETY CIRCLE

In order to fully develop the capabilities of the employees in identification of hazardous processes and improving safety and health, Safety Circles would be constituted in each area of work. The circle would consist of 5-6 employees from that area. The circle normally shall meet for about an hour every week.

6.5 SAFETY TRAINING

In NTPC, training officers are employed at every plant. Safety training will be provided by the Safety Officers with the assistance of external faculty members from Corporate Centre, Professional Safety Institutions and Universities whenever felt necessary. In addition to regular employees, limited contractor labourers are also provided safety training.

To create safety awareness safety films will be shown to workers and leaflets etc. will be distributed.

Some precautions and remedial measures proposed to be adopted to prevent fires are:

- Compartmentation of cable galleries, use of proper sealing techniques of cable passages and crevices in all directions would help in localising and identifying the area of occurrence of fire as well as ensure effective automatic and manual fire fighting operations;

- Spread of fire in horizontal direction would be checked by providing fire stops for cable shafts;

- Reliable and dependable type of fire detection system with proper zoning and interlocks for alarms are effective protection methods for conveyor galleries.

- Housekeeping of high standard helps in eliminating the causes of fire and regular fire watching system strengthens fire prevention and fire fighting; and

- Proper fire watching by all concerned would be ensured.

6.6 EMERGENCY PLAN:

Due consideration is given to siting, design, construction, commissioning and operation of power plants as per stringent requirements and regulations to ensure health and safety of plant personnel as well as the public and the environment at large. Nevertheless, inspite of all the precautions and care that are taken, a remote possibility of equipment failure and/or operational error resulting in an accident leading to emergency situation cannot be entirely ruled out. Such an emergency may lead to adverse effect on personnel and property at site and also in the off-site public domain. While responsibility for handling on-site emergency lies with the occupier of the power plant in accordance with Factories Act as ammended in 1987 to safeguard the health and safety of personnel at the plant site as also the inhabitants in the surrounding area the district and State Public Authorities are fully responsible to respond to off site emergency. It is, therefore, essential to plan in advance the actions to be taken during such emergency to limit the adverse effects and bring normalcy within shortest possible time.

For effective implementation of the plan, an open policy will be adopted in providing information to public and media.

Operation of power stations are unlikely to lead to any major disaster. Even if an accident occurs in all probability, it would be restricted within the plant premises and impact in the surrounding is not likely.

6.7 DISASTER MANAGEMENT PLAN:

Emergencies may occur due to many reasons. It may occur due to natural causes like earthquake, cyclone, flood etc. It may occur due to malfunction of standard working systems or practices.

6.7.1 MAJOR CAUSES OF ON-SITE EMERGENCY

A. <u>Release of Chlorine due to leakages:</u>

Due to corrosion or mishandling, on occasions, leakages have been reported.Most of the leakages occur at the valves. On a few occasions, leakage at the shell had also come to light.

To control such leakages, emergency sealing kits will be provided close to the chlorine containers stores. The staff will be fully trained to seal any leakage with the help of such emergency kit in shortest

possible time and neutralise the leaking chlorine in the neutralisation tank. Breathing equipments will be pro vided for use in such operation.

B. ERUPTION OF FIRE:

Appropriate fire fighting and protection systems will be provided and maintained.

C. Explosion:

Explosion in the plant is possible in fuel storage area. Appropriate fire fighting system will be provided.

6.7.2 EMERGENCY ACTION PLAN:

The action plan consists of:

- First Information.
- Responsibilities of Work Incident Controller
- Responsibilities of Chief Incident Controller
- Responsibilities for Declaration of Emergency
- Responsibilities for Emergency Communication Officer.
- Responsibilities of key personnel
- Responsibilities and action to be taken by essential staff and various teams during emergency.
- Responsibilities for All Clear Signal.

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 hazard. The Shift Engineer will inform to works Incident controller, Chief Incident Controller and also telephone operator, who shall communicate it to all key personnel.

Responsibilities of Work Incident Controller:

The work Incident Controller on knowing about an emergency, immediately will rush to the incident site and take overall charge and inform the same to CIC. On arrival, he will assess the extent of emergency and decide if major emergency exists and inform the communication officer accordingly. His responsibilities will be to 1 to 6.

Responsibilities of Chief Incident Controller:

The Additional General manager, who is also the Chief Incident Controller, will assume overall responsibilities for the factory/storage site and its personnel in case of any emergency. His responsibilities are to:-

1. Assess the magnitude of the situation and decide if staff need to be evacuated from their assembly points to identified safer places. Declare ON-SITE/OFF-SITE EMERGENCY.
2. Exercise direct operational control over areas other than those affected.
3. Undertake a continuous review of possible develop-

ments and assess in consultation with key personnel as to whether shutting down of the plant or any section of the plant and evacuation of personnel are required.

4. Liaise with senior officials of Police, Fire Brigade, Medical and Factories Inspectorate and provide advice on possible effects on areas outside the factory premises.

5. Look after rehabilitation of affected persons on disscontinuation of emergency.

6. Issue authorised statements to news media, and ensure that evidence is preserved for enquiries to be conducted by the statutory authorities.

Responsibilities for Declaration of major emergency:

Making the emergency known inside the plant:

The major emergency will be made known to every one inside the plant by resounding the alarm. Separate alarms to warn different types of major emergencies such as fire and explosion or toxic gas escape will be provided. Public address system also available throughout the plant.

Annoucement will be made by the concerned official/interpreter in local language. Similarly accouncement of termination of the emergency will also be announced.

Responsibilities of Emergency Commmunication Officer:

On hearing the emergency alarm he will proceed to Emergency Control Centre. He will

- report to Chief Incident Controller and work Incident Controller and maintain contact with them.

- On information received from the WIC of the situation recommending, if necessary, evacuate the staff from assembly point.

- Identify suitable staff to act as runners or messangers who are listed in the Essential staff, between him and the works incident controller if the telephone and other system of communication fail due to any reason.

- Maintain inventory of items in the emergency control centre.

- Contact local meteorological office to receive early notification of changes in weather condition in case of gas leak and prolonged action.

- Maintain a log of incidents.

- Keep in constant touch with happenings at the emergency site and with WIC.

- Liaise with neighbour fire brigade, hospital,

civil and police authorities on advise from CIC.

Key Personnel:

Apart from Works Incident Controller and Chief Incident Controller, other works personnel will have key role to play in providing advice and in implementing the decisions made by the Chief Incident Controller.

The Key Personnel include:

A. Sr. Supdts./Engineer-in-Charge responsible for:

i) Operation

ii) Electrical maintenance

iii) Mechanical maintenance

iv) C&I

v) Chemical

B. Head of Personnel and Officers connected with IR and Labour Welfare.

C. Head (Technical Service).

Responsibilities of Key Personnel:

A. Departmental Heads:- The departmental heads will provide assistance as required by the WIC. They will decide which members of their departments are required at the incident site.

B. Chief Personnel Manager: He will:-

a) report to work Incident Controller.

b) ensure that all non-essential workers in the affected areas are evacuated to assembly points in

consultation with the Chief Incident Controller.

c) receive reports from nominated persons from assembly points, and pass on the absence information service.

d) keep liaison with other coordinators to meet the requirements of services such as materials, security management, transportation, medical, canteen facilities etc. as required during emergency.

e) be in constant touch with the Chief Incident Controller and feed him correct information of the situation.

f) give information to press, public and authorities concerned on instructions from the CIC/WIC.

g) ensure that casualties receive adequate attention at medical centre and arrange required additional help and inform relatives of the injured.

h) arrange to inform public on Radio and TV about evacuation etc.

i) arrange a TV coverage on handling emergency.

C. In-Charge (TS):

On knowing about an emergency, he will report to CIC and assist him in all activities. He will also liaison with all teams.

D. Medical Officer:

Medical Officer will render medical treatment to the injured and if necessary will shift the injured to

nearby Hospitals. He will mobilise extra medical help from outside if necessary.

E. Head of Safety:

On hearing the emergency alarm, he will proceed to the site. He will -

a) make sure that all safety equipments are made available to the emergency teams.

b) participate in rescue operations.

c) co-ordinate to transfer the injured persons to medical centre and arrange for first aid.

d) keep in contact with ECO and the WIC and advice them on the condition of injured persons.

F. Commandant (CISF):

On hearing the Emergency alarm he will proceed to main entrance/main gate. He will:-

a) arrange to control the traffic at the gate and the incident area.

b) direct the security staff to the incident site to take part in emergency operations under his guidance and supervision.

c) evacuate the persons in the plant or in the nearby areas as advised by WIC after arranging the transport through the Transport In-charge.

d) allow only those people who are associated with handling emergency.

e) maintain law and order in the area, if necessary seek the help of police.

f) maintain communication with CIC/WIC and ECO.

G. CISF Fire Officer:

On hearing the emergency he will reach the fire station and arrange to sound the alarm as per the type of emergency in consultation with WIC. He will:-

a) guide the fire fighting crew i.e. firemen and trained plant personnel and shift the fire fighting facilities to the emergency site. Adequate facilities will be made available.

b) take guidance of the WIC for fire fighting as well as assessing the requirement of outside help.

c) maintain communication with WIC, CIC and ECO.

H. Transport (Auto-base) Engineer-in-Charge:

On hearing the emergency alarm he will immediately report to Work Incident Controller. He will:-

a) Ensure availibility of auto base vehicles for evacuation or other duties, when asked for.

b) make all arrangements regarding transportation.

6.8 EMERGENCY DURING FUEL TRANSPORTATION:

In the event of an accident, the disaster management is taken up on a war footing as per the procedures laid down in "Accident-Manual" of IR and under no circumstances, the procedures are violated. All equipment/communication etc. required for meeting the disaster management plan are taken care of while commissioning a railway track. Railway line from Cochin to Cheppad has inbuilt features for meeting disasters arising out of naphtha transport.

In case of any accident during transportation, it is the responsibility of the Railways to take all remedial actions and to meet all obligations.

6.9 HEALTH AND SAFETY MONITORING PLAN:

All the potential occupational hazardous workplaces such as chlorine storage area, acid and alkali storage areas will be monitored regularly. The health of employees working in these areas will be monitored once in a year for early detection of any ailment due to exposure to hazardous chemicals. The Health and Safety measures followed at other NTPC stations will be adopted at the Kayamkulam station also.