Final Draft

IL&FS | Environment

TECHNICAL EIA GUIDANCE MANUAL
FOR
THERMAL POWER PLANTS

Prepared for

Ministry of Environment and Forests
Government of India

by

IL&FS Ecosmart Limited

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ACRONYMS

AAQ	Ambient Air Quality
ADB	Asian Development Bank
APHA	American Public Health Association
B/C	Benefits Cost Ratio
BIS	Bureau of Indian Standards
BOD	Biological Oxygen Demand
BOQ	Bill of Quantities
BOT	Built-Operate-Transfer
BLEVE	(Boiling Liquid Expanding Vapour Cloud) or Vapour Cloud Explosion
BTEX	Benzene, Ethyl benzene, Toluene, and Xylenes
CCA	Conventional Cost Accounting
CEA	Central Electricity Authority
CEAA	Canadian Environmental Assessment Agency
CER	Corporate Environmental Reports
CETP	Common Effluent Treatment Plant
CFBC	Circulating Fluidized-bed Combustion
CFE	Consent for Establishment
COD	Chemical Oxygen Demand
CP	Cleaner Production
CPCB	Central Pollution Control Board
CRZ	Coastal Regulatory Zone
CSR	Corporate Social Responsibility
CST	Central Sales Tax
DA	Development Authorities
DC	Drill cuttings
DfE	Design for Environment
DMS	Dense Medium Separation
DO	Dissolved Oxygen
EAC	Expert Appraisal Committee
EBM	Environmental Baseline Monitoring
EcE	Economic-cum-Environmental
ECI	Environmental Condition Indicators
EHS	Environment Health and Safety
EIA	Environmental Impact Assessment
EIS	Environmental Information system
EPA	Environmental Protection Agency

EPI	Environmental Performance Indicators
EPR	Extended Producers Responsibilities
EMA	Environmental Management Accounting
EMS	Environmental Management System
EMP	Environmental Management Plan
ERPC	Environment Research and Protection Centre
ETP	Effluent Treatment Plant
FCA	Full Cost Assessment
FE&TI	Fire-Explosion and Toxicity Index
FF	Fabric Filters
GEMS	Global Environmental Monitoring System
GHG	Green House Gas
GLC	Ground-level Concentration
GW	Giga Watt
HTL	High Tide Line
IL&FS	Infrastructure Leasing and Financial Services
ILO	International Labour Organization
IMD	India Meteorological Department
IT	Information Technology
IVI	Importance Value Index
ISO	International Standard Organization
JV	Joint Venture
kCal	Kilo Calories
kWh	Kilo Watt Hour
km	Kilometre
LANDSAT	Land Remote Sensing Satellite / Land Use Satellite
LDAR	Leak Detection and Repair
LCA	Life Cycle Assessment
LEL	Lower Explosive Limit
LNG	Liquefied Natural Gas
LTL	Low Tide Level
MCA	Maximum Credible Accident
MoEF	Ministry of Environment & Forests
MSW	Municipal Solid Waste
NAQM	National Air Quality Monitoring
NGO	Non-Government Organizations
NOC	No Objection Certificate
OCD	Offshore and Coastal Dispersion Model
OECD	Organization for Economic Co-operation and Development

OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbons
PCC	Pollution Control Committee
PPV	Peak Particle Velocity
R&D	Research and Development
R&R	Resettlement and Rehabilitation
RPM	Respirable Particulate Matter
RSPM	Respirable Suspended Particulate Matter
QA/QC	Quality Assurance/Quality Control
QRA	Quantitative Risk Assessment
SEAC	State Level Expert Appraisal Committee
SEIAA	State Level Environment Impact Assessment Authority
SEZ	Special Economic Zone
SPCB	State Pollution Control Board
SPM	Suspended Particulate Matter
SS	Suspended Solids
TA	Technology Assessment
TCA	Total Cost Assessment
TDS	Total Dissolved Solids
TEQM	Total Environmental Quality Movement
TGM	Technical EIA Guidance Manuals
toe	Tonne Oil Equivalent
TPES	Total Primary Energy Supply
TPP	Thermal Power Plant
TSDF	Treatment Storage Disposal Facility
TSS	Total Suspended Solids
UNEP	United Nations Environmental Programme
USEPA	United States Environment Protection Agency's
UT	Union Territory
UTEIAA	Union Territory Level Environment Impact Assessment Authority
UTPCC	Union Territory Pollution Control Committee
VOC	Volatile Organic Compound
VEC	Valued Environmental Components
WB	World Bank Group / The World bank
WBCSD	World Business Council on Sustainable Development
WBDF	Water-based Drilling Fluids

1. INTRODUCTION TO THE TECHNICAL EIA GUIDANCE MANUALS PROJECT

Environmental Impact Assessment (EIA) is a process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made. These studies integrate the environmental concerns of developmental activities into the process of decision-making.

EIA has emerged as one of the successful policy innovations of the 20th Century to ensure sustained development. Today, EIA is formalized as a regulatory tool in more than 100 countries for effective integration of environmental concerns with the economic development process. The EIA process in India was made mandatory and was also given a legislative status through a Notification issued in January 1994. The Notification, however, covered only a few selected industrial developmental activities. While there are subsequent amendments, this Notification issued on September 14, 2006 supersedes all the earlier Notifications, and has brought out structural changes in the clearance mechanism.

The basic tenets of this EIA Notification could be summarized into following:

- Pollution potential as the basis for prior environmental clearance instead of investment criteria; and
- Decentralization of clearing powers to the State/Union Territory (UT) level Authorities for certain developmental activities to make the prior environmental clearance process quicker, transparent and effective mechanism of clearance.

Devolution of the power to grant clearances at the state-level for certain categories of the developmental activities / projects would fulfill the basic tenets of the re-engineering process *i.e.*, quicker, transparent and effective process but many issues come on its way of functional efficiency. These issues could be in technical and operational domains as listed below:

Technical Issues

- Ensuring level playing ground to avoid arbitrariness in the decision-making process
- Classification of projects which do not require public hearing and detailed EIA (Category B2)
- Variations in drawing the Terms of Reference (ToR) for EIA studies for a given developmental activity across the States/UTs
- Varying developmental-activity-specific expertise requirement for conducting EIA studies and their appraisal
- Availability of adequate sectoral experts and variations in competency levels
- Inadequate data verification, cross checking tools and supporting institutional framework

- Meeting time targets without compromising with the quality of assessments/ reviews
- Varying knowledge and skill levels of regulators, consultants and experts
- Newly added developmental activities for prior environmental clearance, *etc.*

Operational Issues

- State level /UT level EIA Authorities (SEIAA/UTEIAA) are formulated for the first time and many are functioning
- Varying roles and responsibilities of involved organizations
- Varying supporting institutional strengths across the States/UTs
- Varying manpower availability *etc.*

1.1 Purpose

The purpose of developing these sector-specific technical EIA guidance manuals (TGM) is to provide clear and concise information on EIA to all the stakeholders *i.e.*, the project proponent, the consultant, the reviewer, and the public. The TGMs are organized to cover the following:

- Conceptual facets of an EIA
- Details on the developmental activity including environmental concerns and control technologies, *etc.*
- Operational aspects; and
- Roles and responsibilities of various organizations involved in the process of prior environmental clearance

For any given industry, each topic listed above could alone be the subject of a lengthy volume. However, in order to produce a manageable document, this project focuses on providing summary information for each topic. This format provides the reader with a synopsis of each issue. Text within each section was researched from many sources, and was usually condensed from more detailed sources pertaining to specific topics.

The contents of the document are designed with a view to facilitate in addressing the relevant technical and operational issues as mentioned in the earlier section. Besides, facilitates various stakeholders involved in the process of EIA clearance process.

- Project proponent will be fully aware of the procedures, common ToR for EIA studies, timelines, monitoring needs, *etc.*, in order to plan the projects/ studies appropriately.
- Consultants across India will have similar understanding about a given sector, and also the procedure for conducting the EIA studies, so that the quality of the EIA reports gets improved and streamlined
- Reviewers across the States/UTs will have the same understanding about an industry and would able to draw a benchmark in establishing the significant impacts for the purpose of prescribing the ToR for EIA studies and also in the process of review and appraisal.
- Public who are concerned about a new or expansion projects, can have access to this manual to know the manufacturing/production details, rejects/wastes from the operations, choice of cleaner/ control technologies, regulatory requirements, likely

environmental and social concerns, mitigation measures, *etc.* in order to seek clarifications appropriately in the process of public consultation. The procedural clarity in the document will further strengthen them to understand the stages involved in clearance and roles and responsibilities of various organizations.

- In addition, these manuals would substantially ease the pressure on reviewers at the scoping stage and would bring in functional efficiency at the central and state levels.

1.2 Project Implementation

The Ministry of Environment & Forests (MoEF), Government of India took up the task of developing sector-specific TGMs for all the developmental activities listed in the re-engineered EIA Notification. Infrastructure Leasing and Financial Services (IL&FS), Ecosmart Limited (Ecosmart), has been entrusted with the task of developing these manuals for 27 industrial and related sectors. Thermal Power Plant (TPP) is one of these sectors, for which this manual is prepared.

The ability to design comprehensive EIA studies for specific industries depends on the knowledge of several interrelated topics. Therefore, it requires expert inputs from multiple dimensions *i.e.,* administrative, project management, technical, scientific, social, economic risks *etc.*, inorder to comprehensively analyze the issues of concern and to logical interpretations. Thus, Ecosmart has designed a well-composed implementation framework has been designed to factor inputs of the experts and stakeholders in the process of finalization of these manuals.

The process of manual preparation involved collection & collation of the secondary available information, technical review by sectoral resource persons and critical review and finalization by a competent Expert Committee composed of core and sectoral peer members.

The MoEF appreciates the efforts of ECOSMART, Expert Core and Peer Committee, resource persons and all those who have directly and indirectly contributed to this Manual.

1.3 Additional Information

This TGM is brought out by the MoEF to provide clarity to all the stakeholders involved in the 'prior environmental clearance' process. As such, the contents and clarifications given in this document do not withstand in case of a conflict with the statutory provisions of the Notifications and Executive Orders issued by the MoEF from time-to-time.

TGMs are not regulatory documents. Instead these are the tools designed to assist successful completion of an EIA.

For the purposes of this project, the key elements considered under TGMs are: conceptual aspects of EIA; developmental activity-specific information; operational aspects; and roles and responsibilities of involved stakeholders.

This manual is prepared considering the Notification issued on September 14, 2006 and the updations. For recent updations, if any, may please refer the website of the MoEF, Government of India *i.e.* www.envfor.nic.in

2. CONCEPTUAL FACETS OF EIA

2.1 Environment in EIA Context

"Environment" in EIA context mainly focuses, but is not limited to physical, chemical, biological, geological, social, economical, and aesthetic dimensions along with their complex interactions, which affects individuals, communities and ultimately determines their forms, character, relationship, and survival. In the EIA context, 'effect' and 'impact' can often be used interchangeably. However, 'impact' is considered as a value judgment of the significance of an effect.

Sustainable development is built on three basic premises *i.e.,* economic growth, ecological balance and social progress. Economic growth achieved in a way that does not consider, the environmental concerns, will not sustain in the long run. Therefore, sustainable development needs careful integration of environmental, economic, and social needs in order to achieve both an increased standard of living in short term, and a net gain or equilibrium among human, natural, and economic resources to support future generations in the long term.

"It is necessary to understand the links between environment and development in order to make choices for development that will be economically efficient, socially equitable and responsible, as well as environmentally sound." Agenda 21

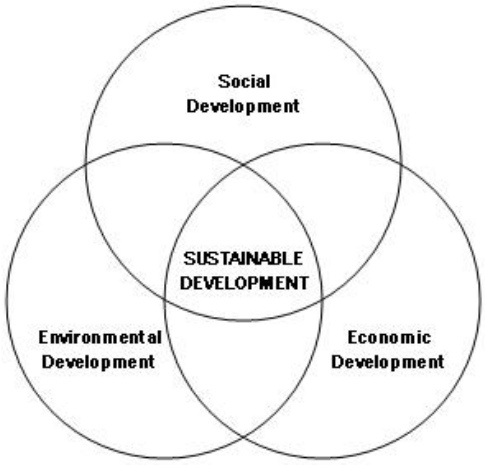


Figure 2-1: Inclusive Components of Sustainable Development

2.2 Pollution Control Strategies

Pollution control strategies can be broadly categorized into preventive and reactive. The reactive strategy refers to the steps that may be applied once the wastes are generated or contamination of receiving environment takes place. The control technology or a combination of technologies to minimize the impact due to process rejects/wastes varies with the quantity and characteristics desired control efficiency and economics.

Many a number or combination of techniques could be adopted for treatment of a specific waste or the contaminated receiving environment, but are often judged based on techno-economic feasibility. Therefore, the best alternative is to take all possible steps to avoid pollution itself. This preventive approach refers to a hierarchy that involves: i) prevention & reduction; ii) recycling and re-use; iii) treatment; and iv) disposal, respectively.

Therefore, there is a need to shift the emphasis from the reactive to preventive strategy *i.e.,* to promote preventive environmental management. Preventive environmental management tools may be classified into following three groups:

Management Based Tools	Process Based Tools	Product Based Tools
Environmental Management System (EMS)	Environmental Technology Assessment	Industrial Ecology
Environmental Performance Evaluation	Toxic Use Reduction	Extended Producers Responsibility
Environmental Audits	Best Operating Practices	Eco-labeling
Environmental Reporting and Communication	Environmentally Best Practice	Design for Environment
Total Cost Accounting	Best Available Technology (BAT)	Life Cycle Assessment (LCA)
Law and Policy	Waste Minimization	
Trade and Environment	Pollution Prevention	
Environmental Economics	Cleaner Production	
	Cleaner Technology	
	Eco-efficiency	

These tools are precisely discussed in next sections.

2.3 Tools for Preventive Environmental Management

The tools for preventive environmental management can be broadly classified into following three groups *i.e.,*

- Tools for assessment and analysis
- Tools for action; and
- Tools for communication

Specific tools under each group are discussed precisely in next sections.

2.3.1 Tools for assessment and analysis

2.3.1.1 Risk assessment

Risk is associated with the frequency of failure and consequence effect. Predicting such situations and evaluation of risk is essential to take appropriate preventive measures. The major concern of the assessment is to identify the activities falling in a matrix of high & low frequencies at which the failures occur and the degree of its impact. The high frequency, low impact activities can be managed by regular maintenance *i.e.*, Leak detection and repair (LDAR) programmes. Whereas, the low frequency, high impact activities are of major concern (accidents) in terms of risk assessment. As the frequency is low, often the required precautions are not realized or maintained. However, the risk

assessment identify the areas of major concerns which require additional preventive measures, likely consequence distances considering domino effects, which will give the possible casualties and ecological loss in case of accidents. These magnitudes demand the attention for preventive and disaster management plans (DMPs). Thus is an essential tool to ensure safety of operations.

2.3.1.2 Life cycle assessment

A broader approach followed to deal with environmental impacts in manufacturing is called LCA. This approach recognizes that environmental concerns are associated with every step of the processing w.r.t the manufacturing of the products and also examines environmental impacts of the product at all stages of the product life cycle. LCA includes the project design, development, manufacturing, packaging, distribution, usage and disposal. LCA is concerned with reducing environmental impacts at all the stages and considering the total picture rather than just one stage of the production process.

By availing this concept, firms can minimize the life cycle environmental costs of their total product system. LCA gives sufficient scope to think about the alternatives, which are lower at cost.

2.3.1.3 Total cost assessment

Total Cost Assessment (TCA) is an enhanced financial analysis tool that is used to assess the profitability of alternative courses of action ex. raw material substitution to reduce the costs of managing the wastes generated by process; an energy retrofit to reduce the costs of energy consumption. This is particularly relevant for pollution prevention options, because of their nature, often produce financial savings that are overlooked in conventional financial analysis, either because they are misallocated, uncertain, hard to quantify, or occur more than three to five years after the initial investment. TCA involves all of the relevant costs and savings associated with an option so that it can compete for scarce capital resources fairly, on a level playing field. The assessments are often beneficial in respect of the following:

- Identification of costly resource inefficiencies
- Financial analysis of environmental activities/projects such as investment in cleaner technologies
- Prioritization of environmental activities/projects
- Evaluation of product mix and product pricing
- Benchmarking against the performance of other processes or against the competitors

A comparison of cost assessments is given below:

- Conventional cost accounting (CCA): Direct and indirect financial costs+ Recognized contingent costs
- Total Cost Assessment (TCA): A broader range of direct, indirect, contingent and less quantifiable costs
- Full Cost assessment (FCA): TCA + External social costs borne by society

2.3.1.4 Environmental audit/statement

The key objectives of an environmental audit includes compliance verification, problem identification, environmental impact measurement, environmental performance measurement, conforming effectiveness of EMS, providing a database for corrective

actions and future actions, developing companies environmental strategy, communication and formulating environmental policy.

The MoEF, Government of India issued Notification on '*Environmental Statements'* (ES) in April, 1992 and further amended in April 1993 – As per the Notification, the industries are required to submit environmental statements to the respective State Pollution Control Boards (SPCBs). ES is a pro-active tool for self-examination of the industry itself to reduce/minimize pollution by adopting process modifications, recycling and reusing of the resources. The regular submission of ES will indicate the systematic improvement in environmental pollution control being achieved by the industry. In other way, the specific points in ES may be used as environmental performance indicators for relative comparison, implementation and to promote better practices.

2.3.1.5 Environmental benchmarking

Environmental performance and operational indicators could be used to navigate, manage and communicate the significant aspects and give enough evidence of good environmental house keeping. Besides prescribing standards, an insight to identify the performance indicators and prescribing schedule for systematic improvement in performance of these indicators will yield better results.

Relative indicators may be identified for different industrial sectors to be integrated with the companies and organizations to monitor and manage the different environmental aspects of the company, to benchmark and compare two or more companies from the same sector. These could cover the water consumption, wastewater generation, energy consumption, solid/hazardous waste generation, chemical consumption, *etc.*, per tonne of final product. Once these benchmarks are developed, the industries which are below them may be guided and enforced to reach the level and those which are better than the benchmark may be encouraged further by giving incentives, *etc.*

2.3.1.6 Environmental indicators

Indicators can be classified into environmental performance indicators (EPI) and environmental condition indicators (ECI). The EPIs can be further divided into two categories *i.e.* operational performance indicators and management performance indicators.

The operational performance indicators are related to the process and other operational activities of the organization, these would typically address the issue of raw material consumption, energy consumption, water consumption in the organization, the quantities of wastewater generated, other solid wastes generated, emission from the organization *etc.*

Management performance indicators, on the other hand, are related to the management efforts to influence the environmental performance of the organization's operations.

The environmental condition indicators provide information about the environment. These indicators provide information about the local, regional, national or global condition of the environment. This information helps the organization to understand the environmental impacts of its activities and thus helps in taking decisions to improve the environmental performance.

Indicators are basically used to evaluate environmental performance against the set standards and thus indicate the direction in which to proceed. Selection of type of indicators for a firm or project depends upon its relevance, clarity and realistic cost of collection and its development.

2.3.2 Tools for action

2.3.2.1 Environmental policy

An environmental policy is a statement of the organization's overall aim and principles of action w.r.t the environment, including compliance with all relevant regulatory requirements. It is a key tool in communicating the environmental priorities of the organization to all its employees. To ensure an organization's commitment towards formulated environmental policy, it is essential for the top management to be involved in the process of formulating the policy and setting priorities. Therefore, the first step is to get the commitment from the higher levels of management. The organization should then conduct an initial environmental review and draft an environmental policy. This draft should be discussed and approved by the board of directors and finally the approved environmental policy statement must be communicated internally among all its employees and must also be made available to the public.

2.3.2.2 Market-based economic instruments

Market-based instruments are regulations that encourage behavior through market signals rather than through explicit directives regarding pollution control levels. These policy instruments such as tradable permits pollution charge are often described as harnessing market forces. Market based instruments can be categorized into the following four major categories which are discussed below.

- **Pollution charge:** Charge system will assess a fee or tax on the amount of pollution a firm or source generates. It is worthwhile for the firm to reduce emissions to the point, where its marginal abatement costs are equal to the tax rate. Thus the firms control pollution to different degrees *i.e.*, High cost controllers – less; low-cost controllers – more. The charge system encourages the industries to further reduce the pollutants. The charges thus collected can form a fund for restoration of the environment. Another form of pollution charge is a deposit refund system, where the consumers pay a surcharge when purchasing a potentially polluting product, and receive a refund on return of the product after useful life span at appropriate centers. The concept of extended producer's responsibility is brought in to avoid accumulation of dangerous products in the environment.
- **Tradable permits:** Under this system, firms that achieve the emission levels below their allotted level may sell the surplus permits. Similarly, the firms, which are required to spend more to attain the required degree of treatment/allotted levels, can purchase permits from others at lower costs and may be benefited.
- **Market barrier reductions:** Three known market barrier reduction types are as follows:
  - Market creation: Measures and facilitates the voluntary exchange of water rights and thus promote efficient allocation of scarce water supplies.
  - Liability concerns: Encourages firms to consider potential environmental damages of their decisions

  - Information programmes: Ecolabeling and energy – efficiency product labeling requirements
- **Government subsidy reduction:** Subsidies are the mirror images of taxes and, in theory, can provide incentives to address environmental problems. However, it has been reported that the subsidies encourage economically inefficient and environmentally unsound practices, and often lead to market distortions due to differences in the area. However, in the national interest, subsidies are important to sustain the expansion of production. In such cases, the subsidy may be comparable to the net social benefit.

2.3.2.3 Innovative funding mechanism

There are many forums under which the fund is made available for the issues which are of global/regional concern (GEF, OECD, Deutch green fund *etc*.) *i.e*., climate change, Basal convention and further fund sources are being explored for the Persistent Organic Pollutants Convention. Besides these global funding mechanisms, a localized alternative mechanism for boosting the investment in environmental pollution control must be put in place. For example, in India the Government has established mechanism to fund the common effluent treatment plants, which are specifically serving the small and medium scale enterprises *i.e.,* 25% share by the State Government, matching grants from the Central Government and surety for 25% soft loan. It means that the industries need to invest only 25% initially, thus encouraging voluntary compliance.

There are some more options *i.e*., if the pollution tax/charge is imposed on the residual pollution being caused by the industries, municipalities, *etc.*, funds will be automatically generated, which in turn, can be utilized for funding the environmental improvement programmes. The emerging concept of build-operate-transfer (BOT) is an encouraging development, where there is a possibility to generate revenue by application of advanced technologies. There are many opportunities which can be explored. However, what is required is the paradigm shift and focused efforts.

2.3.2.4 EMS and ISO certification

EMS is that part of the overall management system, which includes the organizational structure, responsibilities, practices, procedures, processes and resources for determining and implementing the forms of overall aims, principles of action w.r.t the environment. It encompasses the totality of organizational, administrative and policy provisions to be taken by a firm to control its environmental influences. Common elements of an EMS are the identification of the environmental impacts and legal obligations, the development of a plan for management & improvement, the assignment of the responsibilities and monitoring of the performance.

2.3.2.5 Total environmental quality movement

Quality is regarded as

- A product attribute that must be set at an acceptable level and balanced against the cost
- Something delivered by technical systems engineered by experts rather than the organization as a whole

- Assured primarily through the findings and correction of mistakes at the end of the production process

One expression of the total environment quality movement (TEQM) is a system of control called Kaizen. The principles of Kaizen are:

- Goal must be continuous improvement of quality instead of acceptable quality
- Responsibility of the quality shall be shared by all members of an organization
- Efforts should be focused on improving the whole process and design of the products

With some modifications, the TQM approach can be applied in the improvement of corporate environmental performance in both process and product areas.

2.3.2.6 Eco-labeling

It is known as the practice of supplying information on the environmental characteristics of a product or service to the general public. These labeling schemes can be grouped into three types:

- Type I: Multiple criteria base; third party (Govt. or non-commercial private organizations) programme claims overall environmental preferability.
- Type II: Specific attributes of a product; often issued by a company/industrial association
- Type III: Agreed set of indices; provides quantified information; self declaration

Among the above, Type I schemes are more reliable because they are established by a third-party and considers the environmental impacts of a product from cradle to grave. However, the labeling program will only be effective if linked with complementary programme of consumer education and up on restriction of umbrella claims by the producers.

2.3.2.7 Cleaner production

Cleaner production is one of the tools, which influences the environmental pollution control. It is also seen that the approach is changing with time *i.e.*, dumping-to-control-to-recycle-to-prevention. Promotion of cleaner production principles involves an insight into the production processes not only to get desired yield, but also to optimize raw material consumption, *i.e.*, resource conservation and implications of the waste treatment and disposal.

2.3.2.8 4-R concept

The concept endorses utilization of waste as a by-product to the extent possible *i.e.*, Recycle, Recover, Reuse, Recharge. Recycling refers to using wastes/ by-products in the process again as a raw material to maximize the production. Recovery refers to engineering means such as solvent extraction, distillation, precipitation, *etc.*, to separate the useful constituents of the wastes, so that these recovered materials can be used. Reuse refers to the utilization of waste from one process as a raw material to other. Recharging is an option in which the natural systems are used for renovation of waste for further use.

2.3.2.9 Eco-efficiency

The World Business Council on Sustainable Development (WBCSD) defines eco-efficiency as "the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with earth's carrying capacity". The business implements the eco-efficiency on four levels *i.e.*, optimized processes, recycling of wastes, eco-innovation and new services. Fussler (1995) defined six dimensions of eco-efficiency, which are given below to understand/examine the system.

- Mass: There is an opportunity to significantly reduce mass burdens (raw materials, fuels, utilities consumed during the life cycle)
- Reduce Energy Use: The opportunity is to redesign the product or its use to provide significant energy savings.
- Reduce Environmental Toxins: This is a concern to the environmental quality and human health. The opportunity here is to significantly control the dispersion of toxic elements.
- Recycle when Practical: Designing for recycling is important
- Working with Mother Nature: Materials are borrowed and returned to the nature without negatively affecting the balance of the ecosystem.
- Make it Last Longer: It relates to useful life and functions of products. Increasing the functionality of products also increases their eco-efficiency.

The competitiveness among the companies and long-term survival will continue and the successful implementation of eco-efficiency will contribute to their success. There is a need to shift towards responsible consumerism equal to the efficiency gains made by corporations – doing more with less.

2.3.2.10 Industrial eco-system or metabolism

Eco-industrial development is a new paradigm for achieving excellence in business and environmental performance. It opens up innovative new avenues for managing business and conducting economic development by creating linkages among local 'resources', including businesses, non-profit groups, governments, unions, educational institutions, and communities for creative fostering of dynamic and responsible growth. Antiquated business strategies based on isolated enterprises are no longer responsive enough to market, environmental and community requirements.

Sustainable eco-industrial development has a systematic view of development, business and environment attempting to stretch the boundaries of current practice - on one level, it is as directly practical as making the right connections between the wastes and resources needed for production and at the other level, it is a whole new way of thinking about doing business and interacting with communities. At a most basic level, it is each organization seeking higher performance within itself. However, most eco-industrial activity is moving to a new level by increasing the inter-connections between the companies.

Strategic partnership, networked manufacturing and performed supplier arrangements are all the examples of ways used by the businesses to ensure growth, contain costs and to reach out for new opportunities.

For most businesses, the two essentials for success are the responsive markets and access to cost-effective, quality resources for developing products or delivering services. In absence of these two factors, every other incentive virtually becomes a minor consideration.

Transportation issues are important at two levels – the ability to get goods to market in an expeditious way is essential to success in this day of just-in-time inventories. The use of least impact transportation, with due consideration of speed and cost, supports business success and addresses the concerned in the community.

Eco-industrial development works because it consciously mixes a range of targeted strategies shaped to the contours of the local community. Most importantly, it works because the communities want nothing less than the best possible in or near their neighborhoods. For companies, it provides a path towards significant higher operating results and positive market presence. For our environment, it provides greater hope that the waste will be transformed into valued product and that the stewardship will be a joint pledge of both businesses and communities.

2.3.2.11 Voluntary agreements

Voluntary environmental agreements among the industries, government, public representatives, NGOs and other concerned towards attaining certain future demands of the environment are reported to be successful. Such agreements may be used as a tool wherever the Government likes to make the standards stringent in future (phase-wise-stringent). These may be used when conditions are temporary and requires timely replacements. Also these may be used as supplementary/ complimentary in implementation of the regulation. The agreements may include:

- Target objectives (emission limit values/standards)
- Performance objectives (operating procedures)
- R&D activities – Government and industry may have agreement to establish better control technologies.
- Monitoring & reporting of the agreement conditions by other agents (NGOs, public participants, civil authority *etc.*)
-

In India, the MoEF has organized such programme, popularly known as the corporate responsibility for environment protection (CREP) considering identified 17 categories of high pollution potential industrial sectors. Publication in this regard is available with Central Pollution Control Board (CPCB).

2.3.3 Tools for communication

2.3.3.1 State of environment

The Government of India brought out the state of environment report for entire country and similar reports available for many of the states. These reports are published at regular intervals to record trends and to identify the required interventions at various levels. These reports consider the internationally accepted DPSIR framework for the presentation of the information. DPSIR refers to

- D – Driving forces – causes of concern *i.e.* industries, transportation *etc.*

- P – Pressures – pollutants emanating from driving forces *i.e.* emission
- S – State – quality of environment *i.e.* air, water & soil quality
- I – Impact – Impact on health, eco-system, materials, biodiversity, economic damage *etc.*
- R – Responses – action for cleaner production, policies (including standards/ guidelines), targets *etc.*

Environment reports including the above elements gives a comprehensive picture of specific target area in order to take appropriate measures for improvement. Such reports capture the concerns which could be considered in EIAs.

2.3.3.2 Corporate environmental reporting

Corporate Environmental Reports (CER) are just a form of environmental reporting defined as publicly available, stand-alone reports, issued voluntarily by the industries on their environmental activities (Borphy and Starkey-1996). CER is a means to environmental improvement and greater accountability, not an end in itself.

Three categories of environmental disclosure are:

- Involuntary Disclosure: Without its permission and against its will (env. Campaign, press *etc.*)
- Mandatory Disclosure: As required by law
- Voluntary Disclosure: The disclosure of information on a voluntary basis

2.4 Objectives of EIA

Objectives of EIA include the following:

- To ensure that the environmental considerations are explicitly addressed and incorporated into the development and decision-making process;
- To anticipate and avoid, minimize or offset the adverse significant biophysical, social and other relevant effects of development proposals;
- To protect the productivity and capacity of natural systems and the ecological processes which maintain their functions; and
- To promote development that is sustainable and optimizes resource use and management opportunities.

2.5 Types of EIA

Environmental assessments could be classified into four types *i.e.* strategic environmental assessment, regional EIA, sectoral EIA and project level EIA. These are precisely discussed below:

Strategic environmental assessment

Strategic Environmental Assessment (SEA) refers to systematic analysis of the environmental effects of development policies, plans, programmes and other proposed strategic actions. SEA represents a proactive approach to integrating environmental

considerations into the higher levels of decision-making – beyond the project level, when major alternatives are still open.

Regional EIA

EIA in the context of regional planning integrates environmental concerns into development planning for a geographic region, normally at the sub-country level. Such an approach is referred to as the economic-cum-environmental (EcE) development planning (Asian Development Bank, 1993a). This approach facilitates adequate integration of economic development with management of renewable natural resources within the carrying capacity limitation to achieve sustainable development. It fulfils the need for macro-level environmental integration, which the project-oriented EIA is unable to address effectively. Regional EIA addresses the environmental impacts of regional development plans and thus, the context for project-level EIA of the subsequent projects, within the region. In addition, if environmental effects are considered at regional level, then the cumulative environmental effects of all the projects within the region can be accounted.

Sectoral EIA

Instead of project-level-EIA, an EIA should take place in the context of regional and sectoral level planning. Once sectoral level development plans have the integrated sectoral environmental concerns addressed, the scope of project-level EIA will be quite minimal. Sectoral EIA will helps in to addressing specific environmental problems that may be encountered in planning and implementing sectoral development projects.

Project level EIA

Project level EIA refers to the developmental activity in isolation and the impacts that it exerts on the receiving environment. Thus, it may not effectively integrate the cumulative effects of the development in a region.

From the above discussion, it is clear that the EIA shall be integrated at all levels *i.e.*, strategic, regional, sectoral and project level. Whereas, the strategic EIA is a structural change in the way the things are evaluated for decision-making, the regional EIA refers to substantial information processing and drawing complex inferences. The project-level EIA is relatively simple and reaches to meaningful conclusions. Therefore in India, largely, the project-level EIA studies are taking place and are being considered. However, in the re-engineered Notification, provisions are incorporated for giving a single clearance for the entire industrial estate for e.g., Leather parks, pharma cities, *etc.*, which is a step towards the regional approach.

As we progress and the resource planning concepts emerge in our decision-making process, the integration of overall regional issues will become part of the impact assessment studies.

2.6 Basic EIA Principles

By integrating the environmental impacts of the development activities and their mitigation in early stages of project planning, the benefits of EIA could be realized in all

the stages of a project, from exploration, planning, through construction, operations, decommissioning, and beyond site closure.

A properly-conducted-EIA also lessens conflicts by promoting community participation, informing decision-makers, and also helps in laying the base for environmentally sound projects. An EIA should meet at least three core values (EIA Training Resource Manual, UNEP 2002,):

- Integrity: The EIA process should be fair, objective, unbiased and balanced
- Utility: The EIA process should provide balanced, credible information for decision-making
- Sustainability: The EIA process should result in environmental safeguards

Ideally an EIA process should be:

- Purposive- should inform decision-makers and result in appropriate levels of environmental protection and community well-being.
- Rigorous- should apply 'best practicable' science, employing methodologies and techniques appropriate to address the problems being investigated.
- Practical- should result in providing information and acceptable and implementable solutions for problems faced by the proponents.
- Relevant- should provide sufficient, reliable and usable information for development planning and decision-making.
- Cost-effective- should impose the minimum cost burdens in terms of time and finance on proponents and participants consistent with meeting accepted requirements and objectives of EIA..
- Efficient- should achieve the objectives of EIA within the limits of available information, time, resources and methodology.
- Focused- should concentrate on significant environmental effects and key issues; *i.e.*, the matters that need to be considered while making decisions.
- Adaptive- should be adjusted to the realities, issues and circumstances of the proposals under review without compromising the integrity of the process, and be iterative, incorporating lessons learnt throughout the project life cycle.
- Participative- should provide appropriate opportunities to inform and involve the interested and affected public, and their inputs and concerns should be addressed explicitly in the documentation and decision-making.
- Inter-disciplinary- should ensure that the appropriate techniques and experts in the relevant bio-physical and socio-economic disciplines are employed, including the use of traditional knowledge as relevant.
- Credible- should be carried out with professionalism, rigor, fairness, objectivity, impartiality and balance, and be subject to independent checks and verification.
- Integrated- should address the inter-relationships of social, economic and biophysical aspects.
- Transparent- should have clear, easily understood requirements for EIA content; ensure public access to information; identify the factors that are to be taken into account in decision-making; and acknowledge limitations and difficulties.

- Systematic- should result in full consideration of all relevant information on the affected environment, of proposed alternatives and their impacts, and of the measures necessary to monitor and investigate residual effects.

2.7 Project Cycle

The generic project cycle including that of TPP has six main stages:

1. Project concept
2. Pre-feasibility
3. Feasibility
4. Design and engineering
5. Implementation
6. Monitoring and evaluation

▪

It is important to consider the environmental factors on an equal basis with technical and economic factors throughout the project planning, assessment and implementation phases. EIA should be introduced at the earliest in the project cycle and must be an integral part of the project pre-feasibility and feasibility stage. If the EIA considerations are given due respect in the site selection process by the project proponent, the subsequent stages of the clearance process would get simplified and would also facilitate easy compliance to the mitigation measures throughout the project life cycle.

A project's feasibility study should include a detailed assessment of significant impacts, the prediction and quantification of impacts and delineation of Environmental Management Plan (EMP). Findings of the EIA study should preferably be incorporated in the project design stage so that the project as well as the site alternatives is studied and necessary changes, if required, are incorporated in the project design stage. This practice will also help the management in assessing the negative impacts and in designing cost-effective remedial measures. In general, EIA enhances the project quality and improves the project planning process.

2.8 Environmental Impacts

Environmental impacts resulting from proposed actions can be grouped into following categories:

- Beneficial or detrimental
- Naturally reversible or irreversible
- Repairable via management practices or irreparable
- Short-term or long-term
- Temporary or continuous
- Occurring during construction phase or operational phase
- Local, regional, national or global
- Accidental or planned (recognized before hand)
- Direct (primary) or Indirect (secondary)
- Cumulative or single

The category of impact as stated above and its significance will facilitate the Expert Appraisal Committee (EAC)/State Level EAC (SEAC) to take a look at the ToR for EIA studies, as well as, in decision making process about the developmental activity.

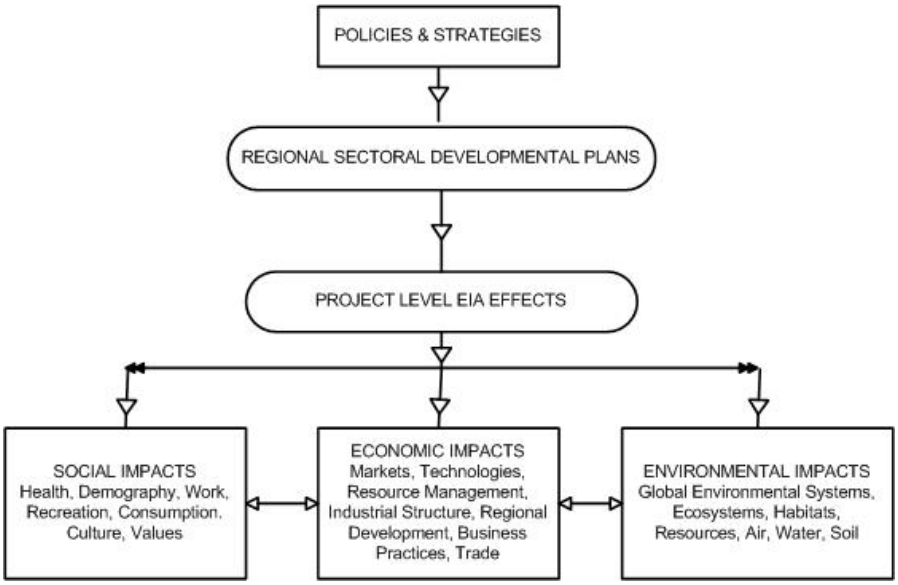


Figure 2-2: Types of Impacts

The nature of impacts could fall within three broad classifications namely direct, indirect and cumulative, based on the characteristics of impacts. The assessment of direct, indirect and cumulative impacts should not be considered in isolation nor can be considered as separate stages in the EIA. Ideally, the assessment of such impacts should form an integral part of all stages of the EIA. The TGM does not recommend a single method to assess the types of impacts, but suggests a practical framework/approach that can be adapted and combined to suit a particular project and the nature of impacts.

2.8.1 Direct impacts

Direct impacts occur through direct interaction of an activity with an environmental, social, or economic component. For example, a discharge of TPP or an effluent from the Effluent Treatment Plant (ETP) into a river may lead to a decline in water quality in terms of high biological oxygen demand (BOD) or dissolved oxygen (DO) or rise of water toxins. Another example of direct impact of a TPP is the emissions of SOx in flue gases shall enhance the ambient air pollution concentration of SO_2, *etc.*

2.8.2 Indirect impacts

Indirect impacts on the environment are those which are not a direct result of the project, often produced away from or as a result of a complex impact pathway. The indirect impacts are also known as secondary or even tertiary level impacts. For example, ambient air SO_2 rise due to stack emissions may deposit on land as SO_4 and cause acidic soils. Another example of indirect impact is the decline in water quality due to rise in temperature of water bodies receiving cooling water discharge from the nearby industry. This, in turn, may lead to a secondary indirect impact on aquatic flora in that water body and may further cause reduction in fish population. Reduction in fishing harvests, affecting the incomes of fishermen is a third level impact. Such impacts are characterized

as socio-economic (third level) impacts. The indirect impacts may also include growth-inducing impacts and other effects related to induced changes to the pattern of land use or additional road network, population density or growth rate (e.g. around a power project). In the process, air, water and other natural systems including the ecosystem may also be affected.

2.8.3 Cumulative impacts

Cumulative impact consists of an impact that is created as a result of the combination of the project evaluated in the EIA together with other projects in the same vicinity causing related impacts. These impacts occur when the incremental impact of the project is combined with the cumulative effects of other past, present and reasonably foreseeable future projects. Figure 2-3 depicts the same. Respective EAC may exercise their discretion on a case-by-case basis for considering the cumulative impacts.

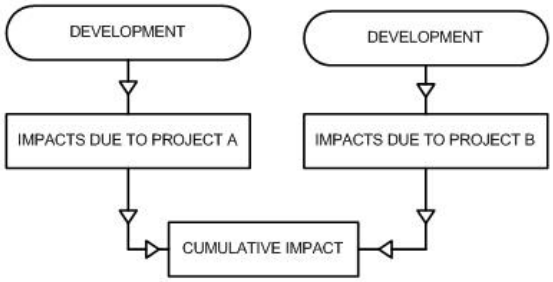


Figure 2-3: Cumulative Impact

2.8.4 Induced impact

The cumulative impacts can be due to induced actions of projects and activities that may occur if the action under assessment is implemented such as growth-inducing impacts and other effects related to induced changes to the pattern of future land use or additional road network, population density or growth rate (e.g. excess growth may be induced in the zone of influence around the proposed industry, and in the process causing additional effects on air, water and other natural ecosystems). Induced actions may not be officially announced or be a part of any official plan. Increase in workforce and nearby communities contributes to this effect.

They usually have no direct relationship with the action under assessment, and represent the growth-inducing potential of an action. New roads leading from those constructed for a project, increased recreational activities (e.g., hunting, fishing), and construction of new service facilities are examples of induced actions.

However, the cumulative impacts due to induced development or third level or even secondary indirect impacts are difficult to be quantified. Because of higher levels of uncertainties, these impacts cannot normally be assessed over a long time horizon. An EIA practitioner can only guess as to what such induced impacts may be and the possible extent of their implications on the environmental factors. Respective EAC may exercise their discretion on a case-by-case basis for considering the induced impacts.

2.9 Significance of Impacts

This TGM establishes the significance of impacts first and proceeds to delineate the associated mitigations and measures. So the significance here reflects the "worst-case-scenario" before mitigation is applied, and therefore provides an understanding of what may happen if mitigation fails or if it is not as effective as predicted. For establishing significance of different impacts, understanding the responses and interaction of the environmental system is essential. Hence, the impact interactions and pathways are to be understood and established first. Such an understanding will help in the assessment process to quantify the impact as accurately as possible. Complex interactions, particularly in case of certain indirect or cumulative impacts, may give rise to non-linear responses which are often difficult to understand and therefore their significance difficult to assess their significance. It is hence understood that indirect or cumulative impacts are more complex than the direct impacts. Currently the impact assessments are limited to direct impacts. In case mitigation measures are delineated before determining significance of the effect, the significance represents the residual effects.

However, the ultimate objective of an EIA is to achieve sustainable development. The development process shall invariably cause some residual impacts even after implementing an EMP effectively. Environmentalists today are faced with a vital, not-easy-to-answer question—"What is the tolerable level of environmental impact within the sustainable development framework?" As such, it has been recognized that every ecosystem has a threshold for absorbing deterioration and a certain capacity for self-regeneration. These thresholds based on concept of carrying capacity are as follows:

- Waste emissions from a project should be within the assimilative capacity of the local environment to absorb without unacceptable degradation of its future waste absorptive capacity or other important services.
- Harvest rates of renewable resource inputs should be within the regenerative capacity of the natural system that generates them; depletion rates of non-renewable inputs should be equal to the rate at which renewable substitutes are developed by human invention and investment.

The aim of this model is to curb over-consumption and unacceptable environmental degradation. But because of limitation in available scientific basis, this definition provides only general guidelines for determining the sustainable use of inputs and outputs. To establish the level of significance for each identified impact, a three-stage analysis may be referred:

- First, an impact is qualified as being either negative or positive.
- Second, the nature of impacts such as direct, indirect, or cumulative is determined using the impact network
- Third, a scale is used to determine the severity of the effect; for example, an impact is of low, medium, or high significance.

It is not sufficient to simply state the significance of the effect. This determination must be justified, coherent and documented, notably by a determination methodology, which must be described in the methodology section of the report. There are many recognized methodologies to determine the significance of effects.

2.9.1 Criteria/methodology to determine the significance of the identified impacts

The criteria can be determined by answering some questions regarding the factors affecting the significance. This will help the EIA stakeholders, the practitioner in particular, to determine the significance of the identified impacts eventually. Typical examples of such factors (one approach reported by Duval and Vonk 1994) include the following:

- Exceedance of a Threshold: Significance may increase if the threshold is exceeded. For e.g., Emissions of PM10 exceed the permissible threshold.
- Effectiveness of Mitigation: Significance may increase as the effectiveness of mitigation measures decreases. e.g., control technologies, which may not assure consistent compliance to the requirements.
- Size of Study Area: Significance may increase as the zone of effects increases.
- Incremental Contribution of Effects from Action under Review: Significance may increase as the relative contribution of an action increases.
- Relative Contribution of Effects of Other Actions: Significance may decrease as the significance of nearby larger actions increase.
- Relative Rarity of Species: Significance may increase as a species becomes increasingly rare or threatened.
- Significance of Local Effects: Significance may increase as the significance of local effects is high.
- Magnitude of Change Relative to Natural Background Variability: Significance may decrease if effects are within natural assimilative capacity or variability.
- Creation of Induced Actions: Significance may increase as the significance of the induced activities is also high.
- Degree of Existing Disturbance: Significance may increase if the surrounding environment is pristine.

For determining the significance of impacts, it is important to remember that secondary and higher order effects can also occur as a result of a primary interaction between the project activity and local environment. Wherever a primary effect is identified, the practitioner should always think if secondary or tertiary effects on other aspects of the environment could also arise.

The EIA should also consider the effects that could arise from the project due to induced developments, which take place as a consequence of the project. Ex. Population density and associated infrastructure and jobs for people attracted to the area by the project. It also requires consideration of cumulative effects that could arise from a combination of the effects due to other projects with those of other existing or planned developments in the surrounding area. So the necessity to formulate a qualitative checklist is suggested to test significance, in general.

3. THERMAL POWER PLANTS

3.1 Introduction to the Industry

Thermal Power Plants (TPPs) convert the energy content of an energy carrier (fuel) into either electricity or heat. The type of power plant employed depends on the source of energy and the type of energy being produced. Possible fuel sources include:

- Fossil fuels such as coal, petroleum products and natural gas
- Residual and waste materials such as domestic and industrial refuse and fuel made from recovered oil
- Fissionable material (the scope of this document do not include fissionable material)

Anthracite coal is the largest source of fuel for electricity generation followed by brown coal, natural gas and petroleum oils. Non-fossil sources of fuel such as landfill gas and biogases are also used. In some cases these non-fossil fuels are co-fired with coal. Emission factors for coal-bed methane and non-fossil fuels are not included in this Manual. Renewable sources of electricity generation such as wind power and solar power are making an increasing contribution but again are not included here.

The major components of TPP include the power system (*i.e.*, power source, turbine and generator) and associated facilities, which may include the cooling system, stack gas cleaning equipment, fuel storage handling areas, fuel delivery systems, solid waste storage areas, worker colonies, electrical substations and transmission lines, *etc.* The type of facility and size of thermoelectric projects, as well as technological configuration of generation system and also of other associated facilities besides, environmental and social concerns of plant location, will determine the nature and intensity of environmental impacts of proposed TPP facility. Figure 3-1 is a generalized flow schematic of different major components of a boiler-based TPP operations. The major pollution sources are also depicted for a typical TPP plant operational configuration.

The frame of reference of this document is limited to the fossil-fueled based power plants, in particular types using coal and petroleum products (including diesel and petro-coke). The hydropower sector will be dealt separately.

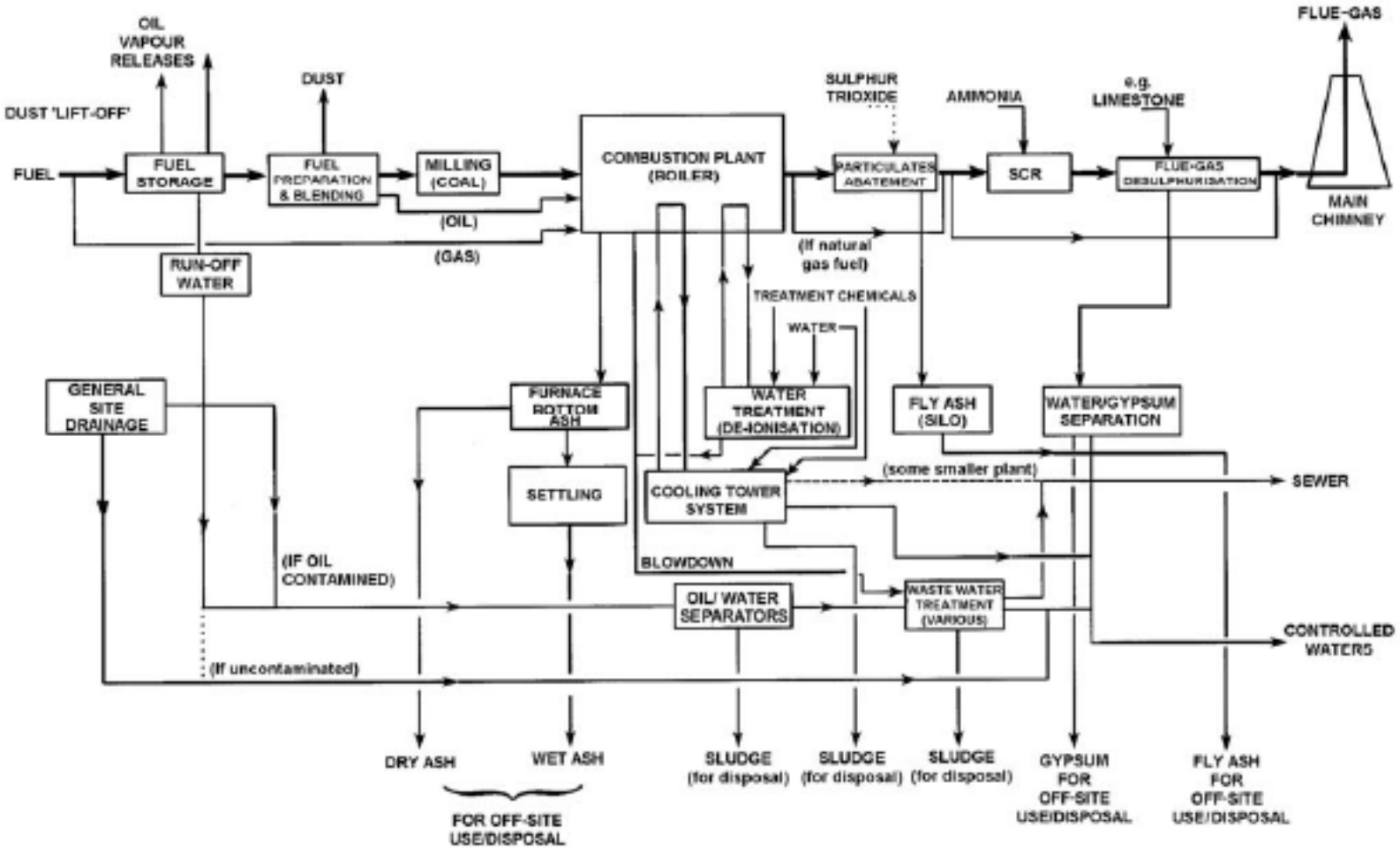


Figure 3-1: Generalized Flow Diagram of TPP and Associated Operations

Source: WorldBank/IFC

3.1.1 National power scenario

Power development in India was first started in 1897 in Darjeeling, followed by commissioning of a hydropower station at Sivasamudram in Karnataka during 1902 (India 2007). While India has made enormous strides in electricity growth, power availability India falls far short of global benchmarks. Lack of power availability is widely seen as a bottleneck to industrial development as the country aims to rapidly increase its pace of economic growth (World Bank, 1999). Long term projections indicate that an installed capacity of nearly 800 Gigawatt (GW) by 2030 is required to maintain an average annual GDP growth of 8% (Planning Commission, 2006).

Key features of the Indian electricity sector:

- Power sector is one of the core industrial sectors, which plays a very vital role in overall economic growth of the country. The power sector needs to grow at the rate of atleast 12% to maintain the present GDP growth of about 8%.
- As per the Ministry of Power report, during the year 2004 – 2005, the per capita consumption of electricity in India is 606 kWh/year. The per capita consumption of electricity is expected to grow to 1000 kWh / year by the year 2012.
- To meet the per capita consumption of 1000 kWh / year by the year 2012 the capacity augmentation requirement is about 1, 00,000 Megawatt (MW).
- The present installed capacity of the power generating units is 1, 24,311 MW.
- Presently there is a significant gap between the demand and supply of power. The energy deficit is about 8.3% and the power shortage during the peak demand is about 12.5%.
- The details of power situation from April 2005 to February 2006 are as below.

The installed power generation capacity in the country has increased from 1,400 MW in 1947 to 1,24,287.17 MW as on 31 March 2006 comprising 82,410.54 MW thermal, 32,325 MW hydro, 6190.86 Renewable Energy Sources (RES) and 3360 MW nuclear (India 2007). As the demand for electricity is expected to rise exponentially over the next decade out of three major energy sources, thermal power generation shall be dominating for medium term needs.

Demand for energy growth: Though, India has made enormous strides in electricity growth, it still has much lower global benchmark in electricity usage. In 2002, per capita consumption was 420 kWh, in contrast to the non-OECD (Organization for Economic Cooperation and Development) average of 1100 kWh and the OECD average of 8000 kWh (International Energy Agency 2004). The country has been routinely experiencing energy shortages of 6-12% whereas peak demand shortages varied between 11-20% over the last decade. Lack of power availability is widely seen as a bottleneck to industrial development, as the country aims to rapidly increase its pace of economic growth (World Bank, 1999). Furthermore, energy security has rightly emerged as a priority area for India's development prospects. Such a backdrop indicates the situation and warrants a long-term power sector development strategy that addresses various issues, in a balanced manner. India has an installed capacity of 112 GW, Transmission & Distribution infrastructure of over 5.7 million circuit kilometres. The general feature of Indian electricity sector is as under:

Table 3-1 presents the international comparative scenario of the Indian energy sector with a number of key indicators and reflects India has extremely low levels of energy use on a

per-capita basis, in comparison to the global average. The total primary energy supply (TPES) in the country was 0.51 Tonne Oil Equivalent (toe) in 2002 – this is almost one-tenth of the OECD average, less than a third of the global average.

Table 3-1: Indicators of Energy and Electricity Use in Various Countries

	TPES/Capita (toe)		TPES*/Capita (toe)		Electricity/Capita (kWh)		Electricity/GDP (MWh/million 2000 international PPP$)		GDP/Capita (2000 international PPP$)	
	1990	**2002**	**1990**	**2002**	**1990**	**2002**	**1990**	**2002**	**1990**	**2002**
India	0.43	0.51	0.22	0.31	275	421	161	165	1702	2555
China	0.78	0.96	0.60	0.79	511	1184	320	270	1597	4379
US	7.72	7.94	7.70	7.92	11713	13186	413	383	28391	34430
Japan	3.61	4.06	3.61	4.06	6609	8223	282	316	23442	26021
Global	1.64	1.65	1.46	1.47	848	888	327	310	6312	7649

(TPES: refers to total primary energy supply and TPES* refers to TPES excluding renewable and combustible sources. Source: (World Bank, 2002; IEA, 2004a, 2004b)

The priority issues of immediate concern include (i) meeting the growing demand for electricity at affordable cost; (ii) ensuring the security of primary energy supply through an appropriate mix of sources; and (iii) minimizing the environmental impacts and also (iv) complying with the climate change needs.

Coal and lignite accounted for about 57% of installed capacity (68 GW out of 118 GW) and 71% of generated electricity (424 TWh out of 594 TWh) in the country in 2004-05 where as, currently, the power sector consumes about 80% of the coal produced in the country. To meet the projected power requirement by 2012, an additional capacity of 1,00,000 MW is required during the 10th & 11th Five-Year Plans. A capacity of nearly 41,110 MW is targeted to be set up in the Tenth Plan and the remaining in the Eleventh Plan with a Thermal generation of 25416.24 MW.

Keeping in view, the huge power generation capacity requirement, Ministry of Power/Central Electricity Authority has proposed 100,000 MW environment friendly thermal initiative. This initiative intends to prepare shelf of projects, which could be taken up during the course of 11th and 12th Plan. However, coal is the only well-proven significant domestic resource to increase energy security in the country, the technology choices will be impacted by the quality of the domestic coal reserves but still preference should be for high-efficiency.

3.1.2 Fuel quality & availability

The projected rapid growth in electricity generation in the country over the next couple of decades is expected to be met by using coal as the primary fuel for electricity generation. Other resources are uneconomic (as in the case of naphtha or LNG), have insecure supplies (diesel and imported natural gas), or simply too complex and expensive to build (nuclear and hydroelectricity) to make a dominant contribution to the near-to-mid term growth.

Liquid fuels such as heavy oils have limited use in the power sector for economic and environmental reasons. Distillates such as naphtha, high sulphur diesel (HSD), and other condensates are either expensive or too polluting for large-scale use. Although domestic distillates are now allowed for use in the power sector, they are used in only niche applications. Given the limited domestic oil reserves (790 million tons in 2004-05114 – 0.5% of world reserves) and production (34 million tons in 2004-05114), as far as natural gas in the power sector is concerned, its long-term availability and cost are uncertain. Similar to oil, domestic reserves are very limited (1100 billion cubic meters in 2004-05114 – 0.6% of world's reserves). Although recent gas findings have increased this hope, the high cost of natural gas is still another crucial factor that is limiting the growth of the gas based power generation. However, the use of natural gas in the power sector is expanding fast and it is projected to increase faster by Planning Commission (2006) and others to increase in the short-to-medium term.

3.1.2.1 Coal quality & availability constraints

Indian coal has general characteristics of the Southern Hemisphere Gondwana coal which is of low calorific value and high ash typically has the following qualities (Sachdev, 1998; IEA, 2002a):

- Ash content ranging from 40-50%, with low iron content and negligible toxic trace elements
- Moisture content between 4 – 20%
- Sulphur content between 0.2 – 0.7%
- Gross calorific value between 2500 – 5000 kcal/kg, with non-coking steam coal being in the range of 2450 – 3000 kcal/kg (Visuvasam et al., 2005).
- Volatile matter content between 18 – 25%.

It is quite clear that the quality of Indian coal is poor and has gotten worse over the past decades as ash content increased from 25% (calorific content 4700 kcal/kg) to 45% (3000 kcal/kg). On an average, the Indian power plants consume about 0.7 kg of coal to generate a kWh (CEA, 2004b), whereas the U.S. power plants consume about 0.45 kg of coal per kWh (EIA, 2001).

Table 3-2: Coal Supply Position for Utility TPPs

STATUS	YEAR			
	2003-04	**2004-05**	**2005-06**	**2006-07**
Demand	260.00	277.00	310.00	322.00
Linkage	292.37	302.26	308.98	338.553
Receipt (Indigenous Coal)	261.427	276.074	282.185	293.637
Receipt (Imported Coal)	1.946*	2.537*	10.443	9.664
Total Receipt (Including Imported Coal)	263.373	278.611	292.628	303.301
Opening Stock (Includes Imported Coal)	10.714	9.924	10.499	18.174
Consumption (Includes Imported Coal)	263.608	277.735	281.336	302.539
Closing Stock (Includes Imported Coal)	9.924	10.499	18.174	14.122

3.1.2.2 Coal beneficiation

In 1997, the MoEF mandated the use of beneficiated coals with ash content of 34% (or lower) in power plants located beyond 1000 km from their coal source, and plants located in critically polluted areas, urban areas, and ecologically sensitive areas (CPCB, 2000b). There were about 18 coking coal washeries in India with a total annual capacity of 30 Metric Tonne (MT) (Singh, 2005). However, only 5 MT of washed coal was being produced and the quality of washed coking coal has reportedly been inconsistent and deteriorating over time primarily because of supply of poorer grade of raw coal (Ministry of Coal, 2006).

In this situation, the private sector took increasing interest in building coal washeries. In the last few years, the coal washery capacity in India has risen to 90 MT. More than 40 plants (about 24 GW of capacity) reportedly need better quality coals and the estimated annual cleaner coal consumption was expected to be about 87 MT (CPCB, 2000b).

The most commonly used coal washing technology in India (primarily for coking coals) is the jig washer which can be engaged for both Baum and Batac types. Some washeries also engage Dense Medium Separation (DMS) systems for coal beneficiation.

Besides technology limitations, the other constraints for the development of washery capacity are the institutional structures of the coal industry. Secondly, the quality of coal supplied to the TPPs is not guaranteed (sizing, ash content, calorific value, *etc.*), and there is no penalty for non-compliance. Hence, the power plants had to use the blended coals – using better quality foreign or a small quantity of well-cleaned domestic coal (CPCB, 2000b).

In order to bridge the gap in the supply of coal from the indigenous sources, the Ministry of Power advised the utilities to import 20.00 Million Tonnes of coal during the year 2006-07.

3.1.3 Oil and natural gas

India's domestic oil and natural gas reserves are very minimal (about 0.5% of world reserves) and over 75% of India's petroleum consumption was met through imports in 2004- 05; 126 petroleum and related products account for about a quarter of India's TPCES (Total Primary Commercial Energy Supply), Planning Commission, 2006. Furthermore, the existing domestic oil and natural gas reserves are likely to be consumed sooner, since the demand will inevitably rise and domestic production will be ramped up to meet the demand. Clearly, today's oil situation in India is not conducive to being energy secure.

3.1.3.1 Gas requirement and supply position

The production and supply of gas had not been keeping pace with the growing demand of gas in the country, including for that of power sector. Even the commitments of gas allocations made earlier to power stations were not fulfilled. The supply of gas to power plants up to 2006-07 is given in Table 3-3.

Table 3-3: Supply of Gas to Power Plants

Years	Gas Required (MMSCMD)	Gas Allocation (MMSCMD)	Gas Supplied (MMSCMD)	Shortfall (MMSCMD)
(1)	(2)	(3)	(4)	(5) = (2) - (4)
2000-01	44.54	36.67@	24.40@	20.14
2001-02	46.31	38.76@	24.33@	21.96
2002-03	48.26	39.47@	25.12@	23.14
2003-04	49.25	39.47@	25.62@	23.63
2004-05	49.73	40.95@	30.70@	19.03
2005-06	52.66	Not Available	35.37	17.29
2006-07 (As on 28th Feb.07)	54.15	Not Available	35.71	18.44

Note:

MMSCMD — Million Metric Standard Cubic Metre per Day

**Normative gas requirement at 90% Plant Load Factor with GCV of 9000 kCal/SCM (except for Ramgarh CCGT for which GCV of 4150 kCal/SCM) and Station Heat Rate of 2000 kCal/kWhr for combined cycle and 2900 kCal/kWhr for open cycle*

@ Based on the data made available by MoP&NG

3.1.4 Thermal power generation-capacity addition

India has an installed capacity of 112 GW and a Transmission & Distribution infrastructure of over 5.7 million circuit kilometres. India ranked sixth in world electricity generation and third in Asia-Pacific, next only to China and Japan In 2002. India's share in world electricity generation has steadily increased from 2.4% in 1994 to 3.6% in 2002. 12704.2 MW thermal capacity is expected to be added during 2007-08. The general feature of Indian electricity sector is as under:

Table 3-4: Power Generation Capacity

Year	Target (MW)	Achievement (MW)	Achievement (%)
2002-03	2058.00*	2223.10	108.00
2003-04	1437.34	1361.60	94.73
2004-05	2661.52	2933.92	110.23
2005-06	3458.52	1588.80	45.93
2006-07	13122.92	4006.80	30.53
Total	22738.3	12114.22	53.27

Excluding Dabhol CCGT Phase II (1444 MW)

3.1.5 Power generation technology

During pre-independent era, not only the technology for generating electricity, but also the materials and equipment necessary for construction, was imported from Britain. The coal-fired boilers were of the stoker water-tube kind, where coal was burned on a grate, and the resultant hot flue gas was directed towards water-tubes, in which water was converted to high pressure and high temperature steam (Singer et al., 1958; Miller, 2005). Most of the units installed in the 1940s were of sizes ranging from 1 MW to 15 MW, and they were designed to work with high quality coal, with calorific value greater than 6000 kcal/kg (CBIP, 1997).

In the post independence era, a key priority of the country was to become self-sufficient in food production, and hence the government planned to develop the irrigation and power sectors jointly. There were also concerns about coal availability since explored coal resources in India were limited (60 billion tons (BT)) and 'workable' coal resource was estimated to be only 20 BT (Shah, 1949). The quality of Indian coal was also very poor and conversion efficiency was very low – nearly 0.7 kg of coal was consumed to produce a unit of power (Shah, 1949). Hence, the initial emphasis was on producing power through large 'multipurpose' hydroelectric projects that would provide both water and electricity for canal-based irrigation. However, the generation from these projects was not as high as expected (annual rate of generation growth was 12% in the same period because, their construction took much longer than expected.

3.2 Scientific Aspects of Industrial Process

3.2.1 Industrial processes in the context of environmental pollution

Different types of fossil fuel electricity generation facilities broadly include:

- Steam cycle facilities (most commonly used for large utilities);
- Gas turbines (commonly used for moderate sized peaking facilities);
- Cogeneration and combined cycle facility (the combination of gas turbines or internal combustion engines with heat recovery systems); and
- Internal combustion engines (commonly used for small remote sites or stand-by (emergency) generation).

3.2.1.1 Steam cycle facility

Most of the electricity generated in India is produced by steam cycle facility. Figure 3-2 is a basic flow diagram for a steam cycle facility. In the Indian context, conventional steam-producing TPPs generate electricity through a series of energy conversion stages: fuel is burned in boilers to convert water to high-pressure steam, which is then used to drive a steam turbine to generate electricity. Heat for the system is usually provided by the combustion of coal, natural gas, oil, or biomass. High-temperature, high-pressure steam is generated in the boiler and then enters the steam turbine. At the other end of the steam turbine is the condenser, which is maintained at a low temperature and pressure. Steam rushing from the high-pressure boiler to the low-pressure condenser drives the turbine blades, which powers the electric generator. Low-pressure steam exiting the turbine enters the condenser shell and is condensed on the condenser tubes, which are maintained at a low temperature by the flow of cooling water. As the steam is cooled to condensate, the condensate is transported by the boiler feed water system back to the

boiler, where it is used again. A constant flow of low-temperature cooling water in the condenser tubes is required to keep the condenser shell (steam side) at proper pressure and to ensure efficient electricity generation. The boiler water is commonly treated to reduce corrosion and scaling in the boiler tubes. Cooling water used to condense the steam is often treated to reduce algal growth which include Sulphuric acid, Ammonia, *etc.* Wet cooling towers, commonly used to dissipate heat from the cooling water, may also be a minor source of aerosol emissions.

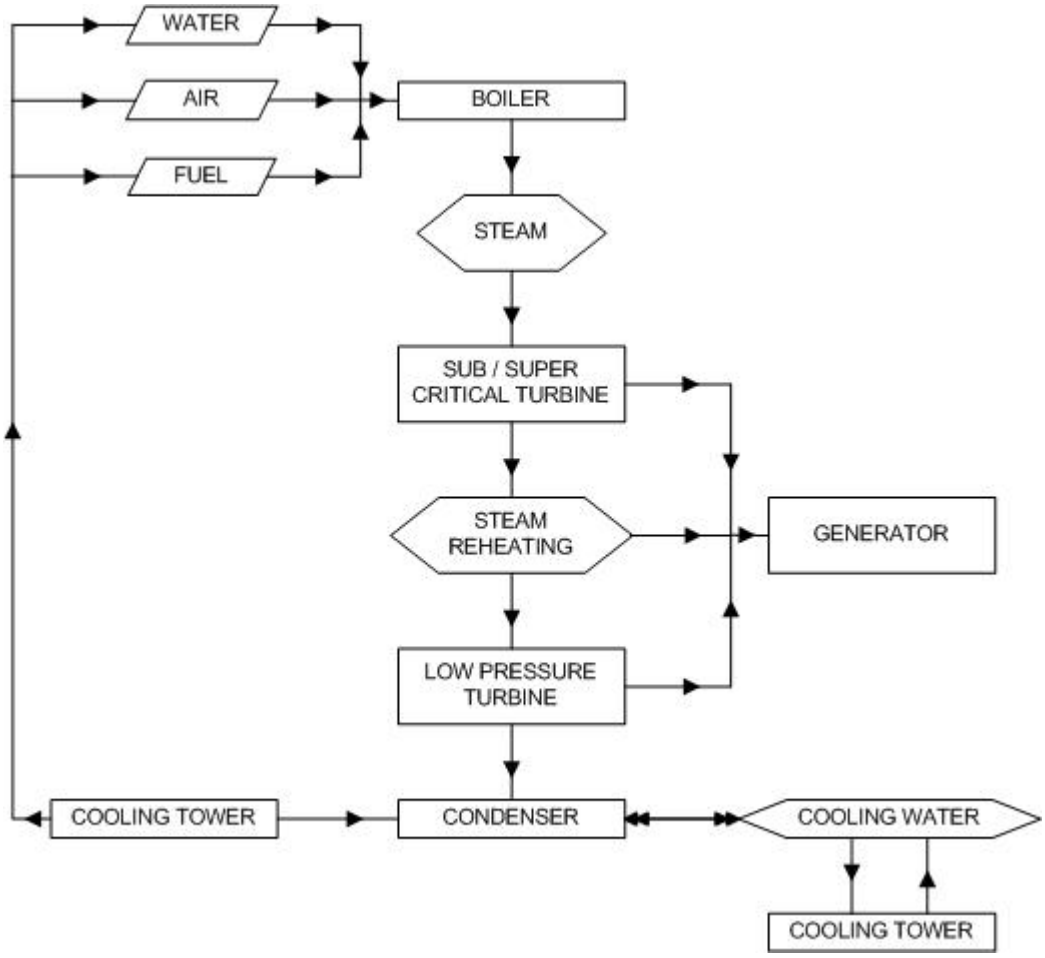


Figure 3-2: Schematic Representation of a Steam Cycle Facility

The properties and composition of Indian coals used for electricity generation vary widely. It is difficult to characterize single set of emission factors that apply to the range of coals used. Steam turbines typically have a thermal efficiency of about 35%, meaning that 35% of the heat of combustion is transformed into electricity. The remaining 65% of the heat either goes up the stack (typically 10%) or is discharged with the condenser cooling water (typically 55%).

Particulate material (e.g., fly ash or particulate matter) in gas streams from the combustion process are captured by electrostatic precipitators or fabric filters (FF – also called bag houses). Ash is also extracted from the bottom of the boiler (bottom ash). Ash is transported to ash ponds as a slurry, dense phase (paste), or dry. Fly ash from some power stations is used for blending with cement. Ash is composed of modified coal mineral matter, *i.e.*, primary compounds of silicon, aluminum, iron, calcium, manganese, potassium, sodium and titanium which form a matrix for traces of compounds of other

metals. Ash composition depends on the coal properties, combustion technology and combustion conditions. Usually very small amount of ash is released to air after ash control technology. The major emissions to air include carbon dioxide (CO_2), water vapour, carbon monoxide (CO), oxides of nitrogen (NOx), and sulphur dioxide (SO_2). There are much lower emissions of metals and organic compounds. CO_2 and water vapour are not considered as pollutants and are not included in the purview of EIA.

Common boiler types used can be divided into wall firing (*i.e.*, burners on one or two walls), or tangential firing (*i.e.* corner burners that create a circular shaped flame). Coal and ash storage, their handling facilities, and bulk hydrocarbon storage associated with power station operations, can lead to fugitive dust (*i.e.*, coal or ash) and hydrocarbon emissions to air respectively. The pollution potentials concerning air, water, land and soil environments are summarized in Table 3-5.

Table 3-5: Emissions from Steam Cycle TPPs

Source	Input	Output
Air Pollution Emissions		
Steam cycle/natural gas	Natural gas, auxiliary fuel (fuel oil, distillate, LPG), dematerialized water, cooling water, lubricants, degreasers, water treatment chemicals.	NOx, CO, SOx (very low), PM10, Organic Compounds (OCs), and trace metals & compounds
Steam cycle/oil	Fuel oil, auxiliary fuel (natural gas, distillate, LPG), dematerialized water, lubricants, degreasers	NOx, SOx, CO, particulates (including PM10), trace metals & compounds, OCs.
Steam cycle/Pulverized coal	Coal, dematerialized water, auxiliary fuel (fuel oil, natural gas, briquettes, lubricants, degreaser, water treatment chemicals)	NOx, CO, SOx, particulates (including PM10), fugitive dust, trace metals & compounds, OCs.
Water Pollution Emissions		
Steam cycle/pulverized coal, natural gas, oil	Coal, dematerialized water, auxiliary fuel (fuel oil, natural gas, briquettes), lubricants, degreasers, water treatment chemicals/effluent, detergents	Chlorine, acids, alkalis, suspended solids, nitrogen, phosphorus, trace metals & compounds, oil spills, degreasers, detergents
Land Pollution Emissions		
Steam cycle/pulverized coal, natural gas, oil	Coal, dematerialized water, auxiliary fuel (fuel oil, natural gas, briquettes), lubricants, degreasers, water treatment chemicals	ash, oil/chemical spills, metals & compounds, wastes

Fluidized-bed combustion: Indian power sector ventured into the circulating fluidized-bed (CFBC) boilers at the utility scale with external collaboration but did not progress much. The key advantage of using CFBC boilers is their relative insensitivity to coal properties – these boilers can burn high-ash, high-moisture content, and low calorific value coal (including lignite), and therefore are well suited for Indian poor-quality coals. CFBC boilers (2x125 MW) were successfully commissioned in 2000 in the Surat Lignite Power Plant. Installation of 2x125 MW CFBC units is in progress in Akrimota, Gujarat.

However, for recycling of coal washery middling and other low-quality domestic coal, CFBC offers a good opportunity addition.

Gas and oil-fired steam cycle: A major difference between coal-fired facilities and gas or oil-fired facilities, is that gas and oil facilities burn the fuel with minimal on-site processing before combustion. Generally, they do not have control equipment to collect particulate matter, as emissions of particulate matter are low. Emissions to air include CO_2, water vapour, NOx, CO, minor emissions of metals and metal compounds and organics, and SO_2 for oil firing. Bulk hydrocarbon storage can be a source of emissions of Total Volatile Organic Compounds (TVOCs) and of individual hydrocarbon substances due to evaporative losses from storage tanks.

Natural gas and liquid fuels are usually transported to TPPs via pipelines. Coal and biomass fuels can be transported by rail, barge, or truck. In some cases, coal is mixed with water to form slurry that is pumped to the TPP in a pipeline. Once coal arrives at the plant, it is unloaded to storage or directly to the stoker or hopper. In transporting coal during warmer months and in dry climates, dust is air borne.

3.2.1.2 Gas turbine

Gas turbine systems operate in a manner similar to steam turbine systems except that combustion gases are used to turn the turbine blades instead of steam. In addition to the electric generator, the turbine also drives a rotating compressor to pressurize the air, which is then mixed with either gas or liquid fuel in a combustion chamber. The greater the compression, the higher the temperature and the efficiency that can be achieved in a gas turbine. Higher temperatures, however, typically lead to increase in NOx emissions. Exhaust gases are emitted to the atmosphere from the turbine. Unlike a steam turbine system, gas turbine systems do not have boilers or a steam supply, condensers, or a waste heat disposal system. Therefore, capital costs are much lower for a gas turbine system than for a steam system.

Figure 3-3 illustrates a simple open cycle gas turbine facility. Gas turbine facilities are generally physically smaller and produce less electricity than steam cycle facilities and can be operated with short start-up periods. They are commonly used to generate electricity at peak load periods. Gas turbines are also used as standby (*i.e.* emergency) facilities. Occasionally, gas turbine facilities are used for base load operations. Emissions to air from a gas turbine facility include CO_2, water vapour, CO, NOx, and minor emissions of metals and metal compounds and organics. Emissions to water from gas turbine facilities tend to be minor and relate to maintenance activities. Bulk hydrocarbon storage can be a source of emissions. The pollution potentials concerning air, water, land and soil environments from Gas Turbine Facility are summarized in Table 3-6.

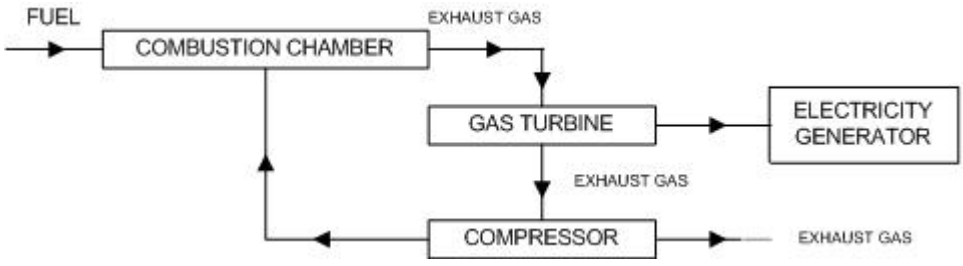


Figure 3-3: Flow Diagram of a Gas Turbine Facility

Table 3-6: Emissions from Gas Turbine

Technology/Fuel	Inputs	Output
Air Pollution Emissions		
Gas turbine/distillate	Distillate, auxiliary fuel (LPG), lubricants, degreasers, dematerialized water (cogeneration cycle)	NOx, SOx, CO, particulates (including PM_{10}), trace metals and compounds, OCs.
Gas turbine/natural gas	Natural gas, auxiliary fuel (distillate, LPG), lubricants, degreasers, dematerialized water (cogeneration/combined cycle)	NOx, SOx (very low), CO, OCs, and trace metals & compounds
Water Pollution Emissions		
Gas turbine/natural gas, distillate	Natural gas, auxiliary fuel (distillate, LPG), lubricants, degreasers, detergents, cooling system inhibitors	Oil spills, degreasers, cooling system inhibitors, detergents
Land/Soil Pollution Emissions		
Gas turbine/natural gas, distillate	Natural gas, auxiliary fuel (distillate, LPG), lubricants, degreasers	Oil spills, wastes

3.2.2 Power generation technology options

Coal-based power plants since the 1970s have dominated the power generation sector and are almost exclusively based on sub-critical pulverized coal (PC) technology. This domination of coal in the power sector is likely to continue in the future. About 50 GW of new coal-based capacity is planned for the 11th Plan, and longer term scenarios explored by the Planning Commission suggest that coal will continue to dominate the power sector consumption at least for the next three decades (Planning Commission, 2006).

As far as different efficient generation technologies are concerned there are now a number of different existing and emerging technological options that potentially can help the coal power sector meet its goal of rapid capacity addition in a manner consistent with its other challenges as highlighted earlier. However, the appropriate technology choices are also constrained by the quality of Indian coal. Furthermore, the extent of available coal reserves will also impact technology choices in the long term, with high-efficiency being preferred. The focus on rapid capacity additions, limited competition with dominance of government-owned enterprises, and lack of long-term technology planning have resulted in technology replication rather than innovation for development and deployment of new technologies.

Though, pulverized coal combustion continues to dominate the thermal power generation in India there are number of proven options available based on advanced coal technologies to meet the Indian requirements of making power generation cleaner, more efficient, and more able to utilize the varying characteristics relevant to the Indian coal reserves. Pulverized coal technologies have improved, resulting in increased efficiency and reduced local pollution. New combustion technology using circulating fluidized-beds

has been demonstrated that lower quality coals including waste coal and washery middlings or even biomass can be used for power generation. Efforts are also underway to commercialize coal-gasification-based integrated power generation. Use of pure oxygen (oxyfuel combustion) instead of air is also being considered for addressing GHG requirements.

The efficiency of the power plant is also the most sensitive parameter in determining cost of generation. When it comes to old plants there is a large gap between the actual and design efficiencies. The operational status also indicates that there is ample scope for efficiency improvements. Increasing efficiency by one percentage point in a power plant can reduce coal use, and also the emissions of air pollutants and CO_2 emissions, by 3% (Deo Sharma, 2004).

The above discussions reflect that the two fundamental processes for extraction of energy from coal are (i) Direct Solid Combustion such as conventional Pulverised Coal (PC) Combustion or the emerging Fluidised Bed Combustion (FBC) and (ii) Indirect combustion through Coal Gasification followed by coal gas combustion.

Fluidised Bed Combustor is a "three-in-one device" characterised by highly desirable features of multi-fuel capability, pollution (SO_2 and Nox) control, and energy conservation. All the four members of this family, namely Atmospheric Fluidised Bed Combustor (AFBC), Circulating Fluidised Bed Combustor (CFBC), Pressurised Fluidised Bed Combustor (PFBC) and Pressurised Circulating Fluidised Bed Combustor (PCFBC) have the potential for clean power generation. Additionally, PFBC and PCFCB systems operating in a combined cycle mode (Rankine and Brayton) have the potential for overall plant efficiencies of the order of 40-45% compared to 33-37% efficiencies offered by power plants based on Conventional PC firing, AFBC and CFBC operating on a single (Rankine) cycle. Coal gasification, at pressures up to 40 atm and suitable temperatures, results in a low calorific value (4 -7 MJ/Nm^3) gas mixture of CO and H_2, which can be burnt and expanded in a gas turbine for power generation. In an Integrated Gasifier Combined Cycle (IGCC) plant, this is supplemented by steam turbine power generation using steam generated from the gas turbine exhaust gases. Three types of coal gasifiers are in different stages of demonstration andcommercialisation in the world: Fixed Bed (Moving Bed) Gasifier (e.g. the LURGI Dry Ash System), Fluidised Bed Gasifier (e.g. KRW system)

Clean coal based technologies

A number of technologies based on coal combustion/coal gasification/combination of coal combustion and coal gasification aimed at environmental acceptability and high efficiency have been under development for almost three decades. Four of these are proven commercial technologies while the rest are in different stages of development and demonstration as given in the Table 3-7.

Table 3-7: Comparison of Different Technologies and Status of their Development in India

S. No.	Technology	Worldwide Status	Status in India
A.	PC Firing with SO_x and NO_x Control system	Commercialized	NO_x Control commercialized

B.	AFBC Power Plant	Commercialized up to 165 MWe (USA)	2 x 10 MWe units operating
C.	CFBC Power Plant	Commercialized up to 250 MWe (France)	1 x 30 Mile unit commissioned by BHEL – LURGI Maharashtra (1997)
D.	PFBC Power Plant	Demonstration units up to 130 MWe (Sweden, Spain, USA, Japan)	Bench scale R&D at BHEL and IIT Madras
E.	(i) IGCC Power Plant	Demonstration units up to 250 MWe (USA, Netherlands)	6.2 MWe demo plant at BHEL, 600 MWe Conceptual design at IICT Hyderabad; Gasifier pilot plants at BHEL and IICT; Proposal for a 250 MWe demo plant by CSIR with the Government
	(ii) Hybrid IGCC Power Plant	Pilot Plant R&D (UK)	No activity
F.	Fuel Cell based PFBC Power Plant	Advanced R&D	On-going R&D in fuel cells

Supercritical Boiler Technology is commercialized in several countries with overall plant efficiencies of 43 – 45% and with DENOX and DESOX systems. There is negligible interest in India in the technology at present. Slagging combustion technology has the special feature of burning high ash coal at very high temperatures in a primary chamber where molten ash slag can be removed before allowing almost ash -free hot gases to enter a secondary chamber to generate steam. After laboratory scale studies, this technology has been abandoned because of the inadequate flowing ability of Indian molten ash.

Control technology for petcoke use

It is difficult to valorise as it cannot be mixed with fuels due to its high sulphur content and dirtiness Petroleum coke is a challenging fuel in terms of its low volatile content, high sulphur and nitrogen content, which give rise to undesirable emission characteristics. However, the low price and increased production of petroleum coke from high-sulphur feedstocks give a powerful economic stimulus to use it for power generation. The clean combustion of petroleum coke are focused on removal of CO_2 and sulphur. The high carbon content and low moisture content of petroleum coke ensure high purity of the CO_2 stream. The low ash content is also important since it reduces the possibility of ash fusion in the calciner. It also reduces the heat loss and the requirement for ash disposal, and hence contributes to high overall efficiency. Simulation results show that high efficiency can be achieved with incorporation of the proposed scheme for power generation, even after the penalty of CO_2 recovery. Thus, there is a potential for the abundant available and low cost, but environmentally challenging petroleum coke to become a fuel for clean combustion and power generation.

Choice of energy fuel

The simplest and, in many circumstances, most cost-effective form of pollution prevention is to use cleaner fuels. For new power plants, burning natural gas currently has a decisive advantage in terms of their capital costs, thermal efficiency, and environmental

performance. Natural gas is also a preferred fuel for minimizing green house gas (GHG) emissions because it produces lower CO_2 emissions per unit of energy and enhances energy efficiency. If availability or price rules out natural gas as an option, the use of low-sulphur fuel oil or high-heat content, low-sulphur, low-ash coal should be considered. Typically, such fuels command a premium price over their dirtier equivalents, but the reductions in operating or environmental costs that they permit are likely to outweigh this premium. In preparing projects, an evaluation of alternative fuel options should be conducted at the outset to establish the most cost-effective combination of fuel, technology, and environmental controls for meeting performance and environmental objectives.

If coal is used, optimal environmental performance and economic efficiency will be achieved through an integrated approach across the whole coal-energy chain, including the policy and investment aspects of mining, preparation, transport, power generation, heat conversion, and clean coal technologies. Coal washing, in particular, has a beneficial impact in terms of reducing the ash content and ash variability of coal used in TPPs, which leads to consistent boiler performance, reduced emissions, and less maintenance.

Pet coke fuel

Petroleum coke (often abbreviated petcoke) is a carbonaceous solid derived from oil refinery coker units or other cracking processes. Petcoke is a by-product of petroleum refining. IT is a carbonaceous solid residual byproduct of the oil refining coking process. As crude oil is refined, lighter fractions or products, such as gasoline and jet fuel, are driven off leaving a residual oil of relatively little value. In refineries with cokers, this residual oil is processed further to yield additional amounts of light products, along with petroleum coke. Over 75% of the petcoke produced is considered to be fuel grade and has about 15% higher heating value than coal.

Some 40 to 60 percent of the sulphur in the oil feedstock remains in the coke, which means that the sulphur content of this refinery byproduct is usually quit high. While the actual amount of sulphur in the coke will vary depending on the sulphur in the crude oil entering the refinery, the sulphur content of coke typically ranges from four to eight percent % much greater than even high-sulphur coal. Therefore, control of sulphur emissions is very important when using petcoke as a fuel.

Though, its high heat and low ash content make it a good fuel for power generation in coal fired boilers, but petroleum coke is high in sulphur and low in volatile content which pose some environmental and technical problems with its combustion. In order to meet current North American emissions standards some form of sulphur capture is required.

Circulating fluidized beds

Circulating fluidized beds burn various types of fuels without violating emission-control norms. This makes CFBs suitable for burning fuels - high-sulphur coal, lignite, peat, oil, sludge, petroleum coke, gas and wastes - cleanly and economically in CFB boilers. This technology does away with the need for complex scrubbers, catalytic systems or other costly chemical clean-up systems.

According to the international monitoring, fluidized-bed combustion evolved from efforts to find a combustion process able to control pollutant emissions without external emission controls (such as scrubbers). The technology burns fuel at temperatures of 1,400

to 1,700 degrees F, well below the threshold where nitrogen oxides form (at approximately 2,500 degrees F, the nitrogen and oxygen atoms in the combustion air combine to form nitrogen oxide pollutants).

The mixing action of the fluidized bed brings the flue gases into contact with a sulphur-absorbing chemical, such as limestone or dolomite. More than 95 per cent of the sulphur pollutants in coal can be captured inside the boiler by the sorbent.

The popularity of fluidized bed combustion is due largely to the clean coal technology's fuel flexibility - almost any combustible material, from coal to municipal waste, can be burned - and the capability of meeting sulphur dioxide and nitrogen oxide emission standards without the need for expensive add-on controls.

The clean coal technology programme led to the initial market entry of 1st generation pressurized fluidized bed technology, with an estimated 1,000 mw of capacity installed worldwide. These systems pressurise the fluidized bed to generate sufficient flue gas energy to drive a gas turbine and operate it in a combined-cycle, the DoE report adds.

3.2.3 Environmental impacts of power plants

The impacts of TPPs on the environment are governed by Thermal Power Processes as well as project location characteristics in different ways and at different locations. The Plant processes and major pollution sources are depicted in Figure 3-1.

Coal-based power plants significantly impact the local environment. Direct impacts resulting from construction and ongoing operations include:

- Ambient Air Pollution – particulates, sulphur oxides, nitrous oxides, and other hazardous chemicals and toxic metals like Hg, As, *etc.*
- Water Pollution – occurs in local water streams, rivers and ground water from effluent discharges and percolation of hazardous materials from the stored fly ash
- Land Degradation – occurs due to alterations of land used for storing fly ash
- Noise Pollution – during operation and cause occupational as well as public health hazards

The indirect impacts result mainly from coal mining, which includes degradation and destruction of land, water, forests, habitats, and societies. In addition to the impact of the coal-power plants, there is also the much larger issue of the environmental and social impact of coal mining. In a typical TPP, environmental impacts are likely to comprise the following principal components:

- transportation of raw material
- preparing and storing raw material
- burning fuel and generating steam
- generating electricity and available heat
- treating exhaust gases and solid and liquid residues
- cooling infrastructures
- safe handling and disposal of wastes

Air Environment

Initially, perceptions of objectionable effects of air pollutants were limited to those easily detected like odour, soiling of surfaces and smoke stacks. Later, it was the concern over

long term/chronic effects that led to the identification of six criteria pollutants. These six criteria pollutants are sulphur di-oxide (SO_2), Carbon Mono-oxide (CO), Nitrogen oxide (NO_2), Ozone (O_3), suspended particulates and non-methane hydrocarbons (NMHC) now referred to as volatile organic compounds (VOC). There is substantial evidence linking them to health effects at high concentrations. Three of them namely O_3, SO_2 and NO_2 are also known phytotoxicants (toxic to vegetation). In the later part Mercury (Hg) has been added to that list.

Nitrogen Oxide (NOx): Most of the NOx is emitted as NO which is oxidised to NO_2 in the atmosphere. All combustion processes are sources of NOx at the high temperature generated in the combustion process. Formation of NOx may be due to thermal NOx which is the result of oxidation of nitrogen in the air due to fuel NOx which is due to nitrogen present in the fuel. Some of NO_2 will be converted to NO_3 in the presence of 02. In general, higher the combustion temperature the higher NOx is produced. Some of NOx is oxidised to NO_3, an essential ingredient of acid precipitation and fog. In addition, NO_2 absorbs visible light and in high concentrations can contribute to a brownish discoloration of the atmosphere.

Sulphur Oxide: The combustion of sulphur containing fossil fuels, especially coal is the primary source of SOx. About 97 to 99% of SOx emitted from combustion sources is in the form of Sulphur Di-oxide which is a criteria pollutant, the remainder is mostly SO_3, which in the presence of atmospheric water is transformed into Sulphuric Acid at higher concentrations, produce deleterious effects on the respiratory system. In addition, SO_2 is phytotoxicant.

Particulate matter: The terms particulate matter, particulate, particles are used interchangeably and all refer to finely divided solids and liquids dispersed in the air.

Mercury Emissions: Mercury can be emitted in three different forms viz., elemental (Hg0), oxidized (Hg2+) and particle bound (HgP). Upon combustion, coal flyash tends to have a higher concentration of mercury, and estimates indicate that Indian coal ash has an average mercury concentration of 0.53 mg/kg, based on measurements from a few selected power plants. The details on mercury emission status & control technology **Annexure I** may be referred.

Water environment

Water pollution refers to any change in natural waters that may impair further use of the water, caused by the introduction of organic or inorganic substances or a change in temperature of the water. In thermal power stations the source of water is either river, lake, pond or sea where from water is usually taken. There is possibility of water being contaminated from the source itself. Further contamination or pollution could be added by the pollutants of thermal power plant waste as inorganic or organic compounds.

Land degradation

The thermal power stations are generally located on the non-forest land and do not involve much Resettlement and Rehabilitation problems. However it's effects due to stack emission etc, on flora and fauna, wild life sanctuaries and human life *etc.* have to be studied for any adverse effects. One of the serious effects of thermal power stations is land requirement for ash disposal and hazardous elements percolation to ground water through ash disposal in ash ponds. Due to enormous quantity of ash content in India coal, approximately Acre per MW of installed thermal capacity is required for ash disposal.

According to the studies carried out by International consultants if this trend continues, by the year 2014 -2015, 1000 sq. km of land should be required for ash disposal only.

Noise pollution

Some areas inside the plant will have noisy equipments such as crushers, belt conveyors, fans, pumps, milling plant, compressors, boiler, turbine *etc.* Various measures taken to reduce the noise generation and exposure of workers to high noise levels in the plant area will generally include:

i) Silencers of fans, compressors, steam safety valves *etc.*

ii) Using noise absorbent materials.

iii) Providing noise barriers for various areas.

iv) Noise proof control rooms.

v) Pro vision of green belt around the plant will further reduce noise levels.

Thermal Power Stations in India, where poor quality of coal is used, add to environmental degradation problems through gaseous emissions, particulate matter, fly ash and bottom ash. Growth of man ufacturing industries, in public sector as well as in private sector has further aggravated the situation by deteriorating the ambient air quality. Ash content being in abundance in Indian coal, problem of fly ash and bottom ash disposal increase day by day. The fly ash generated in thermal power station causes many hazardous diseases like Asthma, Tuberculosis *etc.* Table 3-8 indicates, TPPs can affect the media air, water and soil, as well as human beings, plants, animals and the landscape.

Table 3-8: Potential Emissions from a TPP

Type of Emission	Process Stage/Operation					
	Fuel Storage and Processing	Combustion and Steam Generation	Flue gas Cleaning (if any)	Power Generation	Cooling Systems	Treatment of Residue
Particulates	*	*			*	*
Noxious gases		*				*
Wastewater	*	*	*		*	*
Solid Residues		*	*			*
Waste heat		*		*	*	
Noise	*	*	*	*	*	*
Groundwater contamination	*			*		

Occupational Health and Safety Concerns

Occupational health and safety performance should be evaluated against industrial hygiene exposure guidelines, of which examples include the Threshold Limit Value (TLV®)

Occupational exposure guidelines, United States National Institute for Occupational Health and Safety (NIOSH), Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA), Indicative Occupational Exposure Limit Values published by European Union member states, or other similar sources. Additional indicators specifically applicable to electric power sector activities include the ICNIRP exposure limits for occupational exposure to electric and magnetic fields.

Trans-boundary Impacts

Emissions from thermoelectric projects can act as precursors of acid precipitation, particularly when coal with its high sulphur content is the fuel. Acid precipitation accelerates the deterioration of buildings and monuments, radically alters aquatic ecosystems of certain lakes, and damages vegetation in forest ecosystems. The combustion of fossil fuel in thermoelectric plants also generates CO_2, NO. Global warming has been attributed to increases in CO_2 and NO in the atmosphere. However, it is currently impossible to predict the exact contribution of specific emissions from a particular thermoelectric project to these regional and global problems.

Global Warming Concerns

It is predicted that due to current trends of GHG rising the average surface temperature in India will increase between 2.3 to 4.8°C for a doubling of pre-industrial CO_2 levels (Dinar et al., 1998 and shell have significant implications such as changes in monsoon precipitation patterns as well as rise in extreme rainfall events, coastal storms, and droughts. Such changes in the climate could have enormous human, ecological, and economic impacts on the country. So given that the country has about 7000 km of coastline Global Warming is an important issue for India, given the range and magnitude of the possible impacts.

The carbon intensity of the Indian energy economy (carbon emission per unit energy use) has risen significantly over the past two decades, presumably because commercial, fossil-based, energy supplies have been contributing a greater share to the overall energy supply. Though, overall, the carbon intensity of the Indian economy remains relatively low but, still India's overall CO_2 emissions have been increasing at a compounded annual growth rate of 4.9% from 1990 to 2003 (Marland et al., 2005), in comparison to ~4.5% for China, ~1.6% of US, and ~1.5% globally. More recently (from 2000 to 2004), India's emission growth rate slowed down to 3.8%, as has the U.S. with 0.3%; however, Chinese emission rates increased dramatically to 10.7% over this period (Marland et al., 2007). Moreover, India's contribution to annual global emissions remained at about 4.5% between 1999 and 2004; in contrast, China's contribution increased from 13% in 2000 to 17% in 2004 (Marland et al., 2007).187 Thus, although India is now the 4th largest emitter of CO_2 worldwide, its total emissions are still about 1/5th and 1/3rd of U.S. and China, respectively. Furthermore, India's carbon emissions on a per-capita basis are almost 1/20th that of the United States and less than half that of China. There fore, it is logical that India should have significant headroom for GHG emissions growth as its economy grows.

Though, India has no commitments yet under Kyoto Protocol, although there are a range of ongoing GHG-mitigation projects in the country under the umbrella of CDM. As TPP have emerged as the major source of GHG, the early considerations of various options to reduce the country's GHG emissions, especially from the coal-power TPP, would be warranted. The various options in reducing overall GHG emissions under trial include (a) reducing energy demand through conservation and lifestyle changes, (b) increasing efficiency of energy conversion and end-use processes, (c) switching to less carbon-intensive fuels (renewables, natural gas, *etc.*), (d) capturing and storing CO_2 from emission sources, and (e) sequestering atmospheric CO_2 by enhancing the natural sinks such as forests, *etc.*

3.2.4 Qualitative and quantitative analysis of rejects

Air Emissions

The particulate and noxious gas emissions from TPPs primarily and directly pollute the air. Eventually, the particulate emissions and, for the most part, the noxious gases and any atmospheric transformation products that may have formed (e.g., NO2 and nitrate from NO) fall to earth either by way of precipitation or dry deposition, thereby imposing a burden on the water and/or soil, with resultant potential damage to flora and fauna.

Depending on the fuel employed (type, composition, calorific value) and the type of combustion (e.g., dry or slag-tap firing), given amounts of pollutants (particulates, heavy metals, SOx, NOx, CO, CO_2, HCl, HF, organic compounds) become entrained in the exhaust gases. Table 3-9 shows the potential concentration ranges of different emissions for various fuels in facilities in the absence of flue-gas emission control measures.

Table 3-9: Potential Ranges of Pollutant Concentration Levels in Untreated Gas Type of Fuel

Type of Emission	Natural Gas	Light Fuel Oil	Heavy Fuel Oil	Hard Coal	Lignite (Brown Coal)
Sulphur Oxides (SOx) [mg/m^3 STP]	20-50	300-2000	100-10000	500-800	500-18000
Oxides of Nitrogen (NOx) [mg/m^3 STP]	100-1000	200-1000	400-1200	600-2000	300-800
Particulates [mg/m^3 STP]	0-30	30-100	50-1000	3000-40000	3000-50000
Heavy Metals					

The above table lists the noxious emissions in mg/m³ STP as flue gas standards prevailing in EU countries. SOx and NOx are postulated as SO_2 and NO_2. Some emissions are limited in terms of mass flow, e.g., in kilogram per hour (kg/h), or of minimum separation efficiency. With a view to enabling conversion of the stated concentrations to other units such as parts per million (ppm), g/GJ or pounds (lb) of pollutant per 106 BTU energy input, as commonly employed in the U.S.A

The ranges quoted in Table 3-9 for oxides of sulphur relate to differences in fuel-specific sulphur content, whereas in India large quantities of indigenous fuels have comparatively

low calorific values as well as low Sulphur coal. Such a combination naturally produces low SOx concentrations in the (untreated) flue gas.

The lesser part of the NOx concentrations derives from the Nitrogen content of the fuel (fuel NOx). The major share results from the oxidation of atmospheric Nitrogen at combustion temperatures exceeding 1200°C (thermal NOx). Consequently, high combustion temperatures go hand in hand with relatively high NOx emission levels. Appropriate combustion engineering measures that are relatively inexpensive for new plants can keep the emissions at the lower end of the respective range. However, care must be taken to ensure that a high quality of combustion is maintained. Otherwise, excessive combustion engineering measures aimed at reducing NOx emissions could result in a disproportionate increase in other emissions, e.g., CO and combustible (unburned) hydrocarbons.

In general, CO_2 emissions are mainly limited by controlling the burnout process such as to minimize the discharge of CO and the escape of combustible hydrocarbons. Unlike particulates, SO_2, NOx and halogen compounds, CO and combustible hydrocarbons effectively defy retentive measures. Combustible hydrocarbons, in particular, include numerous chemical substances that can cause toxicological problems, e.g., benzpyrene.

Plants fueled with coal or heavy fuel oil also emit small amounts of hydrogen chloride and hydrofluoric acid (HCl and HF) ranging from 50 to 300 mg/m³ STP. As a rule, the concentrations stay well below the SO_2 levels and respond favorably to desulphurization processes, by which they are reduced even more than S2. There are many combustion-stage and post-combustion alternatives for use in reducing air pollution from TPPs which are discussed later.

Noise

Noise is another air pollution and the principal source of noise in a TPP includes the turbine generators and auxiliaries; boilers and auxiliaries, such as coal pulverizers; reciprocating engines; fans and ductwork; pumps; compressors; condensers; precipitators, including rappers and plate vibrators; piping and valves; motors; transformers; circuit breakers; and cooling towers. TPPs used for base load operation may operate continually while smaller plants may operate less frequently but still pose a significant source of noise if located in urban areas.

Water and Wastewater

The wastewater streams in a TPP include cooling tower blow down; ash handling wastewater; material storage runoff; metal cleaning wastewater; and low-volume wastewater, such as air heater and precipitator wash water, boiler blow down, boiler chemical cleaning waste, floor and yard drains and sumps, laboratory wastes, and backflush from ion exchange boiler water purification units . Such wastewater is usually generated in power plants which burn coal or biomass. Some of these streams (e.g., ash handling wastewater) may be generated in reduced quantities or may not be present at all in oil-fired or gas-fired power plants. The characteristics of the wastewaters generated depend on the ways in which the water is used. Contamination arises from demineralizers, lubricating and auxiliary fuel oils, chlorine, biocides, and other chemicals used to manage the quality of water in cooling systems. Cooling tower blow down tends to be very high in total dissolved solids but is generally classified as non-contact cooling water and, as such, is typically subject only to limits for pH and residual chlorine.

In Oil or Gas-based TPP, the same wastewater sources are usually present in plants except some of these streams (e.g., ash handling wastewater) may not be present at all. Apart from their cooling-water consumption, power plants have very modest water requirements (0.1 - 0.3 $m^3/h•MWel$).

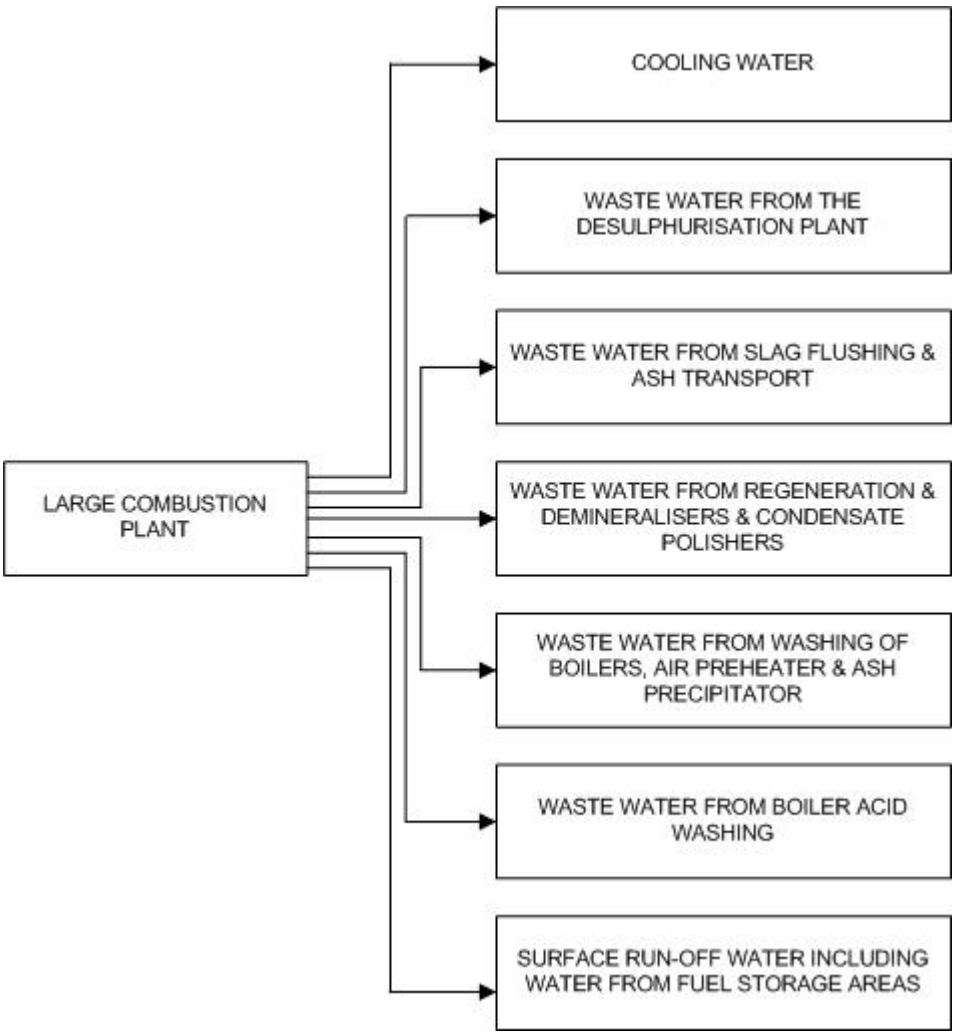


Figure 3-4: Major Sources of Wastewater from TPP

The discharges may cause water quality problems, which vary widely, depending on the type of fuel used, the abatement technique applied, the cooling technique and consequently the amount of water used, and the chemical and biological treatment reagents added for cleaning and maintenance purposes. The constituents of wastewater are wide and include:

Temperature, pH ,TOC, Colour, TDS, BOD, COD, N (total) , Mineral oils, Free chlorine , NH3, Fish, toxicity, Sb, PAH Metals (Co, Mn, Tl, V, Sn, Cd, Cr, Ni, Cu, Hg, Pb, Zn , *etc.*) CN, S, SO_3, SO_4, EOX, Phenol, PCDD/PCDF, P (total) TSS, Cl-, FAs , BTEX *etc.*

Because of their physical, chemical and biological characteristics, release of such compounds may have a high impact on the aquatic environment. These substances can impart significant toxicity to the receiving water. For instance, water from slag flush and ash transport has an alkaline character due to the composition of the ash, whereas water

from boiler washing is acidic. Wastewater from the wet desulphurisation plant contains salts such as chlorides and sulphates. Salt derived from the sea is found in most coastal waters. However, discharges from industrial activities such as energy generating facilities provide a further source of salt. This effect is even more significant if the water is discharged to a river or lake.

Two sources of wastewater from TPP are cooling water and wastewater generated from other processes.

Cooling Water Sources and Issues: TPP with steam-powered generators and once-through cooling systems use significant volume of water to cool and condense the steam for return to the boiler. The heated water is normally discharged back to the water source (*i.e.* river, lake, estuary, or the ocean) or the nearest surface water body, although it does not immediately mix with the source/receiving water bodies. Typical cooling systems used in TPPs include:

- once-through cooling system where sufficient cooling water and receiving surface water are available;
- closed circuit wet cooling system; and
- closed circuit dry cooling system (e.g. air cooled condensers).

Power plants designed for non-circulating water cooling require about 160 - 220 $m^3/h \bullet MWel$ (with cooling water losses usually staying below 2%).

In a TPP, the cooling water absorbs approximately 60% to 80% of the fuel's energy content as waste heat. Less energy is wasted by plants with inherently higher efficiency, e.g., cogenerating facilities. Depending on local conditions, the waste heat can impose a thermal burden on surface water, e.g., cause an increase in the temperature of a river, with the volumetric flow and/or water regimen as an actuating variable. Particularly in our country, water bodies are subject to pronounced seasonal variation. Oxygen depletion therefore has two main causes—accelerated consumption due to rapid metabolism, and lower solubility of oxygen in warm water. Oxygen deficiency can be seriously detrimental to aquatic life.

The in/out temperature gradient of cooling water can be limited by putting it through a cooling tower (once-through or circulation cooling) before it is returned to the river. Depending on the prevailing climatic conditions, however, such cooling systems involve major evaporative water losses and, hence, locally elevated atmospheric dampness. Such problems can be minimized by the use of closed-loop cooling systems in combination with dry or hybrid cooling towers. Natural-draft cooling towers are relatively expensive to build but comparatively inexpensive to operate. The induced-draft cooling towers have the disadvantage of operating on electricity, the generation of which increases the overall ecological burden.

Intakes and Discharge Point Issues: The withdrawal of such large quantities of water and discharge with elevated temperature along with various pollutants, chemical contaminants picked up during process such as biocides or other additives, if used for controlling bio-growth, may affect aquatic organisms, including phytoplankton, zooplankton, fish, crustaceans, shellfish, and many other forms of aquatic life. Cooling tower blowdown tends to be very high in total dissolved solids but is generally classified as non-contact cooling water and, as such, is typically subject only to limits for pH and residual chlorine.

Intake Point: Aquatic organisms drawn into cooling water intake structures are either impinged on components of the cooling water intake structure or entrained in the cooling water system itself. In case of either impingement or entrainment, aquatic organisms may be killed or subjected to significant harm. In some cases (e.g., sea turtles), organisms are entrapped in the intake canals. There may be special concerns about the potential impacts of cooling water intake structures located in or near habitat areas that support threatened, endangered, or other protected species or where local fishery is active.

Conventional intake structures include traveling screens with relative high through-screen velocities and no fish handling or return system. Measures to prevent, minimize, and control environmental impacts associated with water withdrawal should be established based on the results of a project EA, considering the ecological characteristics of the project affected area.

Recommended management measures to prevent or control impacts to aquatic habitats include:

- Reduction of maximum through-screen design intake velocity to 0.5 feet per second (ft/s);
- Reduction of intake flow to a level commensurate with a closed-cycle recirculating cooling water system;
- Reduction of intake flow to the following levels:
  - For freshwater rivers or streams, to a flow sufficient to maintain resource use (*i.e.*, irrigation and fisheries) as well as biodiversity during annual mean low flow conditions
  - For lakes or reservoirs, intake flow must not disrupt the thermal stratification or turnover pattern of the source water
  - For estuaries or tidal rivers, reduction of intake flow to 1% of the tidal excursion volume
- If there are threatened, endangered, or other protected species within the hydraulic zone of influence of the intake, reduction of impingement and entrainment of fish and shellfish can be reduced by the installation of barrier nets (seasonal or year-round), fish handling and return systems, fine mesh screens, wedge wire screens, and aquatic filter barrier systems. Examples of operational measures to reduce impingement and entrainment include seasonal shutdowns or reductions in flow or continuous use of screens. Designing the location of the intake structure in a different direction or further out into the water body may also reduce impingement and entrainment.

Discharge Point: After absorbing enough heat to raise its temperature by 4 - 8°C, the water normally is returned to the extraction point or is released to some receiving water body. Thermal discharges should be designed to prevent negative impacts to the receiving water taking into account the following criteria:

- The elevated temperature areas because of thermal discharge from the project should not impair the integrity of the water body as a whole or endanger sensitive areas (such as recreational areas, breeding grounds, or areas with sensitive biota);
- There should be no lethality or significant impact to breeding and feeding habits of organisms passing through the elevated temperature areas;
- There should be no significant risk to human health or the environment due to the elevated temperature or residual levels of water treatment chemicals. If a once-through cooling system is used for large projects, impacts of thermal discharges

should be evaluated in the EIA with a mathematical or physical hydrodynamic plume model, which can be a relatively effective method for evaluating a thermal discharge to find the maximum discharge temperatures and flow rates that would meet the environmental objectives of the receiving water. Recommendations to prevent, minimize, and control thermal discharges include:

- Use of multi-port diffusers;
- Adjustment of the discharge temperature, flow, outfall location, and outfall design to minimize impacts to acceptable level (*i.e.*, extend length of discharge channel before reaching the surface water body for pre-cooling or change location of discharge point to minimize the elevated temperature areas) ;
- Use of a closed-cycle, recirculating cooling water system (e.g., natural or forced draft cooling tower), or closed circuit dry cooling system (e.g., air cooled condensers) if necessary to prevent unacceptable adverse impacts.

Liquid Wastes from Other Processes

The mitigation measures for non-cooling tower discharges include:

- Recycling of wastewater from flue gas desulphurization (FGD) systems in coal-fired plants as FGD makeup. This practice not only eliminates this wastewater stream but also conserves water;
- In coal-fired power plants without FGD systems, treatment of process wastewater in conventional physical-chemical treatment systems for pH adjustment and removal of total suspended solids (TSS), at a minimum.
- Depending on local regulations, these treatment systems can also be used to remove heavy metals to parts per billion (ppb) levels by chemical precipitation as either metal hydroxide or metal organo-sulfide compounds;
- Collection of fly ash in dry form and bottom ash in drag chain conveyor systems in new coal-fired power plants;
- Consider use of soot blowers or other dry methods to remove fireside wastes from heat transfer surfaces so as to minimize the frequency and amount of water used in fireside washes;
- Use of control measures such as protective liners and collection and treatment of runoff from coal piles;
- Spraying of coal piles with anionic detergents to inhibit bacterial growth and minimize acidity of leachate;
- Use of SOx removal systems that generate less wastewater, if feasible; however, the environmental and cost characteristics of both inputs and wastes should be assessed on a case-by-case basis;
- Treatment of low-volume wastewater streams that are typically collected in the boiler and turbine room sumps in conventional oil-water separators before discharge;
- Treatment of acidic low-volume wastewater streams, such as those associated with the regeneration of makeup demineralizer and deep-bed condensate polishing systems, by chemical neutralization in-situ before discharge;
- Pretreatment of cooling tower makeup water, installation of automated bleed/feed controllers, and use of inert construction materials to reduce chemical treatment requirements for cooing towers;

- Elimination of metals such as Chromium and Zinc from chemical additives used to control scaling and corrosion in cooling towers;
- Use the minimum required quantities of chlorinated biocides in place of brominated biocides.

Sanitary Wastes

Sanitary wastewater from industrial facilities may include effluents from domestic sewage, food service, and laundry facilities serving site employees. Miscellaneous wastewater from laboratories, medical infirmaries, water softening, *etc.*, may also be discharged to the sanitary wastewater treatment system.

Solid/Hazardous Waste

Solid Waste: Coal or biomass-fired TPPs generate the greatest amount of solid wastes in India due to the relatively high percentage of fly ash in the fuel. The other solid waste from large-volume coal combustion wastes includes bottom ash, boiler slag. At this stage FGD is not common and hence, FGD sludge is not a common solid waste because Indian coal contains less sulphur; therefore FGD may not be necessary. Fluidized-bed combustion (FBC) boilers generate fly ash and bottom ash, which is called bed ash. Fly ash removed from exhaust gases makes up more than 60–85% of the coal ash residue in pulverized-coal boilers. Bottom ash includes slag and particles that are coarser and heavier than fly ash. Due to the presence of sorbent material, FBC wastes have relatively higher content of Calcium and sulfate and a lower content of silica and alumina than conventional coal combustion wastes. Low-volume solid wastes from coal-fired TPPs and other plants include coal mill rejects/pyrites, cooling tower sludge, wastewater treatment sludge, and water treatment sludge. Oil combustion wastes also include fly ash and bottom ash but are generated in significant quantities when residual fuel oil is burned in oil-fired steam electric boilers. Other technologies (e.g., combustion turbines and diesel engines) and fuels (e.g., distillate oil) generate little or no solid wastes. Overall, oil combustion wastes are generated in much smaller quantities than the large-volume coal fired discussed above. Gas-fired TPPs generate virtually no solid waste because of the negligible ash content, regardless of the combustion technology.

Fly ash generated is typically not classified as a hazardous waste due to its inert nature. However, it may be enriched with metals being constituents of concern in both coal fired and low-volume solid wastes as a result ash residues and the dust removed from exhaust gases may contain significant levels of heavy metals and some organic compounds, in addition to inert materials. Therefore, where ash residues are expected have potentially significant levels of heavy metals or other potentially hazardous materials, they are required to be tested at the start of plant operations to verify their classification as hazardous or non-hazardous according to National Hazardous Waste rules.

Hazardous Waste: Hazardous materials and petroleum products stored and used at combustion facilities include solid, liquid, and gaseous fuels; air, water, and wastewater treatment chemicals; and equipment and facility maintenance chemicals (e.g., paint, lubricants, and cleaners). The other sources of hazardous materials are petroleum, including spills during transport and storage.

Fly Ash and Bottom Ash: Indian coal has general properties of the Southern Hemisphere Gondwana coal, which has interbanded seams with mineral sediments (IEA, 2002a). Therefore much of the coal is of low calorific value with high ash content. Run-of-mine

coals typically have ash content ranging from 40-50%, with low iron content and negligible toxic trace elements and gross calorific value varies between 2500 – 5000 kcal/kg, with non-coking steam coal being in the range of 2450 – 3000 kcal/kg (Visuvasam et al., 2005). In addition the quality of Indian coal has gotten worse over the past decades. The ash generated by TPP is of three kinds (Govil 1998):

- Bottom ash – ash that is settled at the bottom of the boiler, and is generally evacuated out as slurry (10-20% of total).
- Coarse fly ash – ash that is collected at the first stage of the ESP. It contains small ash chunks with carbon content around 6-7%, and is generally useful for the brick manufacturing industry (70-80% of total).
- Fine fly ash – fine ash that is collected by the later electrostatic precipitator (ESP) stages. This fine ash is either removed dry or as a slurry and put in ash yards and ponds (5-7% of total).

As a consequence of high ash content in Indian coals, the land requirement has become very high around one acre for one MW of installed capacity (CEA, 2004b), and many large power plants (more than 4000 MWs) require extremely high land just for ash storage. Over the past decade, 1.4-1.5 million tons of ash was annually produced per GW of installed capacity (CEA, 2005e), with the number increasing slightly over time because of increasing ash content in coal and increasing PLF. The fly ash generation and utilization over the past decade is depicted in Figure 3-5.

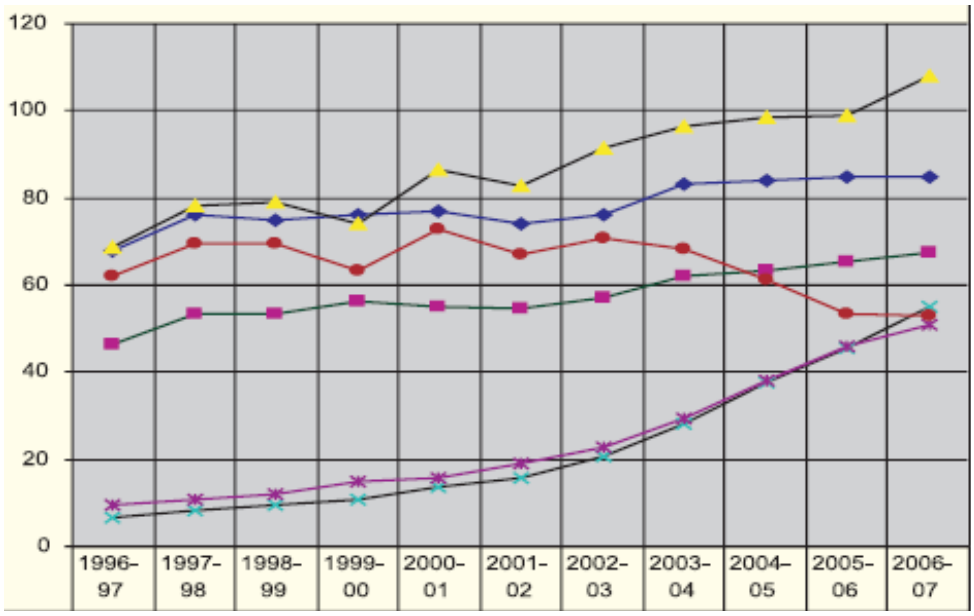


Figure 3-5: Progressive Ash Generation and Utilization of Coal/Lignite-based Thermal Stations

The ash in ash pond is stored even more than 30 m in height. After the ash pond is completely "filled", the power plant must 'reclaim' the pond by landscaping it and covering with vegetation. Fly ash utilization has increased ten-fold from 1992-93 to 2003-04, and about 30% of the generated ash is utilized today. This dramatic improvement in fly ash utilization is primarily a result of following two MoEF's policies and guidance.

- In order to increase fly-ash utilization, the MoEF in 1999 mandated a 100% utilization of fly ash in a phased manner by 2013-14. It has stipulated that fly ash from power plants be given free (at least until 2010) to brick and cement manufacturers within 50 km radial distance from power plants; these manufacturers have also been given specific targets for ash utilization (MoEF, 1999; CEA, 2005e).
- In 1997, the MoEF mandated the use of beneficiated coals with ash content of 34% (or lower) in power plants located beyond 1000 km from their coal source, and plants located in critically polluted areas, urban areas, and ecologically sensitive areas (CPCB, 2000b).

3.2.5 Exposure pathways

Exposure pathway is the path due to which exposure of the receptor takes place. The "Exposure" has been defined as contact with a chemical or physical agent. It is the process by which an organism acquires a dose (Suter, 1993). The estimation of exposure of a target organism requires an exposure scenario that answers to four questions (Suter, 1993):

- given the output of fate models (see section on mass balance equation for water quality), which media (ecosystem components) are significantly contaminated;
- to which contaminated media are the target organisms exposed;
- how are they exposed (pathways and rates of exposure); and
- given an initial exposure, will the organism modify its behavior to modify exposure pathways or rates (attraction or avoidance)?

For Environmental Risk Management there are three major risk factors and exposure Pathway is one of three factors. To determine whether risk management actions are warranted, the following assessment approach should be applied to establish whether the three risk factors of 'Contaminants', 'Receptors', and 'Exposure Pathways' co-exist, or are likely to co-exist, at the project site after the operational phase of the proposed development.

- Contaminant(s): Presence of pollutants and/or any hazardous materials, waste, or oil in any environmental media at potentially hazardous concentrations
- Receptor(s): Actual or likely contact of humans, wildlife, plants, and other living organisms with the contaminants of concern
- Exposure Pathway(s): A combination of the route of migration of the contaminant from its point of release (e.g., leaching into potable groundwater) and exposure routes

Table 3-10 identifies some of the major exposure pathways.

Table 3-10: Exposure Pathways

Media	Pathways	Comment
Air-Gases and Aerosols	Respiration	Assuming accurate fate model estimates, exposure is relatively predictable based on assumption of homogenous distribution in air
Water – Soluble Chemicals	Respiration	Assuming accurate fate model estimates, exposure is relatively predictable based on assumption of homogenous distribution in water

Media	Pathways	Comment
Sediment (Solids and pore water)	Benthic animals absorb chemicals, respire pore water or food or food from the water column. Plants rooted in the sediment may take up material from sediments, surface water and air	Processes are very complicated and usually simplifying assumptions are required
Soil (solids, pore water and pore air)	Organisms in soils may absorb material from soil, pore water, pore air, ingest soil, soil – associated food.	Processes are very complicated and usually simplifying assumptions are required.
Ingested Food and Water	Consumption by fish and wildlife	Assume the test animal consumption rates in laboratory for a given availability of food or water are the same as those occurring naturally in the environment.
Multimedia	More than one of the above pathways	It is often possible to assume one pathway is dominant. In some cases, it will be necessary to estimate the combined dosage.

TPP emissions or rejects (gaseous, solid & hazardous as well as liquid effluents) can cause damage to human health, aquatic and terrestrial ecology as well as material due to various exposure routes (pathways). For example adverse effects of TPPs on human health can derive from the direct impact of noxious gases on the organism and/or their indirect impact via the food chain and changes in the environment. Especially in connection with high levels of fine particulates, noxious gases like SO_2 and NOx can lead to respiratory diseases. SO_2 and NOx can have health-impairing effects even at concentrations below those of standard of 120 $\mu g/m^3$. The duration of exposure is decisive. Injurious heavy metals (e.g., lead, mercury and cadmium) can enter the food chain and, hence, the human organism by way of drinking water and vegetable and animal products. Climatic changes such as warming and acidification of surface waters, Forest depletion can occur due to acid rain and/or the greenhouse effect of CO_2 and other trace gases can have long-term detrimental effects on human health. Similarly important are the effects of climatic changes on agriculture and forestry (and thus on people's standard of living), e.g., large-scale shifts of cultivation to other regions and/or deterioration of crop yields due to climate change impacts. Hence, the construction and operation of TPPs can have both socioeconomic and socio-cultural consequences; appropriate preparatory studies, gender-specific and otherwise, are therefore required, and the state of medical services within the project area must be clarified in advance. Beside, noise pollution generated from turbines is an important source of Occupational exposure, has direct effects on humans and animals. The main sources of noise in a power plant are: the mouth of the smokestack, belt conveyors, fans, motors/engines, transformers, flues, piping and turbines.

3.3 Technological Aspects

3.3.1 Cleaner technologies

3.3.1.1 Clean coal technologies

Clean Coal Technologies (CCTs) offer the potential for major improvements in efficiency and significant reduction in the environmental emissions when used for power generation. These technologies may be utilized in new as well as existing plants and are therefore, an effective way of reducing emissions in the coal fired generating units. Several of these systems are not only very effective in reducing SOx and NOx emissions but because of their higher efficiencies they also emit lower amount of CO_2 per unit of power produced. CCTs can be used to reduce dependence on foreign oil and to make use of a wide variety of coal available.

To meet increasing demand of power with minimal environmental impact for sustainable development, adoption of clean coal technologies with enhanced power plant efficiency, fuel switching, use of washed coal, efficient pollution control systems and proper by-product and waste handling & utilization, is necessary.

Pre-Combustion Technologies

Coal Beneficiation: Ash sulphur and other impurities can be reduced from the coal before it is burnt.

Combustion Technologies

Generation of emissions of SO_2, NOx & CO_2 can be minimized by adopting improved combustion technologies

Super-critical Technology: By increasing steam temperature and pressure, the efficiency of the steam turbine (and hence, of electricity generation) can be increased. As the steam-pressure and temperature increases to a critical point, the characteristics of steam are altered such that water and steam are no longer distinguishable and it is known as super-critical steam and this technology is more efficient.

Fluidized Bed Combustion Technologies (CBFC, AFBC & PFBC)

Integrated coal gasification combined cycle (IGCC)

As per recommendation of an advisory sub-group for coal power technology (set up in 1989) Indian utilities should have moved to 750 MW size units with the choice of sub-critical/super-critical parameters being left to utilities (CEA, 2003). However, no units larger than the 500 MW were installed in this period and the 500 MW units were all based on sub-critical steam, despite the CEA's and the Planning Commission's calls for super-critical PC technology deployment by the late 1990s.

Use of pure oxygen (oxyfuel combustion) instead of air is also being considered for addressing GHG requirements. Table 3-11 highlights the comparison of different technology options in the Indian context.

At this point of time India is venturing in different technology options. IGCC technologies well proven is perhaps a technology of choice in medium to long term prospective, they rate high on efficiency and environmental attributes but still require more maturity time in the Indian context. Based on overall considerations of the technologies, super-critical PC and CFBC could be considered best in the present circumstances: super-critical PC because of its efficiency, maturity, and relatively low cost and CFBC because of its fuel flexibility and reduction in SOx and NOx emissions. Although sub-critical PC has tremendous experience in India but perform poorly on efficiency and environmental account However, this analysis only a broad view point towards better technology assessments for India that incorporates key challenges and constraints in the Indian coal power sector. As per CEA the choice of a technology is governed by one or more of the following considerations:-

- Higher energy conversion efficiency resulting in less fuel consumption and consequently low level of pollutant emission.
- Reduced environmental degradation through use of pollution abatement technologies.
- Higher plant availability
- Better overall economics

The maturity and appropriateness of the technology, its availability at competitive cost and reliable support during project life are also the consideration. Adoption of 800 MW units with super-critical technology has been taken as major initiative in this regard.

At present, the largest thermal unit size in operation is 500 MW with sub-critical steam parameters. Few 660 MW units with super-critical parameters are under construction. Based on study carried out by CEA, it was recommended to have 800-1000 MW units in the country using super-critical parameters with higher temperatures of 568/593 °C for Superheat /Reheat steam. Higher size coal based units of 800-1000 MW which are environment friendly with super critical technology are proposed to be introduced to achieve the huge capacity addition programme. Also in view of difficulties faced by power utilities in getting coal allocation, now thrust is being given to identify and set up power plants in the coastal regions using imported/washed coal.

Post-combustion Technologies

End of pipe treatment: Installation of pollution control equipments such as ESP, DENOx & De SOx systems)

Table 3-11: Comparison of Clean Power Technologies

Technology	Sub-critical PC	Super-critical PC (SC-PC)	Advanced/Ultra Super-critical PC (USC-PC)	Circulating FBC (CFBC)	Oxyfuel PC/CFBC	IGCC - Entrained-flow	IGCC - Fluidized-bed
Use in India:	Almost all Indian TPS	Sipat-I TPS (in construction); Barh TPS (order placed)		Surat Lignite TPS, Akrimota Lignite PS		Might be useful for using refinery residues	R&D, Pilot scale plant. Plans for demonstration plant.
Worldwide:	Standard technology worldwide	Europe (Denmark, Netherlands, Germany); Japan, U.S., China, Canada	Netherlands, Denmark, Japan	U.S., Europe, Japan, China, Canada	Development and planned pilot plants in Europe, Australia, Canada. Useful mainly for CCS	Demonstration/Commercial plants in U.S., Europe, Japan, China	A6 MW Unit in Europe, 100 MW demo plant in U.S., biomass IGCC in Brazil Widespread use for chemical production and poly generation
Level of Maturity	Commercial	Commercial	Commercial/Demonstration	Commercial	R&D/Pilot Scale	Gasifier - Commercial; IGCC - Commercially proven	Gasifier - Commercial; IGCC - demonstration
Output flexibility	Electricity; steam and Heat are also possible	Electricity; steam and heat are also possible	Electricity; steam and heat are also possible	Electricity; steam and heat are also possible	Electricity; steam and heat are also possible	Electricity; syn-ga, chemicals, FT liquids. H_2, steam, heat	Electricity; syn-ga, chemicals, FT liquids. H_2, steam, heat

Technology	Sub-critical PC	Super-critical PC (SC-PC)	Advanced/Ultra Super-critical PC (USC-PC)	Circulating FBC (CFBC)	Oxyfuel PC/CFBC	IGCC - Entrained-flow	IGCC - Fluidized-bed
Fuel Flexibility	Can be flexible, with loss in efficiency	Can be flexible, with loss in efficiency	Can be flexible, with loss in efficiency	Highly flexible, use of high ash coals supported	Same as PC and CFBC	Very flexible, but limited to low ash-content and ash fusion temp. coals	Very flexible, but limited to high ash fusion temp. coals limited use of oils.
Net Efficiency (net HHV) India:	31-34%; 33%	35%		30-33%			40%
Worldwide:	36-39% (w/o FGD)	39-41%	40-44%	34-40%	34% (USC-PC)	35-40%	44-48%
	37-38% (w/o FGD)				25% (CFB-subcritical)		
Capital Cost (TPC: S/kW) India	610 (w/o FGD) 750 (w/o FGD)			770			1290
Worldwide:	930-1090 (w/o FGD) 1080-1280 (w/FGD)	1090-1290	960-1340	1070-1340	1410; 2370-2410 (w/CCS)	1200-1610	1250-1270

Note:

CFBC – Circulating Fluidized-Bed Combustion

PFBC – Pressurized Fluidized-Bed Combustion

IGCC – Integrated Coal Gasification Combined Cycle

3.3.2 Pollution control technologies

Air pollutants emitted from combustion process from boilers consists mainly of particulates, sulphur oxides, nitrous oxides, heavy metals, and CO_2 – chemicals that cause serious health and environmental damages. There are a range of flue gas treatment technologies for reducing such flue gas emissions of these pollutants, they are now typically a part of specific coal-utilization technology packages. The add-on pollution-reducing technologies are broadly installed at three stages namely: pre-combustion, in combustion and post-combustion. In pre-combustion stage coal beneficiation/ washing is carried out to reduce the overall amount of coal ash and also increase energy efficiency. The pollution cleanup technologies in an IGCC plant to remove particulates and sulphur from the combustion gas are also viewed as pre-combustion mechanisms. During in-combustion stage, low NOx to reduce NOx emissions, dry limestone scrubbing for sulphur removal in fluidized-bed combustion and gasification are incorporated as pollution control measures. In India, currently only particulate matter is being controlled using electrostatic precipitator or bag filters as post-combustion pollution control.

Table 3-12: List of Pollution Control Technologies

Cleanup Technology	Stage w.r.t Combustion	Emissions Cleaned
Coal Washing/beneficiation	Pre-combustion	Fly ash Sulphur Mercury CO_2[371]
Electrostatic Precipitator (ESP)	Post-combustion	Fly ash
Bag filter	Post-combustion	Fly ash
Cyclone	Post-combustion	Fly ash Mercury
Sulphur removal plant	Pre-combustion	Sulphur
Limestone	In-combustion	Sulphur
Flue gas desulphurization (FGD)	Post-combustion	Sulphur
Low NOx burners	In-combustion	NOx
Selective Catalytic Reducers	Post-combustion	NOx
CO_2 Shift reactor	Pre-combustion	CO_2
Amine scrubbing	Post-combustion	CO_2

Clean Technology Comparison

Often TPP technologies have been compaired with respect to cost of generation alone but this is not adequate in the current situation. In order to provide a common basis for comparisons, all of the technologies are assumed to be used in power plants built in Northern India, using hard Indian coal as feedstock. In one comprehensive study different technologies were compared with respect to the attributes (listed underneeth) which are not completely independent of each other; for example, as a technology matures, its costs become less through economies of scale, and high-efficiency technologies will have better environmental performance.

The earlier mentioned technologies (earlier in the chapter) were scored on the following attributes that are important for meeting the challenges and constraints for the Indian energy sector:

- Ability to use domestic coal
- Maturity of Technology
- Indigenous technical capacity
- Low Capital Cost
- Efficiency
- Low environmental impact.
- Carbon capture potential

The technologies were rated under current status and performance, as well as in a future scenario (assumed to be about 10 years from now) on a scale of 1 to 10, wherein some assumptions about the trajectory of technology development were also made.

This study/analysis under the mid-term future scenario reflected that the current PC and CFBC technologies using subcritical steam conditions and the advanced-PFBC technology are not suitable for meeting the future Indian challenge of high efficiency and carbon mitigation. The best technologies for India in the mid-term future, which got the highest rating seem to be CFBC technologies, supercritical PC and ultra-supercritical PC. IGCC fluidized-bed and moving-bed technologies also ranked high, but were lower than the more efficient combustion technologies. In addition, oxyfuel and IGCC entrained-flow technologies will become the important options as they are capable of meeting effectively the carbon capture challenge. As in the present scenario, even the sensitivity analysis did not significantly altered this assessments.

However, this analysis should not be considered as ultimate as it can be further refined on various accounts. This analysis is among the various other analysis as an assessment tool for a way forward. For example, the performance of technologies on various attributes can be rated by a number of different experts and stakeholders based on detailed performance data base and actual field surveys.

One study on EU power scenarion reflected that that in the next decades the overall condition is such that research and development for fossil technologies will progress steadily and deployment of improved and advanced fossil technologies will continue in the EU as well as worldwide.

The study proved that since IGCC power plants still are in their early stage of development, supercritical steam power plants will probably be the preferred coal-based power generation technology for installation of new capacity in the short-term, with a development towards more advanced steam conditions. Due to their relative flexibility concerning fuel type and their good environmental performance, IGCC power plants can also efficiently use fuel feedstock such as biomass and refinery residual. Moreover, IGCC systems could be part of a particularly clean power plant system, integrated with advanced gas turbines and fuel cells. There are some main challenges for sound environmental performance in the electricity generation from coal as per EU studies are:

- Increase of the thermal efficiency in order to reduce CO_2 and other emissions per unit of net electricity supplied to the network. The average efficiency of current

technologies has been steadily increasing but there is still potential for further improvements.

- Mitigation or nearly elimination of emissions such as nitrogen oxides, sulphur oxides and particulate matter. This has largely been achieved and costs are decreasing, but this implementation has to be applied to as many units as possible and extended to as many countries as possible, depending on national standards.
- Mitigation or nearly elimination of CO_2 emissions. The development of so-called 'zero emissions technologies' has been tackled and progressed.

3.4 Risk Potential & Quantitative Risk Assessment

A hazard is a danger, peril, source of harm, or an adverse impact on people or property. Risk is an expression of chance, a function of the likelihood of an adverse impact and the magnitude of its consequences.

Environmental risk assessment is the process of evaluating the likelihood of adverse effects in, or transmitted by, the natural environment from hazards that accompany human activities. The effects from hazards may be on human health, economic welfare, quality of life, and valued ecosystem components (VECs). Under QRA the severity, or distribution of the range of magnitude of the adverse effect (damage), are evaluated.

As far as history of QRA is concerned "Technological risks" began to be specifically analyzed during World War II in military operations research and thereafter in the nuclear energy and space exploration fields. The concern was mainly with infrequent but catastrophic events. Since then, the number of severe industrial accidents that have captured headlines has increased. At the same time, environmental concerns have become a central theme in public policy discussions. Factory explosions, oil tanker spills, chemical tank car derailments, and petroleum product fires have generated a public demand for prevention and a profound concern for victims and damage to the natural environment. In 1980, the Scientific Committee on Problems of the Environment (SCOPE) of the International Congress of Scientific Unions published the landmark report "Environmental Risk Assessment" (Whyte and Burton, 1980). The World Bank, after the Bhopal, India methyl isocyanate disaster, issued guidelines and a manual to help control major hazard accidents (World Bank, 1985a, 1985b). Another important development is OECD compilation of a report on risk assessment in the OECD countries with sections on the nuclear industry, chemicals, petroleum processing, transportation of hazardous materials, and dam-reservoir projects (Hubert, 1987).

Some of the major hazards associated with Thermal Power Projects are with flammable or explosive material, extreme conditions of temperature or pressure, large mechanical equipment.

3.4.1 Performing QRA

QRA process involves four questions:

- What can go wrong to cause adverse consequences?
- What is the probability of frequency of occurrence of adverse consequences?
- What are the range and distribution of the severity of adverse consequences?

- What can be done, at what cost, to manage and reduce unacceptable risks and damage?

Typically EIA should answer the first question, and give at least a qualitative expression of the magnitude of the impacts. The major additional consideration in QRA is the frequency of occurrence of adverse events. Risk management is integrated into QRA because it is the attitudes and concerns of decision makers that set the scope and depth of the study. QRA attempts to quantify the risks to human health, economic welfare, and ecosystems from those human activities and natural phenomena that perturb the natural environment. Therefore, the five step sequence in performing QRA is:

1. Hazard identification - sources of adverse impacts;

2. Hazard accounting - scoping, setting the boundaries of the ERA;

3. Scenarios of exposure - how the hazard might be encountered;

4. Risk characterization - likelihood and severity of impact damage; and

5. Risk management - mitigation or reduction of unacceptable risk.

3.4.2 Hazard identification

Identification of hazards in QRA is of primary significance in the analysis, quantification and cost effective control of accidents involving chemicals and process. A classical definition of hazard states that hazard is in fact the characteristic of system/plant/process that presents potential for an accident. Hence, all the components of a system/plant/process need to be thoroughly examined to assess their potential for initiating or propagating an unplanned event/sequence of events, which can be termed as an accident.

The typical methods for hazard identification employed are:

- Identification of major hazardous units based on Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 of Government of India (as amended in 2000); and
- Identification of hazardous units and segments of plants and storage units based on relative ranking technique, viz. Fire-Explosion and Toxicity Index (FE&TI).

Hazardous substances may be classified into three main classes namely Flammable substances, unstable substances and Toxic substances. Flammable substances require interaction with air for their hazard to be realized. Under certain circumstances the vapours arising from flammable substances when mixed with air may be explosive, especially in confined spaces. However, if present in sufficient quantity such clouds may explode in open air also. Unstable substances are liquids or solids, which may decompose with such violence so as to give rise to blast waves. Besides, toxic substances are dangerous and cause substantial damage to life when released into the atmosphere. The ratings for a large number of chemicals based on flammability, reactivity and toxicity have been given in NFPA Codes 49 and 345 M.

Table 3-13: Applicability of GOI Rules To Fuel/Chemical Storage for a TPP

S. No.	Chemical/ Fuel	Listed in Schedule	Threshold Quantity (T) for Application of Rules	
			5,7-9, 13-15	10-12
1	Light Diesel Oil	1 (part I)	5000 MT	50000 MT
2	Heavy Fuel Oil	1(part I)	5000 MT	50000 MT
3	Chlorine	3 (part I)	10 MT	25 MT
4	Hydrogen	1 (part II)	2 MT	50 MT
5	HSD	1 (part I)	5000 MT	50000 MT
6	Natural gas	3 (part I)	--	--

A systematic analysis of the fuels/chemicals and their quantities of storage is required, to determine threshold quantities as notified by GoI Rules, 1989 (as amended in 2000) and the applicable rules are as above.

Table 3-14: Properties of Fuels/Chemicals Used In a TPP

Chemical	Codes/Label	TLV	FBP	MP	FP	UEL	LEL
			°C			%	
Light Diesel Oil	Flammable	--	360	-	66	-	-
Heavy Fuel Oil	Flammable	--	400	338	65	7.5	0.6
Chlorine	Toxic	1 ppm	34	-	-101	-	-
Hydrogen	Reactive	--	--	--	--	-	--
HSD	Flammable	--	375	-	70	-	-
Natural Gas	Flammable	--	--	--	--	-	-

TLV: Threshold Limit Value, FBP: Final Boiling Point, MP: Melting Point, FP: Flash Point, UEL: Upper Explosive Limit, LEL: Lower Explosive Limit

TPP involve handling of various hazardous bulk chemicals (toxic and flammable), which will be used as fuel in the proposed plant. Separate storage areas are provided for these fuels and should be handled with utmost care following the safety norms for handling of hazardous chemicals. Bulk storages are required for those chemicals, which will be required in the large quantity and are flammable/toxic in nature. The storage tanks should be in the isolated zone and should have firewater hydrant system.

Where as for the Gas fuels the turbine will run on Natural Gas as the prime fuel. HSD will also be used only in case of emergency (say for maximum period of 3 days).

Heavy Fuel Oils having flash points above 55°C is not classified as flammable. Flammability limits for fuel vapour /air mixtures lie between approximately 1.0 to 6.0 % (V/V); auto-ignition temperatures are in the range of approximately 220 to 300°C. Ignition of heavy fuel oils at ambient temperature may be difficult, but if ignited at elevated temperatures, the product will burn, it is recommended that the head space of all

heavy fuel oil tanks should be considered potentially flammable and appropriate precautions taken.

3.4.3 Fire explosion and toxicity index approach

Fire, Explosion and Toxicity Indexing (FE & TI) is a rapid ranking method for identifying the degree of hazard. The application of FE & TI would help to make a quick assessment of the nature and quantification of the hazard in these areas. However, this does not provide precise information. Respective Material Factor (RMF), General Hazard Factors (GHF), Special Process Hazard Factors (SPHF) are computed using standard procedure of awarding penalties based on storage handling and reaction parameters. Before hazard indexing can be applied, the installation in question should be subdivided into logical, independent elements or units. In general, a unit can logically be characterized by the nature of the process that takes place in it. In some cases, the unit may consist of a plant element separated from the other elements by space or by protective walls. A plant element may also be an apparatus, instrument, section or system that can cause a specific hazard. For each separate plant process which contains flammable or toxic substances, a fire and explosion index (F) and/or a toxicity index (T) could be determined in a manner derived from the method for determining a fire and explosion index developed by the Dow Chemical Company.

DOW's Fire and Explosion Index (F and E) is a product of Material Factor (MF) and hazard factor (F3) while MF represents the flammability and reactivity of the substances, the hazard factor (F3), is itself a product of General Process Hazards (GPH) and special process hazards (SPH). An accurate plot plan of the plant, a process flow sheet and Fire and Explosion Index and Hazard Classification Guide published by Dow Chemical Company are required to estimate the FE & TI of any process plant or a storage unit.

The Fire and Explosion Index (F&EI) can be calculated from the following formula:

F&EI = MF x (GPH) x (SPH)

The degree of hazard potential is identified based on the numerical value of F&EI as per the criteria given below:

F&EI Range	Degree of Hazard
0-60	Light
61-96	Moderate
97-127	Intermediate
128-158	Heavy
159-up	Severe

The toxicity index is primarily based on the index figures for health hazards established by the NFPA in codes NFPA 704, NFPA 49 and NFPA 345 m.

By comparing the indices F&EI and TI, the unit under QRA is classified into one of the following three categories established for the purpose.

Table 3-15: Categories of QRA

Category	Fire and Explosion Index (F&EI)	Toxicity Index (TI)
I	F&EI < 65	TI < 6
II	65 < or = F&EI < 95	6 < or = TI < 10
III	F&EI > or = 95	TI > or = 10

Certain basic minimum preventive and protective measures are required for the three hazard categories.

Fire and Explosion are also the likely hazards due to the TPP fuel storage hence, FE&TI should be estimated.

3.4.4 Hazard assessment and evaluation

A preliminary hazard analysis is carried out to identify the major hazards associated with storages in the plant. This is followed by consequence analysis to quantify these hazards. Finally the vulnerable zones are plotted for which risk reducing measures are deduced and implemented.

Physical and Health Occupational Hazards in any large scale Chemical /Hydrocarbon Processing Industry (CPI/HPI) can be broadly classified into the following categories:

- Mechanical Risks
- Electrical Risks
- Fire/Explosion Risks
- High /low Temperature Exposure Risks
- Toxic/Carcinogenic Chemicals Exposure Risks
- Corrosive/Reactive/Radioactive Chemicals Exposure Risks

The first two types of risks are of universal nature associated with any industrial activity and not specific to a particular plant or process. Mechanical risks which are generally encountered are injuries to the head, Limbs, eyes, etc usually as a results of negligence on the part of operating/maintenance personnel in the use of improper tools, bypassing prescribed safety procedures neglect of personal protective wear and risks associated with rotating machinery as well as risks associated with high-energy release from compressed gases. Electrical risks which result in shock and/or burns are most often a consequence of poor maintenance, ingress of dust or moisture, handling by unauthorized personnel and use of improper/substandard hardware.

3.4.5 Failure mode analysis: fault tree analysis

During hazard analysis the sequence of events which could lead to hazardous incidents is set out. The likelihood of the incident is then quantified. Fault tree analysis plays a key role in this part of the risk assessment. Fault tree analysis is normally used to evaluate failures in engineering systems. The analysis provides a graphical representation of the relationships between specific events and the ultimate undesired event (sometimes referred to as the “top event”). For example, the ultimate undesired event might be a large fire for which the preceding events might be both spilling a large quantity of flammable liquid and introducing a source of ignition.

Fault tree analysis allows systematic examination of various materials, personnel, and environmental factors influencing the rate of system failure. The method also allows for the recognition of combinations of failures, which may not otherwise be easily discovered. The fault tree analysis is sufficiently general to allow both qualitative and quantitative estimates of failure probabilities within the analysis

There are various modes in which flammable and toxic chemicals can leak into atmosphere causing adverse affects. It may be small leaks from gaskets of the flanged joints, or guillotine failure of a pipeline of even catastrophic failure of the storage tank. Some typical modes of failures and their possible causes are discussed below:

Table 3-16: Failure Mode Analysis

S. No.	Failure Mode	Probable Cause	Remarks
1.	Flange / Gasket failure	Incorrect gasket Incorrect installation.	Attention to be paid during selection and installation of gaskets.
2	Weld failure	It is normally due to poor quality of welds	Welding to be done by certified welders with right quality of welding rods. Inspection and radiography must also be done.
3	Pipe corrosion erosion or failure due to stress	Some times fabrication or installation leaves stress in the pipes. Erosion or corrosion also is sometimes the cause.	Pipes material of construction should be selected correctly. Design should take care of erosion effects. And installation of pipes should not leave any stress.
4	Over pressurization of pipeline	Over pressurization can occur due to failure of SRV or incorrect operation.	Necessary procedures should be there to prevent.
5	Deficient installation of pipes	Pipes design and installation is sometimes not as per appropriate standard.	It must be ensured that installation is as per correct standards completely.
6	Leaks from valve	Leaks from glands, bonnets or failures valves spindle is sometimes the cause.	Right selection of valves and their maintenance should be ensured.
7	Instruments failure	Multifarious instruments are used for control of process parameters. Any such instrument failure can cause mishap.	Reliability of instruments working must be ensured through proper selection and maintenance.
8	Failures of protective system	Protective system like SRV, bursting discs, vent header, drain lines *etc.* are provided to take care of abnormal conditions.	Reliability of protective system must be ensured highest through inspection and proper maintenance.
9	Operational effort	Plant operational parameters should not be exceeded beyond the permissible limits.	Operating procedures must be complete and strictly followed.

S. No.	Failure Mode	Probable Cause	Remarks
10	Other failures	There are external other reasons causing the failures.	Design and operating philosophy must consider all possible reasons.

Example of Development of Fault Tree Logic in Gas-Based TP

An initial step in fault tree analysis is to organize the fault tree study according to the particular risk assessment being carried out. For a particular hazardous event, it is important that the analysis be broad enough to include all identifiable initiating events yet it must also retain a balanced depth. Initiating events fall into three broad categories — operator error, equipment failure, and external events. Generally, the analysis of operator error and equipment failure receives thorough attention and can be considered one of the more reliable stages in risk assessment.

Event and fault trees are approaches to schematically breaking down complex systems into manageable parts for which failure rates or other risk-related data can be found. It is thus possible to construct some idea of the failure rate and resultant risk of a large, complex, and new entity, such as a chemical plant, even if no data about its performance exist.

A typical fault tree is given in Figure 3-6 is an example of a fault tree applied to leakage from a gas pipe line valve in a gas fired power plant

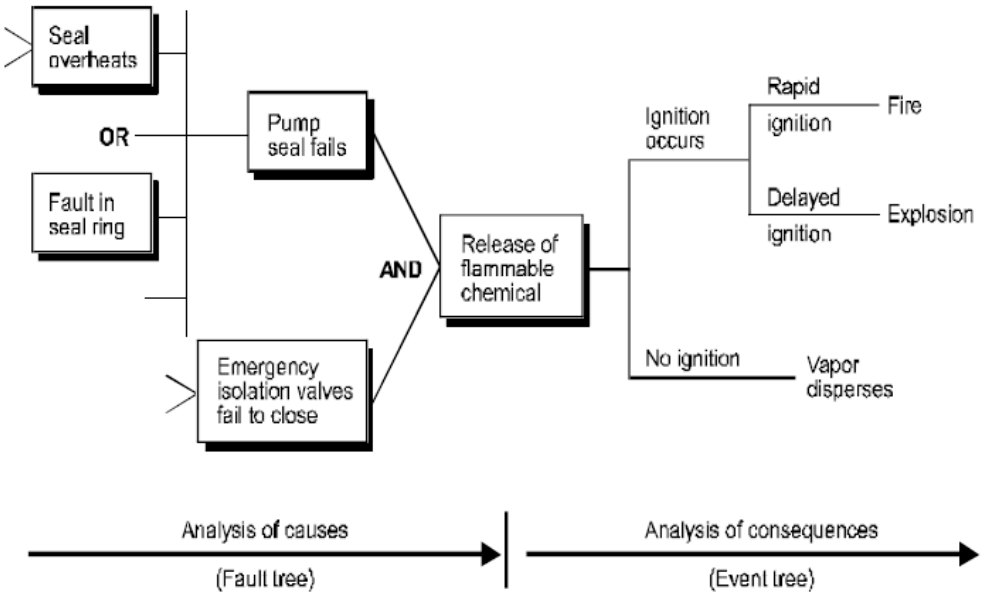


Figure 3-6: Fault Tree (event) Building for a Gas Based Thermal Power Plant

3.4.6 Preliminary hazard analysis

The purpose of the preliminary hazards analysis (PHA) is to identify early in the design process the potential hazards associated with, or inherent in a process design, thus eliminating costly and time consuming delays caused by design changes made later. This also eliminates potential hazard points at design stage itself.

An assessment of the conceptual design is conducted for the purpose of identifying and examining hazards related to feed stock materials, major process components, utility and support systems, environmental factors, proposed operations, facilities, and safeguards.

In the proposed plant major hazard is fire due to the storage of chemicals in the tanks. The process related hazards are very rare as the process is carried out in closed reaction vessels and does not involve exothermic reactions. Other hazardous installation is the boiler where the steam is generated and used in the process at various stages.

3.4.6.1 Electrical hazards

Electrical hazards leading to fire and explosion in switchgear and other equipment mainly due to failure of circuit breakers, insulators, fuses, busbars, and poor maintenance. Accidents may also occur in transformer due to open arcing, flashover above oil level, insulator failure, overloading, failure of air cooling system, lighting *etc.* Nevertheless, all these hazards lead to localized accidents only.

3.4.6.2 Fire hazards

There could be other areas in the plant that have a potential for fire hazard and require adequate fire fighting equipment for example, the raw material storages. These are considered here since uncontrolled fire may trigger the above emergencies due to domino effect. However for the proposed plant, safety guidelines will be as per Tariff Advisory Committee.

3.4.6.3 Cable galleries (DG room)

For containment of fire and preventing it from spreading in the cable galleries, unit wise fire barriers with self-closing fire resistant doors are planned. The ventilation system provided in the cable galleries will be interlocked with the fire alarm system so that, in the event of a fire alarm, the ventilation system is automatically switched off. Also to avoid spreading of fire, all cable entries/openings in cable galleries, tunnels, channels, floors, barriers *etc.*, will be sealed with non-inflammable/fire resistant sealing material.

3.4.6.4 Toxic release

The proposed plant will use chorine, which is toxic. If not handled properly, will lead to toxicity. Self-contained breathing apparatus will be available in the plant premises in the event of leakage in case of emergency. Employees will be trained in handling these self-contained breathing apparatus. Since the quantity of toxic release will be on lower side, off site implications of release are not envisaged.

Table 3-17: Preliminary Hazard Analysis for Process/Storage Areas

Equipment	Process/Storage	Potential Hazard	Provision
Turbine	Converts pressure in the flue gas into mechanical energy.	Mechanical and fire hazards.	Layout of equipment/ machinery is done in accordance to plant and electrical inspectorate.

Equipment	Process/Storage	Potential Hazard	Provision
Generator	Converts mechanical energy into electrical energy.	Mechanical hazards and fire hazards in Lube oil system Cable galleries Short circuits	As above
Power Transformers	-	Fire and explosion	All electrical fittings and cables are provided as per the specified standards. Ensure that all electrical cabling in the area are properly insulated and covered. Foam / CO_2 / dry powder type fire extinguishers are to be provided.
Switch Yard	Switch Yard	Fire	As above
Switch Yard control room	-	Fire in cable galleries and switch	As above
Boilers	-	Fire (mainly near burners), steam; Explosion	As above
DG set		Fires in Cable galleries, Short circuits in Control Rooms and Switch-gears	As above
Natural Gas pipeline		Fire and Explosion	Frequent monitoring of valves and joints. Sprinkling system shall be provided. Ensure that all electrical cabling in the area are properly insulated and covered. Foam / CO_2 / dry powder type fire extinguishers are to be provided. Pipeline design as per OISD norms.
Chlorine	Used for water treatment in different phases in cooling water, potable water and raw water.	Toxic accidental release	Leak detection and neutralization system will be provided.
HFO storage (Heavy Fuel)		Combustion at elevated temperature	Leak detection and neutralization system will be provided.
LDO Storage		Fire	
Hydrogen Plant		Explosion	
HSD		Fire	

Table 3-18: Preliminary Hazard Analysis for the Whole Plant in General

PHA Category	Description of Plausible Hazard	Provision
Environ-mental factors	If there is any leakage and eventuality of source of ignition.	All electrical fittings and cables are provided as per the specified standards. All motor starters are flame proof.
	Highly inflammable nature of the chemicals may cause fire hazard in the plant	A well designed fire protection including protein foam, dry powder, CO_2 extinguisher should be provided. Fire extinguisher of small size and big size are provided at all potential fire hazard places. In addition to the above, fire hydrant network is also provided to complete plant.

3.4.7 Safety measures

3.4.7.1 Maximum credible accident (MCA) analysis

Hazardous substances may be released as a result of failures or catastrophes, causing possible damage to the surrounding area. This section deals with the question of how the consequences of the release of such substances and the damage to the surrounding area can be determined. MCA analysis encompasses certain techniques to identify the hazards and calculate the consequent effects in terms of damage distances of heat radiation, toxic releases, vapour cloud explosion, *etc.* A host of probable or potential accidents of the major units in the complex arising due to use, storage and handling of the hazardous materials are examined to establish their credibility. Depending upon the effective hazardous attributes and their impact on the event, the maximum effect on the surrounding environment and the respective damage caused can be assessed.

Consequence analysis is basically a study of quantitative analysis of hazards due to various failure scenarios. It is that part of risk analysis, which considers failure cases and the damage caused by these failure cases. It is done in order to form an opinion on potentially serious hazardous outcome of accidents and their possible consequences. The reason and purpose of consequence analysis are many folds like:

- Part of Risk Assessment
- Plant Layout/Code Requirements
- Protection of other plants
- Protection of the public
- Emergency Planning
- Design Criteria (e.g. Loading on Control Room)

The results of consequence analysis are useful for getting information about all known and unknown effects that are of importance when some failure scenario occurs in the plant and also to get information as how to deal with the possible catastrophic events. It also gives the workers in the plant and people living in the vicinity of the plant, an understanding of their personal situation.

3.4.8 Damage criteria

The storage and unloading at the storage facility may lead to fire and explosion hazards. The damage criteria due to an accidental release of any hydrocarbon arise from fire and explosion.

Tank fire would occur if the radiation intensity is high on the peripheral surface of the tank leading to increase in internal tank pressure. Pool fire would occur when the flammable liquid in the tank due to leakage gets ignited.

3.4.8.1 Fire damage

A flammable liquid in a pool will burn with a large turbulent diffusion flame. This releases heat based on the heat of combustion and the burning rate of the liquid. A part of the heat is radiated while the rest is converted away by rising hot air and combustion products. The radiations can heat the contents of a nearby storage or process unit to above its ignition temperature and thus result in a spread of fire.

The radiations can also cause severe burns or fatalities of workers or fire fighters located within a certain distance. Hence, it will be important to know beforehand the damage potential of a flammable liquid pool likely to be created due to leakage or catastrophic failure of a storage or process vessel. This will help to decide the location of other storage/process vessels, decide the type of protective clothing the workers/fire fighters need, the duration of time for which they can be in the zone, the fire extinguishing measures needed and the protection methods needed for the nearby storage/process vessels.

Table 3-19 tabulates the damage effect on equipment and people due to thermal radiation intensity whereas; the effect of incident radiation intensity and exposure time on lethality is given in Table 3-20.

Table 3-19: Damage Due to Incident Radiation Intensities

Sl. No.	Incident Radiation (kW/m^2)	Type of Damage Intensity	
		Damage to Equipment	Damage to People
1	37.5	Damage to process equipment	100% lethality in 1 min. 1% lethality in 10 sec.
2	25.0	Minimum energy required to ignite wood at indefinitely long exposure without a flame	50% Lethality in 1 min. Significant injury in 10 sec.
3	19.0	Maximum thermal radiation intensity allowed on thermally unprotected adjoining equipment	--
4	12.5	Minimum energy to ignite with a flame; melts plastic tubing	1% lethality in 1 min.
5	4.5	--	Causes pain if duration is longer than 20 sec, however blistering is un-likely (First degree burns)

Sl. No.	Incident Radiation (kW/m^2)	Type of Damage Intensity	
		Damage to Equipment	Damage to People
6	1.6	--	Causes no discomfort on long exposures
Source: Techniques for Assessing Industrial Hazards by World Bank.			

Table 3-20: Radiation Exposure and Lethality

Radiation Intensity (kW/m^2)	Exposure Time (seconds)	Lethality (%)	Degree of Burns
1.6	--	0	No Discomfort even after long exposure
4.5	20	0	1 st
4.5	50	0	1 st
8.0	20	0	1 st
8.0	50	<1	3 rd
8.0	60	<1	3 rd
12.0	20	<1	2 nd
12.0	50	8	3 rd
12.5	--	1	--
25.0	--	50	--
37.5	--	100	--

3.4.8.2 Damage due to explosion

Explosion is a sudden and violent release of energy accompanied by the generation of pressure wave and a loud noise. The rate of energy release is very large and has potential to cause injury to the people, damage the plant and nearby property *etc.* The effect of over-pressure can directly result in deaths to those working in the immediate vicinity of the explosion. The pressure wave may be caused by a BLEVE (Boiling Liquid Expanding Vapour Cloud) or Vapour Cloud explosion.

3.4.8.3 BLEVE - fireball

BLEVE is sometimes referred to as a fireball. A BLEVE is a combination of fire and explosion with an intense radiant heat emission within a relatively short time interval. This phenomenon can occur as a result of overheating of a pressurized vessel by a primary fire. If a pressure vessel fails as a result of a weakening of its structure the contents are instantaneously released from the vessel as a turbulent mixture of liquid and gas expanding rapidly and dispersing in air as a cloud. When this cloud is ignited a fireball occurs causing enormous heat radiation intensity within a few seconds. This heat intensity is sufficient to cause severe skin burns and deaths at several hundred meters from the vessel, depending on the quantity of gas involved. A BLEVE can therefore be caused by a physical impact on a vessel or a tank, which is already overstressed.

3.4.8.4 Vapour cloud explosion

Explosion can be confined and unconfined vapour cloud explosions. Confined explosions are those, which occur within some sort of containment such as a vessel or pipeline. Explosions in buildings also come under this category. Explosions which occur in the open air are referred to as unconfined explosions and produce peak pressures of only a few kPa. The peak pressures of confined explosions are generally higher and may reach hundreds of kPa. Table 3-21 tabulates the damage criteria as a result of peak over pressure of a pressure wave on structures and people.

Table 3-21: Damage Due To Peak over Pressure

Human Injury		Structural Damage	
Peak Over Pressure (bar)	**Type of Damage**	**Peak Over Pressure (bar)**	**Type of Damage**
5 - 8	100% lethality	0.3	Heavy (90% damage)
3.5 - 5	50% lethality	0.1	Repairable (10% damage)
2 - 3	Threshold lethality	0.03	Damage of Glass
1.33 - 2	Severe lung damage	0.01	Crack of Windows
1 - $1^{1/3}$	50% Eardrum rupture	-	-
Source: Marshall, V.C. (1977) ' How lethal are explosives and toxic escapes'.			

3.4.8.5 Effect due to toxic gas release

Chlorine is a greenish-yellow, highly reactive halogen gas that has a pungent, suffocating odor. The vapor is heavier than air and will form a cloud in the vicinity of a spill. Like other halogens, chlorine exists in the diatomic state in nature. Chlorine is extremely reactive and rapidly combines with both inorganic and organic substances. Chlorine is an eye and respiratory tract irritant and, at high doses, has direct toxic effects on the lungs. The critical values of chlorine concentrations in air are given in Table 3-22.

Table 3-22: Critical Concentrations for Chlorine

Criteria	Concentration
90% lethality (10 min exposure)	866 ppm
50% lethality (10 min exposure)	433 ppm
10% lethality (10 min exposure)	217 ppm
Immediate Damage to life and Health (IDLH)	25 ppm

3.4.8.6 Typical scenarios considered in TPP for MCA analysis

Based on the storage and properties of the chemicals at the TPP, the some typical scenarios relevant for MCA analysis is given in the following Table.

Table 3-23: Scenarios Considered For MCA Analysis

Sl. No.	Fuel/Chemical	Quantity	Pool Fire	Explosion	Toxic Release	Jet Fire
1	Failure of LDO storage tanks		*	-	-	--
2	Catastrophic Failure of LDO + HFO Storage Tanks		*	-	-	--
3	Failure of Chorine cylinder		-	-	*	--
4	Failure of Hydrogen cylinder at Filling Station		-	*	-	--
5	Catastrophic Failure of all HSD Storage Tanks		*	-	-	--
6	Catastrophic Failure of Natural Gas Pipeline connected to turbine		-	-	-	*

Note:

** Considered for MCA Analysis*

 # Most likely scenario is leakage of Chlorine and forming toxic cloud during unloading operation and leakage of Hydrogen leading to explosion during filling operation.

A perusal of the above table indicates that major material storage is flammable liquid. Fires could occur due to presence of ignition source at or near the source of leak or could occur due to flashback upon ignition of the traveling vapor cloud. Tank fires may occur due to the following:

- Ignition if rim seal leak leading to rim seal fire and escalating to full-fledged tank fire. Lighting is a major source of ignition of tank fires; and
- Overflow from tank leading to spillage and its subsequent ignition, which flashes back to the tank leading to tank fire. The chance of overflow should be less unless operator has grossly erred. Spillage due to overflow may result in a dyke fire if ignition occurs after sufficiently long period.
- For radiation calculations, pool fire may be important and the criteria of 4.5 kW/m^2 could be selected to judge acceptability of the scenarios. The assumptions for calculations are:
- It is not continuous exposure;
- It is assumed that No fire detection and mitigation measures are initiated;

- There is not enough time available for warning the public and initiating emergency action;
- Secondary fire at public road and building is not likely to happen;
- The effect of smoke on reduction of source radiation intensity has not been considered; therefore hazard distances calculated tend to be conservative; and
- Shielding effect of intervening trees or other structures has not been considered. No lethality is expected from this level of intensity although burn injury takes place depending on time of exposure.

3.4.9 Consequence analysis

3.4.9.1 Effect of thermal radiation on population

TLV of 1.6 kW/m^2 can be adopted as the safe radiation intensity for human population even for long exposures to calculate safe zone.

Domino Effect

The term domino effect denotes a chain of accidents, or situations, in which a fire/explosion load generated by an accident in one unit in an industry causes secondary and higher order accidents in other units. Such chains of accidents have a greater propensity to cause damage than stand-alone accidents. Most of the past risk assessment studies deal with accident only in a single industry, more so in one of the units of an industry. However, often, accident in one unit causes a secondary accident in a nearby unit, which in turn may trigger a tertiary accident, and so on. The probability of occurrence and adverse impacts of such 'domino' or 'cascading' effects will be more prominent for industrial estates.

3.4.10 Risk management

The communication of QRA results should take the form of decision analysis; that is, what options are available, and for each option what are the risks, costs, and benefits, and how are these distributed within society. Proper comparison and communication can actually change laypeople's misperceptions of risks so participatory decision making may proceed on a more rational, less emotional basis. Risk management is the use of QRA results to mitigate or eliminate unacceptable risks. It is the search for alternative risk reduction actions and the implementation of those that appear to be most cost-effective. Most human activities are undertaken for obvious and direct benefits and risks are intuitively compared with these benefits. Avoiding one risk may create another (risk transference); net risk is a consideration facilitated by QRA. There are strong reiteration and feedback between risk management and hazard accounting because

a) changes in the scope of the ERA may be necessary to fully answer the questions of management, and b) relatively simple changes in the project may alter the hazard and reduce risk (for example, different sitting).

3.5 Summary of Applicable National Regulations

3.5.1 General description of major statutes

A comprehensive list of all the legal instruments applicable to TPPs is annexed as **Annexure II**.

3.5.2 Industry-specific requirements

There are well-defined regulatory requirements which imply that the government must regulate various aspects of the TPP operations and construction to reduce their environmental and social impacts.

The CPCB has noted that many TPPs default on meeting pollution standards. As Table 3-24 shows, about 30% of TPPs continue to fail to meet the expected standards for emissions and about 20% fail to meet effluent standards.

Table 3-24: Compliance of Standards for Coal-based TPPs

Year	Total Number of Operating Plants	Emission Standard		Effluent Standard	
		Comply	Not Comply	Comply	Not Comply
1999-2000	74	34	40		
2000-01	76	48	28		
2001-02	78	42	36	49	29
2002-03	79	48	31	52	27
2003-04	78	56	22	63	15
2004-05	78	55	23	63	15
2005-06	78	56	22	63	15
2006-07	78	56	22	63	15
Source: CPCB Annual Report, Various Years					

Environmental Standards

In order to regulate the discharge of effluent and emission from TPPs, the following standards are notified under Environment (Protection) Act, 1986. Corresponding standards are annexed as **Annexure III**.

- Effluent and emission standards
- Stack height/ limit
- The temperature limit for discharge of condenser cooling water

Dumping and Disposal / Utilization of Fly Ash

In a bid to prevent the dumping and disposal of fly ash discharged from coal/lignite based TPPs, the MoEF has specified the following measures to regulate the use of fly ash. The

Notification, No. S.0.763(E), dated the 14th September, 1999 and subsequent amendments are annexed as **Annexure IV**.

At the time of clearance of thermal power projects generating fly ash, it is ensured that provisions are made for proper utilization and disposal of fly ash. Stipulations are made for 20% utilization and disposal of fly ash within one year of commissioning of the plants, with progressive 10% utilization increases for the next 7 years, reaching 100% utilization within 9 years. The project authorities are also asked to keep provision for dry ash collection system and a maximum of 100 – 350 acres land is permitted to acquire for ash disposal depending upon each case.

Recycling of fly ash by prohibiting the manufacture of clay bricks, tiles or blocks without mixing 25% of the ash with soil on weight-to-weight basis within a radius of 100 km of power plant, has been made mandatory. TPPs are also required to maintain monthly records of ash made available to each brick kiln. To ensure unhindered loading and transport of ash, there is a provision of constituting a Dispute Settlement Committee in each TPP.

Use of Beneficiated / Blended Coal

Govt. of India has promulgated a Gazette Notification (GSR 560(E) & 378(E), dated September 19, 1997 and June 30, 1998 respectively) on use of beneficiated/blended coal containing ash not more than 34 % w.e.f. June 2001 in the following power plants:

- Power plants located beyond 1000 km from pit head;
- Power plants located in critically polluted areas, urban areas and in ecologically sensitive areas.

The power plants using FBC (CFBC, PFBC & AFBC) and IGCC combustion technologies are exempted to use beneficiated coal irrespective of their locations.

3.5.3 Pending and proposed regulatory requirements

Following are the Charter on Corporate Responsibility for Environmental Protection (CREP) action points which needs to be implemented.

Action Points

- Implementation of environmental standards (both emission and effluent) in non-compliant power plants
- Tightening of emission norms for new power plants/expansion projects
- Development of SO_2 and NOx emission standards for coal-based power plants
- Re-circulation of ash pond effluent by all TPPs except the power plants located in coastal area and using sea water for ash disposal
- Installation/activation of opacity meters with recording facility in all the units of TPPs in the country with proper calibration system
- Development of guidelines/standards for toxic metals including mercury, arsenic and fluoride emissions
- Review of stack height requirement and guidelines for power plants

- Implementation of Notification for use of beneficiated coal power plants should sign fuel supply agreement (FSA) to meet the requirement as per the matrix prepared by CEA for compliance of the Notification. Options/mechanism for setting up of coal washeries:
  - Coal India will set up its own washery
  - State Electricity Board to set up its own washery
  - Coal India to ask private entrepreneurs to set up washeries for Coal India Limited (CIL) and taking washing charges
  - State Electricity Board to select a private entrepreneur to set up a washery near pit-head Installation of coal beneficiation plant
- All the TPPs shall indicate their requirement for ash disposal in abandoned mines and Coal India Ltd./ Min. of Coal shall provide list abandoned coalmines
- Thermal power plants to provide dry fly ash to the users outside the plant premises and uninterrupted access at the ash pond
- Power plants to provide dry fly ash free of cost to the users as per the Notification
- The amendments made by the Central Public Works Department (CPWD) in its respective schedules/ specifications for building construction, to be adhered by the State Public Works Departments (PWDs)/construction and development agencies, *etc.*
- Draft amendments in the Notification on use of up to 5% fly ash in OPC for improvement in the performance of the OPC, issued by the Bureau of Indian Standards (BIS) to be finalized and circulated to all concerned
- Fly ash mission to prepare guidelines on prioritization of sector-wise areas for utilization of fly ash particularly in regard to value added products
- New TPPs to be considered for environmental clearance need to adopt dry ash disposal/medium (42-45%) ash concentration slurry disposal systems.
- New power plants shall also promote adoption of clean coal and clean power generation technologies.

Dumping and Disposal / Utilization of Fly Ash

The Govt. of India has proposed to issue a new Notification, in suppression of the existing Notification number S.O. 763(E) dated 14th September 1999, regarding use of fly ash in construction activities, responsibilities of TPPs and specifications for use of ash-based products/responsibility of other agencies. The draft Notification, dated 03 April, 2007 is annexed as **Annexure V**.

Table 3-25: Country-specific Emissions from the TPPs

Country	SO_2 Emissions [mg/m^3]	Size of the Plant	NOx Emissions [mg/m^3]	Size of the Plant	CO_2 Emissions [mg/m^3]	Size of the Plant	Dust Emissions [mg/m^3]	Size of the Plant
EC	400	> 500 MWt	650	> 50 MWt			50	> 500 MWt
World Bank	500 t/d or 50 $\mu g/m^3$ additional immission over slight prior SO_2		858 (780 for lignite)				100 (150 in rural areas and when immission <260	

Country	SO_2 Emissions [mg/m^3]	Size of the Plant	NOx Emissions [mg/m^3]	Size of the Plant	CO_2 Emissions [mg/m^3]	Size of the Plant	Dust Emissions [mg/m^3]	Size of the Plant
	burden (≤ 50 µg/m^3) 100 t/d or 10 µg/m^3 additional immision over high prior SO_2 burden (>100 µg/m^3)						µg/m^3 beyond power plant perimeter)	
Australia	200		800	> 30 MWt	100		80	-
Austria	80% (sep. efficiency)	>200 MWt	800	> 50 MWt	250	> 2 MWt	50	> 50 MWt
Belgium	400	> 300 MWt	200	>100 MWt			50	> 50 MWt
Canada	740		740				125	
Denmark	860	> 50 MWt	1150	> 50 MWt			57	> 5 MWt
Finland	140	> 150 MWt	200	> 300 MWt			57	> 50 MWt
France	1700-3400	(regional)					130	> 9.3 MWt
Germany	400	> 300 MWt	200	> 300 MWt	250	> 50 MWt	50	> 5 MWt
Great Britain	90% (Sep. efficiency)	> 700 MWt	760	> 700 MWt			97	> 700 MWt
India	Height of Stack > 50 MWt : 275 m > 200 < 500 MWt : 200 m < 200 MWt : (equation)		No limits				150 (350 for plants with < 200 MWt in unprotected areas)	
Italy	400	> 100 MWt	650	> 100 MWt			50	> 100 MWt
Japan	Plant-specific		411	>70000 m^3/h			50	> 20000 m^3/h
New Zealand							125-500	> 5 MWt
Netherlands	400	> 300 MWt	400	> 300 MWt			50	
Spain	2400						200	> 200 MWt
Sweden	290		430				35	
USA	740	> 29 MWt	740	> 29 MWt			37	> 73 MWt

The minimum size of the plant to which the relevant limit applies is stated in MWt; the volumetric flue-gas flow is stated in m^3STP/h

4. OPERATIONAL ASPECTS OF EIA

Prior environmental clearance process has been revised in the Notification issued on 14th September, 2006 into following four major stages *i.e.*, screening, scoping, public consultation and appraisal. Each stage is has certain procedures to be followed. This section deals with all the procedural and technical guidance, for conducting objective-oriented EIA studies, their review and decision-making. Besides, the Notification classified projects into Category A, which requires prior environmental clearance from MoEF and Category B from SEIAA/UTEIAA.

Consistency with other requirements

- Clearance from other regulatory bodies is not a pre-requisite for obtaining the prior environmental clearance and all such clearances will be treated as parallel statutory requirements.
- Consent for Establishment (CFE) and prior environmental clearance are two different legal requirements, a project proponent is required t be taken. Therefore, these two activities can be initiated and proceeded with simultaneously.
- If a project is covered by the provisions of CRZ and EIA Notifications, then the project proponent is required to take separate clearances from the concerned Authorities.
- Rehabilitation and Resettlement issues need not be dealt under the EIA Notification as other statutory bodies deal with these issues. However, socio-economic studies be considered while taking environmental decisions.

4.1 Coverage of TPP Under the Purview of Notification

All the new TPP industrial projects including expansion and modernization require prior environmental clearance. Based on pollution potential, these projects are classified into Category A and Category B *i.e.*

- Category A: All TPP development projects that are
  - ≥ 500 MW (coal/lignite/naphtha and gas based); or
  - ≥ 50 MW (Pet coke diesel and all other fuels);
- Category B: All TPP developmental project that has
  - < 500 MW (coal/lignite/naphtha and gas based) or
  - < 50 MW or
  - ≥ 5 MW (Pet coke, diesel and all other fuels).

Besides there are general conditions, when it applies, a Category B project will be treated as Category A project. These conditions are discussed in subsequent sections.

The sequence of steps in the process of prior environmental clearance for category A projects and the Category B projects are shown in Figure 4.1 and Figure 4.2 respectively.

Each stage in the process of prior environmental clearance for the TPPs is discussed in subsequent sections.

In case of Expansion or Modernization of the developmental Activity:

- Any developmental activity, which was issued EIA clearance (existing project), when undergoes expansion or modernization (change in process or technology) with increase in production capacity or any change in product mix beyond the list of products cleared in the issued clearance is required to submit new application for EIA clearance.
- Any developmental activity, which is listed in Schedule of the EIA Notification and after expansion due to its total capacity, if falls under the purview of either Category B or Category A, then such developmental activities requires clearance from respective authorities.

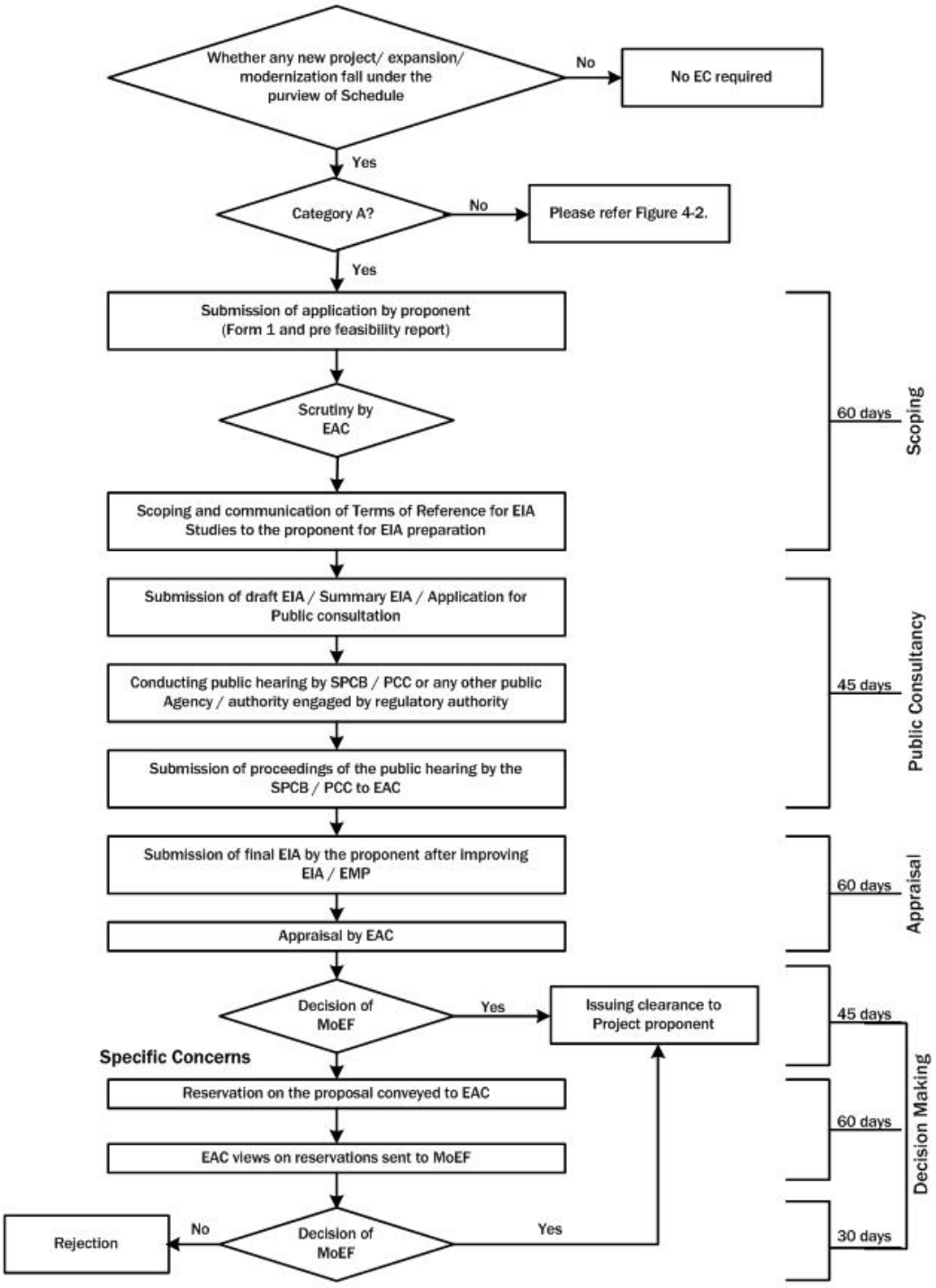


Figure 4-1: Prior Environmental Clearance Process for Activities Falling Under Category A

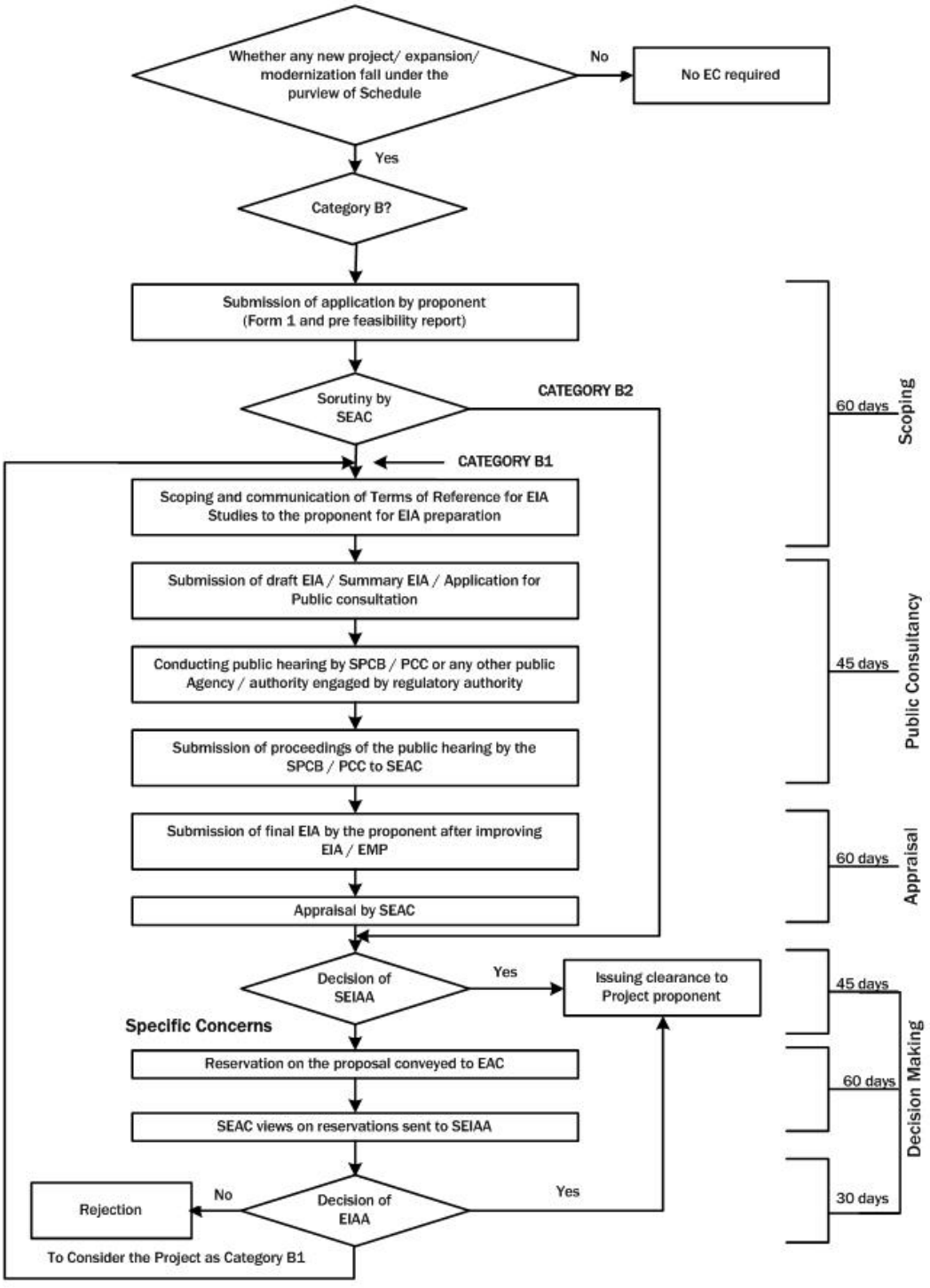


Figure 4-2: Prior Environmental Clearance Process for Activities Falling Under Category B

4.2 Screening

Screening of the project shall be performed at the initial stage of the project development so that proponents are aware of their obligations before deciding on the budget, project design and execution plan.

This stage is applicable only for Category 'B' developmental activity *i.e.* if general conditions are applicable for a Category B project, then it will be treated as Category A project. Besides, screening is also refers to the classification of Category B projects into either Category B1 or Category B2. Category B1 projects require to follow all the stages that are applicable for a Category A project, but are processed at the SEIAA/UTEIAA. Whereas, the Category B2 do not require either EIA or public consultation.

As per the Notification, classification of the Category B projects falls under the purview of the SEAC. This manual provides certain guidelines to the stakeholders for classification of Category B1 and Category B2.

4.2.1 Applicable conditions for Category B projects

General condition:

- Any TPP developmental project that has < 500 MW (coal/lignite/naphtha and gas based) or < 50 MW or ≥ 5 MW (Pet coke, diesel and all other fuels) which is usually falling under Category B will be treated as Category A, if located in whole or in part within 10 km from the boundary of:
  - Protected Areas notified under the Wild Life (Protection) Act, 1972
  - Critically Polluted areas as notified by the CPCB from time to time
  - Notified Eco-sensitive areas
  - Inter-State boundaries and international boundaries. Provided that the requirement regarding distance of 10 km of the inter-state boundaries can be reduced or completely done away with by an agreement between the respective States or UTs sharing the common boundary.
- If any of the conditions listed in above general condition applies, then a Category B project will be treated as Category A.
- The SEIAA shall base its decision on the recommendations of a State/UT level EAC for the purpose of Environmental Clearance.
- In absence of a duly constituted SEIAA or SEAC, a Category B project shall be treated as a Category 'A' project
- The EAC at the State/UT level shall screen the projects or activities in Category B. SEAC shall meet at least once every month
- If any Category B TPP project/activity, after proposed expansion of capacity/production or fuel change, falls under the purview of Category A in terms of production capacity, then clearance is required from the Central Government

4.2.2 Criteria for classification of Category B1 and B2 projects

The classification of Category B projects or activities into B1 or B2 (except the project or activities listed in item 8(b) in the schedule to the EIA Notification, 2006) will be determined based on whether or not the project or activity requires further environmental

studies for preparation of an EIA for its appraisal prior to the grant of environmental clearance. The necessity of which will be decided, depending upon the nature and location specificity of the project, by SEAC after scrutiny of the applications seeking environmental clearance for Category B projects or activities.

The projects requiring an EIA report shall be included in Category B1 and remaining projects will fall under Category B2 and will not require an EIA report and public consultation.

Situations which could be considered for Category B2 are:

- Expansion of existing plants up to 10% additional capacity
- If a power plant is located in an notified industrial estate, expansion up to 15% additional capacity
- Captive power plants up to a capacity of ≤ 5 MW
- Bagasse and bio-fuel based power plants up to a capacity of < 50 MW

4.2.3 Application for prior screening for environmental clearance

- The project proponent, after identifying the site and conducting the pre-feasibility study, is required to apply for the prior environmental clearance by filling and submitting the Form 1 given in **Annexure VI**. The proponent has to submit the filled in Form 1 along with the pre-feasibility report and draft ToR for EIA studies to the concerned Authority *i.e.* MoEF, Government of India for Category A projects and the SEIAA/UTEIAA in case of Category B projects. Please refer subsequent sections for the information on how to fill the Form 1, contents of pre-feasibility report and sector-specific ToRs.
- Prior environmental clearance is required before any construction work, or preparation of land is started on the identified site/project/activity by the project management, except for securing the land.
- If the application is made for a specific developmental activity, which has an inherent area development component as a part of its project proposal and the same project also attracts the construction and area development provisions under 8a and 8b of the Schedule, then the project will be seen as a developmental activity other than 8a and 8b of the Schedule.

4.2.4 Siting guidelines

These are the guidelines, stake holders may consider while siting the developmental projects, to minimize the associated possible environmental impacts. While in some situations, completely sticking to these guidelines is difficult and unwarranted, therefore these guidelines may be kept in the background, as far as possible, while taking the decisions.

Areas preferably be avoided

In siting industries, care should be taken to minimize the adverse impact of the industries on the immediate neighborhood as well as distant places. Some of the natural life sustaining systems and some specific land uses are sensitive to industrial impacts because of the nature and extent of fragility. With a view to protect such sites, the industries may maintain the following distances as far as possible, from the areas listed:

- Ecologically and/or otherwise sensitive areas: Preferably 5 km; depending on the geo-climatic conditions the requisite distance may be decided appropriate by the agency.
- Coastal Areas: Preferably half-a-kilometre away from high tide line (HTL).
- Flood Plain of the Riverine System: Preferably half-a-kilometre away from flood plain or modified flood plain affected by dam in the upstream or by flood control systems.
- Transport/Communication System: Preferably half-a-kilometre away from highway and railway line.
- Major Settlements (3,00,000 population): Distance from settlements is difficult to maintain because of urban sprawl. At the time of siting of the industry, if the notified limit of any major settlement is located within 50 km, the spatial direction of growth of the settlement for at least a decade must be assessed and the industry shall be sited at least 25 km away from the projected growth boundary of the settlement.

Note:

Ecological and/or otherwise sensitive areas include (i) Religious and Historic Places; (ii) Archaeological Monuments (e.g. identified zone around Taj Mahal); (iii) Scenic Areas; (iv) Hill Resorts; (v) Beach Resorts; (vi) Health Resorts; (vii) Coastal Areas rich in Corals, Mangroves, Breeding Grounds of Specific Species; (viii) Estuaries rich in Mangroves, Breeding grounds of Specific Species; (ix) Gulf Areas; (x) Biosphere Reserves; (xi) National Parks and Sanctuaries; (xii) Natural lakes, Swamps; (xiii) Seismic Zones; (xiv) Tribal Settlements; (xv) Areas of Scientific and Geological Interest; (xvi) Defence Installations, specially those of security importance and sensitive to pollution; (xvii) Border Areas (International) and (xviii) Air Ports.

Pre-requisite: State and Central Governments are required to identify such areas on a priority basis.

General sitting factors

In any particular selected site, the following factors must also be recognized.

- No forest land shall be used for non-forest activity for the sustenance of the industry (Ref: Forest Conversation Act, 1980).
- No prime agricultural land shall be converted into industrial site.
- Land acquired shall be sufficiently large to provide space for appropriate treatment of wastewater after maximum possible reuse and recycle. Reclaimed (treated) wastewater shall be used to raise greenbelt and to create water body for aesthetics, recreation and if possible, for aquaculture. The greenbelt shall be at least half-a-kilometre wide around the battery limit of the industry. For industries having odors problem shall have sufficiently thick green belt surrounding the battery limit of the industry.
- Enough space should be provided for storage of recyclable solid wastes so that these could be available for possible reuse.
- Lay out and from of the industry that may come up in the area must conform to the landscape of the area without affecting the scenic features of that place.
- Associated township of the industry may be created at a space having physiographic barrier between the industry and the township.
- Each industry is required to maintain three ambient air quality measuring stations.

Guidelines of central electricity authority [CEA], government of India, for site selection of coal-based thermal power stations

- The choice of location is based on the following:
  - Nearness to coal source;
  - Accessibility by road and rail;
  - Availability of land, water and coal for the final installation capacity;
  - Coal transportation logistics;
  - Power evacuation facilities;
  - Availability of construction material, power and water;
  - Preliminary environmental feasibility including rehabilitation and resettlement requirements, if any;
- Land requirement for large capacity power plant is about 0.2 km^2 per 100 MW for the main power house only excluding land for water reservoir (required if any).
- The land for housing is taken as 0.4 km^2 per project.
- Land requirement for ash pond is about 0.2 km^2 per 100 MW considering 50% of ash utilization. Land for ash pond is considered near the main plant area (say 5 to 10 km away). In case of non-availability of low lying ash pond area at one place, the possibility of having two areas in close proximity is considered.
- Water requirement is about 40 cusecs per 1000 MW.
- First priority is given to the sites those are free from forest, habitation and irrigated/agricultural land. Second priority is given to those sites that are barren, *i.e.* wasteland, intermixed with any other land type, which amounts to 20% of the total land identified for the purpose.
- Location of thermal power station is avoided in the coal-bearing area.
- Coal transportation is preferred by dedicated marry-go-round (MGR) rail system. The availability of corridor for the MGR need to be addressed while selecting the sites.

Guidelines for site selection of coal-based thermal power stations set by the MoEF

- Locations of thermal power stations are avoided within 25 km of the outer periphery of the following:
  - metropolitan cities;
  - National park and wildlife sanctuaries;
  - Ecologically sensitive areas like tropical forest, biosphere reserve, important lake and coastal areas rich in coral formation;
- The sites should be chosen in such a way that chimneys of the power plants does not fall within the approach funnel of the runway of the nearest airport;
- Those sites should be chosen which are at least 500 m away from the flood plain of river system;
- Location of the sites are avoided in the vicinity (say 10 km) of places of archaeological, historical, cultural/religious/tourist importance and defense installations;
- Forest or prime agriculture lands are avoided for setting up of thermal power houses or ash disposal

4.3 Scoping for EIA Studies

Scoping exercise is taken-up soon after the project contours are defined. The primary purpose of scoping is to identify concerns and issues which may affect the project decisions. Besides, scoping defines EIA study requirements and boundaries. The results of the scoping exercise form the basis for rest of the EIA study.

Scoping refers to the process by which the EAC, in case of Category 'A' projects or activities, and SEAC in the case of Category 'B1' projects, including applications for expansion and/or modernization of existing projects, determine ToR for EIA studies addressing all relevant environmental concerns for the preparation of an EIA Report for a particular project.

- Project proponent shall submit the application to the concerned authority. The application (Form 1 as given in **Annexure VI**) shall be attached with pre-feasibility report and proposed ToR for EIA Studies. The proposed sequence to arrive at the draft ToR is discussed below:
  - Precisely, the pre-feasibility report summarizes the project details and also the likely environmental concerns based on the secondary information, which will be availed for filling the Form 1.
  - From the pre-feasibility report and the Form 1, valued environmental components (VECs) may be identified for a given project (the receiving environment/social components, which are likely to get effected due to the project operations/activities).
  - Once the project details from the pre-feasibility report & Form 1; and VECs are identified, a matrix establishing the interactions which can lead to the effects/impacts could be developed (Qualitative analysis).
  - For each identified possible effect in the matrix, significance analysis could be conducted to identify the impacts, which needs to be further studied (quantitative analysis) in the subsequent EIA studies. All such points will become the part of the draft ToR to be proposed by the project proponent along with the application form.
  - The information to be provided in pre-feasibility report, guidelines for filling Form 1 and guidelines for developing draft ToR is summarized in the subsequent sections.
  - Authority consults the respective EAC/SEAC to reply to the proponent. The EAC/SEAC concerned reviews the application form, pre-feasibility report and proposed draft ToR by the proponent and make necessary additions/deletions to make it a comprehensive ToR that suits the statutory requirements for conducting the EIA studies.
- A site visit by a sub-group of EAC/SEAC concerned will be planned, only if considered necessary by the EAC/SEAC with the written approval of the Chairperson of EAC/SEAC concerned. Project proponent will facilitate such site visits of the sub-committees.
- EAC/SEAC shall provide an opportunity to the project proponent for presentation and discussions on the proposed project and related issues as well as the proposed ToR for EIA Studies. If the State Government desires to present their views on any specific project, they can depute an officer for the same at the scoping stage to EAC, as an invitee but not as a member of EAC. However, non-appearance of the project

proponent before EAC/SEAC at any stage will not be a ground for rejection of the application for the prior environmental clearance.

- In case of a new or expansion project in an identified problem area by the CPCB, then the Ministry may invite representative SEIAA to present their views, if any at the stage of scoping, to the EAC.
- The final set of ToR for EIA studies shall be conveyed to the proponent by the EAC/SEAC within sixty days of the receipt of Form 1 and pre-feasibility report. If the finalized ToR for EIA studies are not conveyed to the proponent within sixty days of the receipt of Form 1, the ToR for EIA studies suggested by the proponent shall be deemed as the final approved for the EIA studies.
- The final ToR for EIA studies shall be displayed on the website of the MoEF/SEIAA.
- Applications for prior environmental clearance may be rejected by the concerned Authority based on the recommendation of the EAC or SEAC concerned at this stage itself. In case of such rejection, the decision together with reasons for the same shall be communicated to the proponent in writing within sixty days of the receipt of the application.
- The final EIA report and the other relevant documents submitted by the applicant shall be scrutinized by the concerned Authority strictly with reference to the approved ToR for EIA Studies.

4.3.1 Pre-feasibility report

The pre-feasibility report should include, but not limited to highlight the proposed project information, keeping in view the environmental sensitivities of the selected site, raw material, technology options (based on alternative analysis), fuel availability, interconnectivity with transmission grid, system reliability, efficiency, availability, flexibility for power purchaser to opt for different combinations. The information required in pre-feasibility report varies from case to case even in the same sector depending upon the local environmental setting within which the plant is located. However, the environmental information which may be furnished in the pre-feasibility report for evolving the ToR for EIA Studies includes:

- Description of the project, including in particular:
  - a description of the physical characteristics of the whole project and the land-use requirements during the construction and operational phases,
  - a description of the main characteristics of the production processes, for instance, nature and quantity of the materials used,
  - an estimate, by type and quantity, of expected residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation, *etc.*) resulting from the operation of the proposed project.
- An outline of the main alternatives studied by the developer and an indication of the main reasons for this choice, taking into account the environmental effects.
- A description of the aspects of the environment likely to be significantly affected by the proposed project, including, in particular, population, fauna, flora, soil, water, air, climatic factors, material assets, including the architectural and archaeological heritage, landscape and the inter-relationship between the above factors.
- A description of the likely significant effects of the proposed project on the environment resulting from:
  - the existence of the project,

  - the use of natural resources – Specific consumptions,
  - the emission of pollutants, the creation of nuisances and the elimination of waste, and the description by the developer of the forecasting methods used to assess the effects on the environment.
- A description of the measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment
- A non-technical summary of the information provided under the above headings.
- An indication of any difficulties (technical deficiencies or lack of know-how) encountered by the developer in compiling the required information.

Besides, depending on the scope defined in the pre-feasibility report some pre-feasibility reports are based on various studies and data collection and addresses in detail the concern as technical & economical analysis and detailed feasibility level design of equipment, power optimization, transmission, economic, financial, social and environmental investigations, cost estimates with detailed bill of quantities (BOQ). The components identified here focuses on the requirements of Scoping for EIA study in order to define the ToR for EIA studies. **Annexure VII** can be referred for preferable structure of the pre-feasibility report.

4.3.2 Guidance for Providing Information in Form 1

The information given in specifically designed pre-feasibility report for this developmental activity may also be availed for filling Form 1.

Form 1 is designed to help users identify the likely significant environmental effects of proposed projects during scoping. There are two stages for providing information under two columns:

- First - identifying the relevant project activities from the list given in column 2 of Form 1. Start with the checklist of questions set out below and complete Column 3 by answering:
  - Yes - if the activity is likely to occur during implementation of the project;
  - No - if it is not expected to occur;
  - May be - if it is uncertain at this stage whether it will occur or not.
- Second - For each activity for which the answer in Column 3 is “Yes” the next step is to refer to the fourth column which quantifies the volume of activity which could be judged as significant impact on the local environmental characteristics, and identify the areas that could be affected by that activity during construction /operation / decommissioning of the project. The Form 1 requires information within 15 km around the project, whereas actual study area for EIA studies will be as prescribed by respective EAC/SEAC. Information will be needed about the surrounding VECs in order to complete this Form 1.

4.3.3 Identification of appropriate valued environmental components

VECs are components of the natural resources and human world that are considered valuable and are likely to be affected by the project activities. Value may be attributed for economic, social, environmental, aesthetic or ethical reasons. VECs represent the investigative focal point for further EIA process. The indirect and/or cumulative effects can be concerned with indirect, additive or even synergistic effects due to other projects or activities or even induced developments on the same environmental components as

would be considered direct effects. But such impacts tend to involve larger scale VECs such as within entire region, river basins or watersheds; and, broad social and economic VECs such as quality of life and the provincial economy. Once VECs are identified then appropriate indicators are selected for impact assessments on the respective VECs.

4.3.4 Methods for identification of impacts

There are number of factors which will influence the approach adopted for the assessment of direct, indirect, cumulative impacts, *etc.* for a particular project. The method should be practical and suitable for the project given the data, time and financial resources available. However, the method adopted should be able to provide a meaningful conclusion from which it would be possible to develop, where necessary, mitigation measures and monitoring. Key points to consider when choosing the method(s) include:

- nature of the impact(s),
- availability and quality of data,
- availability of resources (time, finance and staff).

The method chosen should not be complex, but should aim at presenting the results in a way that can be easily understood by the developer, decision maker and the public. A comparative analysis of major impact identification methods is given in the following table:

Table 4-1: Advantages and Disadvantages of Impact Identification Methods

Methods	Description	Advantages	Disadvantages
Checklists	▪ Annotate the environmental features that need to be addressed when identifying the impacts of activities in the project	▪ Simple to understand and use ▪ Good for site selection and priority setting ▪ Simple ranking and weighting	▪ Do not distinguish between direct and indirect impacts ▪ Do not link action and impact ▪ The process of incorporating values can be controversial
Matrices	▪ Grid like table that identify the interaction between project activities (along one axis) and environmental characteristics (along other axis) ▪ Entries are made in the cells which highlights impact severity in the form of symbols or numbers or descriptive comments	▪ Link action to impact ▪ Good method for displaying EIA results	▪ Difficult to distinguish direct and indirect impacts ▪ Significant potential for double-counting of impacts
Networks	▪ Illustrate cause effect relationship of project activities and environmental characteristics ▪ Useful in identifying secondary impacts ▪ Useful for establishing impact hypothesis and other structured science based approaches to EIA	▪ Link action to impact ▪ Useful in simplified form for checking for second order impacts ▪ Handles direct and indirect impacts	▪ Can become very complex if used beyond simplified version

Methods	Description	Advantages	Disadvantages
Overlays	▪ Maps the impacts spatially and display them pictorially ▪ Useful for comparing site and planning alternatives for routing linear developments ▪ Can address cumulative effects ▪ Information incentive	▪ Easy to understand ▪ Good to display method ▪ Good siting tool	▪ Address only direct impacts ▪ Do not address impact duration or probability
GIS	▪ Maps the impacts spatially and display them pictorially ▪ Useful for comparing site and planning alternatives for routing linear developments ▪ Can address cumulative effects ▪ Information incentive	▪ Easy to understand ▪ Good to display method ▪ Good siting tool ▪ Excellent for impact identification and analysis	▪ Do not address impact duration or probability ▪ Heavy reliance on knowledge and data ▪ Often complex and expensive
Expert System	▪ Assist diagnosis, problem solving and decision making ▪ Needs inputs from user by answering systematically developed questions to identify impacts and determine their mitigability and significance ▪ Information intensive, high investment methods of analysis	▪ Excellent for impact identification and analysis ▪ Good for 'experimenting'	▪ Heavy reliance on knowledge and data ▪ Often complex and expensive

The project team made an attempt to construct an impact matrix considering major project activities (generic operations) and stage-specific likely impacts which is given in Table 4-2.

While the impact matrix is each project-specific, Table 4-1 may facilitate the stakeholders in identifying a set of components and phase-specific project activities for determination of likely impacts. However, the location-specific concerns may vary from case to case, therefore, the components even without likely impacts are also retained in the matrix for the location-specific reference.

Table 4-2: Matrix of Impacts

			PHASE I					PHASE II							PHASE III						
			Pre Construction					Construction/ Establishment							Operation and Maintenance						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
ENVIRONMENT	Component	Project Activities / Parameter/ factor	Detailed Topographic Survey	Land Acquirement	Site Clearing	Burning of wastes, refuse and cleared vegetation	Site Preparation / Change in Topography	Civil works such as earth moving and building of structures including temporary structures	Heavy Equipment operations	Disposal of construction wastes	Generation of sewerage	Influx of construction workers	Deforestation	Transportation of material	Movement of Energy Reserves	Crushing of coal, storage and handling/ stock piling	Operation of power source and generator facilities	Abstraction of water	Operation of cooling systems	Storage of chemicals/ flammables	Waste management (fly ash, sludge from water treatment plants, cooling tower, boiler, ETP *etc.*
Physical	**Soil**	Erosion Risks																			
		Contamination						*													
		Soil Quality						*													
	Resources	Fuels/ Electricity													*						
		Construction material- stone, aggregates						*													
		Land especially undeveloped or agricultural land																			
	Water	Interpretation or Alteration of River Beds					*														
		Alteration of Hydraulic Regime																			
		Alteration of surface run-off and interflow					*	*													
		Alteration of aquifers					*	*													

				PHASE I					PHASE II							PHASE III						
				Pre Construction					Construction/ Establishment							Operation and Maintenance						
1	2	3		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		Water quality							*													
		Temperature																		*		
	Air	Air quality					*		*	*							*	*				
		Noise							*	*							*	*				
		Climate																				
Biological	**Terrestrial Flora**	Effect on grass & flowers																				
		Effect on trees & shrubs																				
		Effect on farmland																				
		Endangered species																				
	Aquatic Biota	Habitat removal																				
		Contamination of habitats																				
		Reduction of aquatic biota																				
	Terrestrial Fauna	Fragmentation of terrestrial habitats																				
		Disturbance of habitats by noise or vibration																				
		Reduction of Biodiversity																				
Social	**Economy**	Creation of new economic activities	*																			
		Commercial value of properties																				
		Conflict due to negotiation and/ compensation payments																				
		Generation of temporary and permanent jobs																				
		Effect on crops							*													

				PHASE I					PHASE II							PHASE III						
				Pre Construction					Construction/ Establishment							Operation and Maintenance						
1	2	3		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		Reduction of farmland productivity																				
		Income for the state and private sector																				
		Electricity tariffs																				
		Savings for consumers & private consumers																				
		Savings in foreign currency for the state																				
	Education	Training in new technologies	*																			
		Training in new skills to workers	*																			
	Public Order	Political Conflicts		*															*			
		Unrest, Demonstrations & Social conflicts		*															*			
	Infrastructure and Services	Conflicts with projects of urban, commercial or Industrial development	*					*														
	Security and Safety	Increase in Crime																				
		Accidents caused by															*				*	
	Health	Temporary																				
		Acute																				
		Chronic																				
	Cultural	Land use																				
		Recreation																				
		Aesthetics and human interest																				
		Cultural status																				

Note:

1. The above table represents a model for likely impacts, which will have to be arrived case-to-case basis considering VECs and significance analysis (Ref Section 2.9).

2. Project activities are shown as indicative for a given sector. However, in Form 1 (application for EIA Clearance), for any question for which answer is 'Yes', then the corresponding activity shall reflect in project activities. Similarly 'parameters'/'factors' will also be changed within a component in order to reflect the target species of prime concern.

4.3.5 Testing the significance of impacts

The following set of conditions may be used as the checklist for testing the significance of the impacts and also to provide information in Column IV of Form 1.

- Will there be a large change in environmental conditions?
- Will new features be out-of-scale with the existing environment?
- Will the effect be unusual in the area or particularly complex?
- Will the effect extend over a large area?
- Will there be any potential for trans-frontier impact?
- Will many people be affected?
- Will many receptors of other types (fauna and flora, businesses, facilities) be affected?
- Will valuable or scarce features or resources be affected?
- Is there a risk that environmental standards will be breached?
- Is there a risk that protected sites, areas, features will be affected?
- Is there a high probability of the effect occurring?
- Will the effect continue for a long time?
- Will the effect be permanent rather than temporary?
- Will the impact be continuous rather than intermittent?
- If it is intermittent will it be frequent rather than rare?
- Will the impact be irreversible?
- Will it be difficult to avoid, or reduce or repair or compensate for the effect?

For each "Yes" answer in column 3, the nature of effects and reasons for it should be recorded in the column 4. The questions are designed so that an "Yes" answer in column 3, will generally point towards the need for analyzing for the significance and requirement for conducting impact assessment for the effect.

4.3.6 Terms of reference for EIA studies

ToR for EIA studies in respect of the proposed TPPs include, but not limited to the following:

1) Executive summary of the project – giving a *prima facie* idea of the objectives of the proposal, use of resources, justification, *etc.* In addition, it should provide a compilation of EIA report, EMP and the post-project plan in brief.

Project Description

2) Justification for selecting the proposed unit size.
3) Land requirement for the project including its optimization, break up of land requirement and its availability. Norms prescribed by CEA should be kept in view.

4) Complete process flow diagram describing each of the unit processes and operations, along with material and energy inputs and outputs (material and energy balance).

5) Fuel analysis report (sulphur, ash content and mercury) including details of auxiliary fuel, if any. Details like quantity, quality, storage *etc.*

6) Quantity of fuel required its source and transportation, a confirmed fuel linkage/ copy of the MoU.

7) Source of water and its availability. Proof regarding availability of requisite quantity of water from the competent authority.

8) Details of water balance (water intake, use, wastewater generation) taking into account reuse and re-circulation of effluents. Additional water conservation measures, if any, proposed for the project.

9) Location of intake and outfall points (with coordinates) based on modeling studies. Details of modeling and the results obtained. It may be kept in view that the intake and outfall points are away from the mangroves.

10) Examine the feasibility of zero discharge. In case of any proposed discharge, its quantity, quality and point of discharge, users downstream, *etc.*

11) Explore the possibility of cooling towers installation. Details regarding the same.

12) Details regarding fly ash utilization as per new notification

13) Detailed plan of ash utilization / management.

14) Details of evacuation of ash.

15) Details regarding ash pond impermeability and whether it would be lined, if so details of the lining *etc.*

16) Details of desalination plant and disposal of sludge.

17) Explore the possibility of expansion of Port facilities instead of Copy of the MoU for Port facilities.

Description of the Environment

18) Toposheet with all the coordinates of the plant site demarcated (1:50000 scale).

19) The study area shall be up to a distance of 10 km from the boundary of project area for air quality considerations in view of impacts occurring at distant locations once emitted from a tall stack particularly in view of absence of source control for SO_2 in tail gases whereas for impacts on other components (such as water, soil quality and noise monitoring, *etc*.) the study area may be up to a distance of 5 Km.

20) Land use of study area should include data about the residential/ institutional/nearest village/ township/ locality/ housing society, *etc*., based on the satellite imagery.

21) Topography of the area clearly indicating the presence of pits deeper than one metre, if any. If these pits require to be filled in, details of filling material to be used, quantity required, its source, mode of transport, *etc*.

22) Baseline data of the study area with respect to different components of environment viz. air, noise, water, land, and biology and socio-economic.

23) Information regarding surface hydrology and water regime and impact due to the project, if any, on the same.

24) Site-specific meteorological data of one season.

25) AAQ data (except monsoon) of one complete season along with the monitoring dates. The parameters to be covered shall include SPM, RSPM, SO_2, NOx (ground level). The location of the monitoring stations should be decided in such a way that the pre-dominant downwind direction, population zone and sensitive receptors including reserved forests are considered. There should be at least one monitoring station in the upwind direction and one in down-wind direction where maximum GLC falls.

26) Noise level monitoring data collected from locations from all the four sides surrounding the project area and also at sensitive receptors. If any incompatible land-use attributes fall within a 10 km radius of the project boundary, proponent shall describe the sensitivity (distance, area and significance) and propose the additional points based on significance for review and acceptance by the EAC/SEAC. Incompatible land-use attributes include:

- Public water supply areas from rivers/surface water bodies, from ground water
- Scenic areas/tourism areas/hill resorts
- Religious places, pilgrim centers that attract over 10 lakh pilgrims a year
- Protected tribal settlements (notified tribal areas where industrial activity is not permitted)
- CRZ
- Monuments of national significance, World Heritage Sites
- Cyclone, Tsunami prone areas (based on last 25 years);
- Airport areas
- Any other feature as specified by the State or local government and other features as locally applicable, including prime agricultural lands, pastures, migratory corridors, *etc.*

27) If ecologically sensitive attributes fall with in a 10 km radius of the project boundary, proponent shall describe the sensitivity (distance, area and significance) and propose the additional points based on significance for review and acceptance by the EAC/SEAC. A map marking the location of such areas (existing or proposed) duly authenticated by the Chief Wildlife Warden. Ecological sensitive attributes include:

- National parks
- Wild life sanctuaries Game reserve
- Tiger reserve/elephant reserve/turtle nesting ground
- Breeding grounds
- Core zone of biosphere reserve
- Habitat for migratory birds
- Mangrove area
- Areas with threatened (rare, vulnerable, endangered) flora/fauna
- Protected corals
- Wetlands
- Zoological gardens
- Gene Banks
- Reserved forests
- Protected forests
- Any other closed/protected area under the Wild Life (Protection) Act, 1972, any other area locally applicable

28) If the location falls in a valley, studies on specific issues connected to the management of natural resources.

29) If the location is on Seashore:

- Identification of CRZ area: A CRZ map duly authenticated by one of the authorized agencies demarcating LTL, HTL, CRZ area, location of the project

and associate facilities w.r.t. CRZ, coastal features such as mangroves, if any. The route of the pipeline, conveyor system *etc.* passing through CRZ, if any, should also be demarcated. The recommendations of the State Coastal Management Authority for the activities to be taken up in the CRZ.

- Provide the CRZ map in 1:10000 scale in general cases and in 1:5000 scale for specific observations.
- Environmental parameters – Temperature, sea level pressure, wind speed, mean relative humidity, visibility, salinity, density, rainfall, fog, frequency and intensity of cyclones, sediment transport, seismic characteristics, fresh water influx
- Details on marine biological parameters – microbiological population, pathogenic bacteria, plankton distribution, fish spawning grounds in the adjoining waters, commercial fisheries potential, vegetation including inter tidal, flora and fauna in the marine, benthal quality assessment for biological species and heavy metals and estuarine environment.

Anticipated Environmental Impacts and Mitigation Measures

30) Anticipated generic environmental impacts that require specific studies for significance are given in impact matrix (Table 4-2). Tools as given in this manual may be used for the assessment of environmental impacts.

31) Impact on drainage of the area and the surroundings.

32) Impact of the project on the AAQ of the area. Details of the model used and the input data used for modeling. The air quality contours may be plotted on a location map showing the location of project site, habitation nearby, sensitive receptors, if any. The wind roses should also be shown on this map.

33) Impact of the project on local infrastructure of the study area such as road network, *etc.* In case if the study area requires any additional infrastructure, details of the agency responsible for the same should be included along with the time frame. Details of the permission from Competent Authority for conveyor belt crossing the village road.

34) Impact of the activities to be taken up in the CRZ area including jetty and desalination plant *etc.* should be integrated into the EIA report; however, action should be taken to obtain separate clearance from the competent authority as may be applicable to such activities.

35) Details of rainwater harvesting and its proposed usage in the plant.

36) Details regarding infrastructure facilities such as sanitation, fuel, restroom, *etc.* to be provided to the workers during construction as well as to the casual workers including truck drivers during the operational phase.

37) Details of greenbelt giving details of species, width of plantation, planning schedule, *etc*.

38) Details of flora and fauna. Conservation plan in case of any scheduled fauna.

39) Proposed measures for occupational safety and health of the workers.

40) Oil spill control planning.

41) Off-shore coastal air dispersion models shall be applied.

42) Capital quantity of dredging material, disposal and its impact on aquatic life.

43) Fisheries study should be done with respect to Benthos and Marine organic material and coastal fisheries.

Analysis of alternative resources and technologies

44) Comparison of alternate sites considered and the reasons for selecting the proposed site. Conformity of the site with the prescribed guidelines in terms of Coastal Regulatory Zone (CRZ), river, highways, railways *etc*.

45) Details of alternative sources of energy such as photovoltaic cells use in the plant for various applications.

46) Details on improved technologies.

Environmental Monitoring Program

47) Appropriate monitoring network has to be designed and proposed for regulatory compliance and to assess the residual impacts, if any.

Additional Studies

48) Detailed compensation package for the people affected by the project shall be prepared, considering the socio-economic status of the area, homestead oustees, land oustees, and landless labourers.

49) Points identified in public hearing and commitment of the project proponent to the same. Detailed action plan addressing the issues raised, and the details of necessary allocation of funds.

50) Proposed plan to handle the socio-economic influence on the local community. The plan should include quantitative dimension as far as possible.

51) Details of risk assessment and proposed safeguard measures.

Environmental Management Plan

52) EMP devised to mitigate the adverse impacts of the project along with item-wise cost of its implementation.

53) Proposed post-project monitoring programme to ensure compliance to the approved Management Plan including administrative and technical organizational structure.

Note:

Above points shall be adequately addressed in the EIA report at corresponding chapters, in addition to the contents given in the reporting structure (Table: 4-7).

4.4 Environmental Impact Assessment

The approach for accomplishing EIA studies is shown in Figure 4.3. Each stage is discussed, in detail in subsequent sections.

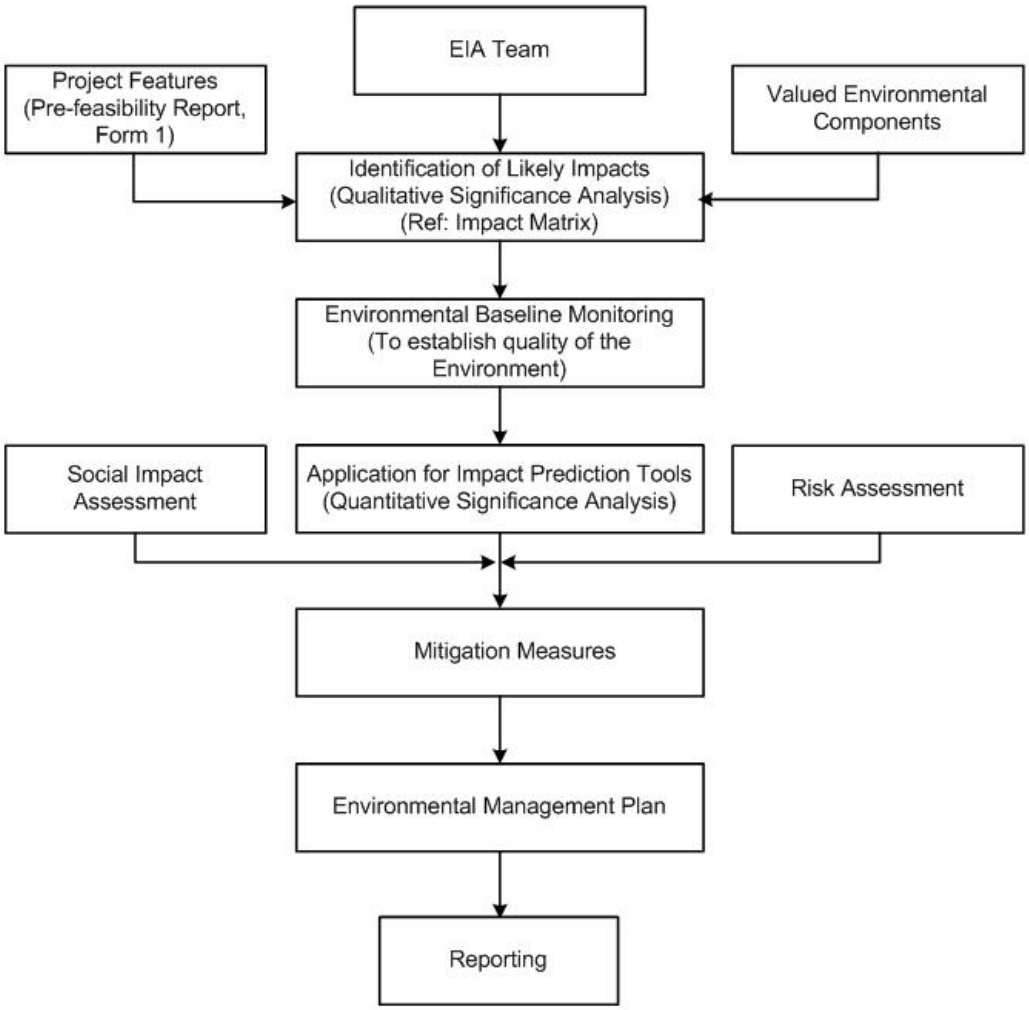


Figure 4-3: Approach for EIA Study

4.4.1 EIA team

The success of a multi-functional activity like an EIA primarily depends on constitution of a right team at the right time (preferable at the initial stages of an EIA) in order to assess the significant impacts (direct, indirect as well as cumulative impacts).

The professional Team identified for a specific EIA study should consist of qualified and experienced professionals from various disciplines, inorder to address the critical aspects identified for the specific project. Based on the nature and the environmental setting, following professionals may be identified for EIA studies:

- Environmental management specialist/regulator
- Air and noise quality
- Occupational health
- Geology/geo-hydrology
- Ecologist
- Transportation Specialist
- Safety and health specialist
- Social scientist, *etc*.

4.4.2 Baseline quality of the environment

EIA Notification 2006 specifies that an EIA Report should contain a description of the existing environment that would be or might be affected directly or indirectly by the proposed project. Environmental Baseline Monitoring (EBM) is a very important stage of EIA. On one hand EBM plays a very vital role in EIA and on the other hand it provides feedback about the actual environmental impacts of a project. EBM during the operational phase helps in judging the success of mitigation measures in protecting the environment. Mitigation measures, in turn are used to ensure compliance with environmental standards, and to facilitate any needed project design or operational changes.

The description of the existing environment should include the natural, cultural, socio-economic systems and their interrelationships. The intention is not to describe all baseline conditions, but to focus the collection and description of baseline data on those VECs that are important and are likely to be affected by the proposed industrial activity.

4.4.2.1 Objective of EBM in the EIA context

The term 'baseline' refers to conditions existing before development against which subsequent changes can be referenced. EBM studies are carried out to:

- identify environmental conditions which might influence project design decisions (e.g., site layout, structural or operational characteristics);
- identify sensitive issues or areas requiring mitigation or compensation
- provide input data to analytical models used for predicting effects;
- provide baseline data against which the results of future monitoring programs can be compared.

At this stage of EIA process, the EBM is primarily discussed in the context of first purpose wherein the feedback from EBM programs may be used to:

- determine the available assimilative capacity of different environmental components within the designated impact zone and whether more or less stringent mitigation measures are needed; and
- improve the predictive capability of EIAs.

There are many institutional, scientific, quality control, and fiscal issues that must be addressed in the implementation of an environmental monitoring program. Careful consideration of these issues in the design and planning stages will help avoid many of the pitfalls associated with environmental monitoring programs.

4.4.2.2 Environmental monitoring network design

Monitoring refers to the collection of data through a series of repetitive measurements of environmental parameters (or, more generally, to a process of systematic observation). The environmental quality monitoring programme design will be dependent upon the monitoring objectives specified for the selected area of interest. Types of monitoring and network design considerations are discussed in **Annexure VIII.**

4.4.2.3 Baseline data generation

List of important physical environmental components and indicators of EBM are given in Table 4-3.

Table 4-3: List of Important Physical Environment Components and Indicators of EBM

Environmental Component	Environmental Indicators
Climatic variables	▪ Rainfall patterns – mean, mode, seasonality ▪ Temperature patterns ▪ Extreme events ▪ Climate change projections ▪ Prevailing wind - direction, speed, anomalies ▪ Stability conditions and mixing height
Geology	▪ Underlying rock type ▪ Surgical material ▪ Geologic structures (faults *etc.*) ▪ Geologic resources (minerals, etc.)
Topography	▪ Slope form ▪ Landform and terrain analysis ▪ Specific landform types
Coastal dynamics and morphology	▪ Wave patterns ▪ Currents ▪ Shoreline morphology – near shore, foreshore ▪ Sediment – characteristics and transport
Soil	▪ Type and characteristics ▪ Porosity and permeability ▪ Sub-soil permeability ▪ Run-off rate ▪ Effective depth (inches/centimeters) ▪ Inherent fertility ▪ Suitability for method of sewage disposal
Drainage	▪ Surface hydrology ▪ Drainage network ▪ Rainfall runoff relationships ▪ Hydrogeology ▪ Groundwater characteristics – springs, *etc.*
Water quality	▪ Terrestrial - rivers, lakes, ponds, gullies ▪ Coastal
Air quality	▪ Ambient ▪ Respirable ▪ Airshed importance ▪ Odour levels
Noise	
Hazardous waste	

Guidance for assessment of baseline components and attributes describing sampling network, sampling frequency, method of measurement is given in **Annexure IX.**

Infrastructure requirements for EBM

In addition to devising a monitoring network design and monitoring plans/program, it is also necessary to ensure adequate resources in terms of staffing and skills, equipment, training, budget, *etc.*, for its implementation. Besides assigning institutional responsibility, reporting requirements, QA/QC plans and its enforcement capability are essential. A monitoring program that does not have an infrastructural support and QA/QC component will have little chance of success.

Defining data statistics/analyses requirements

The data analyses to be conducted are dictated by the objectives of the environmental monitoring program. The statistical methods used to analyze the data should be described in detail prior to data collection. This is important because repetitive observations are recorded in time and space. Besides, the statistical methods could also be chosen so that uncertainty or error estimates in the data can be quantified. For e.g., statistical methods useful in an environmental monitoring program include: 1) frequency distribution analysis; 2) analysis of variance; 3) analysis of covariance; 4) cluster analysis; 5) multiple regression analysis; 6) time series analysis; 7) the application of statistical models (ADB-Green, 1979).

Use of secondary data

The EBM program for EIA can at best address temporal and/or spatial variations limited to a limited extent because of cost implications and time limitations. Therefore analysis of all available information or data is essential to establish the regional profiles. So all the relevant secondary data available for different environmental components should be collated and analyzed.

To facilitate stake-holders, IL&FS Ecosmart Ltd. made an attempt to compile the list of information required for EIA studies and the sources of secondary data, which are given in **Annexure XA** and **Annexure XB**.

4.4.3 Impact prediction tools

The scientific and technical credibility of an EIA relies on the ability of the EIA practitioners to estimate the nature, extent, and magnitude of change in environmental components that may result from project activities. Information about predicted changes is needed for assigning impact significance, prescribing mitigation measures, and designing and developing EMPs and monitoring programs. The more accurate the predictions, the more confident the EIA practitioner will be in prescribing specific measures to eliminate or minimize the adverse impacts of development project.

Choice of models/methods for impact predictions in respect of each of air, noise, water, land and biological environment are precisely tabulated in **Annexure XI**.

4.4.4 Significance of the impacts

Evaluating the significance of environmental effects is perhaps the most critical component of impact analysis. More than other components, however, the interpretation of significance is also a contentious process. The interpretation of significance bears

directly on the subsequent EIA process and also during Environmental Clearance on project approvals and condition setting. At an early stage, it also enters into screening and scoping decisions on what level of assessment is required and which impacts and issues will be addressed.

Impact significance is also a key to choosing among alternatives. In sum, the attribution of significance continues throughout the EIA process, from scoping to EIS review, in a gradually narrowing "cone of resolution" in which one stage sets up the next. But at this stage it is the most important as better understanding and quantification of impact significance is required.

One common approach is based on determination of the significance of predicted changes in the baseline environmental characteristics and compares these with reference to regulatory standards, objective criteria and similar 'thresholds' as eco-sensitivity, cultural /religious values. Often, these are outlined in guidance. A better test proposed by the CEAA (1995) is to determine if 'residual' environmental effects are adverse, significant, and likely (given under). But at this stage, the practice of formally evaluating significance of residual impacts, *i.e.*, after predicting the nature and magnitude of impacts based on before-versus-after-project comparisons, and identifying measures to mitigate these effects is not being followed in a systematic way.

Step 1: Are the environmental effects adverse?

Criteria for determining if effects are "adverse" include:

- effects on biota health
- effects on rare or endangered species
- reductions in species diversity
- habitat loss
- transformation of natural landscapes
- effects on human health
- effects on current use of lands and resources for traditional purposes by aboriginal persons; and
- foreclosure of future resource use or production

Step 2: Are the adverse environmental effects significant?

Criteria for determining 'significance' is to judge that the impacts:

- are extensive over space or time
- are intensive in concentration or proportion to assimilative capacity
- exceed environmental standards or thresholds
- do not comply with environmental policies, land use plans, sustainability strategy
- adversely and seriously affect ecologically sensitive areas
- adversely and seriously affect heritage resources, other land uses, community lifestyle and/or indigenous peoples traditions and values

Step 3: Are the significant adverse environmental effects likely?

Criteria for determining 'likelihood' include:

- probability of occurrence, and
- scientific uncertainty

4.5 Social Impact Assessment

Social impact assessment is the instrument used to analyze social issues and solicit stakeholder views for the design of projects. Social assessment helps make the project responsive to social development concerns, including seeking to enhance benefits for poor and vulnerable people while minimizing or mitigating risk and adverse impacts. It analyzes distributional impacts of intended project benefits on different stakeholder groups, and identifies differences in assets and capabilities to access the project benefits.

The scope and depth of the social assessment should be determined by the complexity and importance of the issues studied, taking into account the skills and resources available. However, social impact assessment may include following:

Description of the socio-economic, cultural and institutional profile

Conduct a rapid review of available sources of information to describe the socio-economic, cultural and institutional interface in which the project operates.

Socio-economic and cultural profile: Describe the most significant social, economic and cultural features that differentiate social groups in the project area. Describe their different interests in the project, and their levels of influence. In particular, explain any particular effects the project may have on the poor and underprivileged. Identify any known conflicts among groups that may affect project implementation.

Institutional profile: Describe the institutional environment; consider both the presence and function of public, private and civil society institutions relevant to the operation. Are there important constraints within existing institutions e.g. disconnect between institutional responsibilities and the interests and behaviors of personnel within those institutions? Or are there opportunities to utilize the potential of existing institutions, e.g. private or civil society institutions, to strengthen implementation capacity

Legislative and regulatory considerations

To review laws and regulations governing the project's implementation and the access of poor and excluded groups to goods, services and opportunities provided by the project. In addition, review the enabling environment for public participation and development planning. Social analysis should build on strong aspects of the legal and regulatory systems to facilitate program implementation and identify weak aspects while recommending alternative arrangements.

Key social issues

The social analysis provides the baseline information for designing the social development strategy. The analysis should determine what the key social and Institutional issues are in relation to project objectives; identify the key stakeholder groups in this context and determine how relationships between stakeholder groups will affect or be affected by the project; and identify expected social development outcomes and actions proposed to achieve those outcomes.

Data collection and methodology

Describe the design and methodology for the social analysis. In this regard:

- Build on existing data;
- Clarify the units of analysis for the social assessment: intra-household, household level, as well as communities/settlements and other relevant social aggregations on which data is available or will be collected for analysis;
- Choose appropriate data collection and analytical tools and methods, employing mixed methods wherever possible; mixed methods include a mix of quantitative and qualitative methods.

Strategy to achieve social development outcomes

Identify the likely social development outcomes of the project and propose a Social development strategy, including recommendations for institutional arrangements to achieve them, based on the findings of the social assessment. The social development strategy could include measures:

- that strengthen social inclusion by ensuring that both poor and excluded groups and intended beneficiaries are included in the benefit stream and in access to opportunities created by the project
- that empower stakeholders through their participation in the design and implementation of the project, their access to information, and their increased voice and accountability (*i.e*. a participation framework); and
- that enhance security by minimizing and managing likely social risks and increasing the resilience of intended beneficiaries and affected persons to socioeconomic shocks

Implications for analysis of alternatives

Review the proposed approaches for the project, and compare them in terms of their relative impacts and social development outcomes. Consider what implications the findings of the social assessment might have on those approaches. Should some new components be added to the approach, or other components reconsidered or modified?

If the social analysis and consultation process indicate that alternative approaches are likely to have better development outcomes, such alternatives should be described and considered, along with the likely budgetary and administrative effects these changes might have.

Recommendations for project design and implementation arrangements

Provide guidance to project management and other stakeholders on how to integrate social development issues into project design and implementation arrangements. As much as possible, suggest specific action plans or implementation mechanisms to address relevant social issues and potential impacts. These can be developed as integrated or separate action plans, for example, as Resettlement Action Plans, Indigenous Peoples Development Plans, Community Development Plans, *etc.*

Developing a monitoring plan

Through the social assessment process, a framework for monitoring and evaluation should be developed. To the extent possible, this should be done in consultation with key

stakeholders, especially beneficiaries and affected people. The framework shall identify expected social development indicators, establish benchmarks, and design systems and mechanisms for measuring progress and results related to social development objectives. The framework shall identify organizational responsibilities in terms of monitoring, supervision, and evaluation procedures. Where possible, participatory monitoring mechanisms shall be incorporated. The framework should

- Establish a set of monitoring indicators to track the progress achieved. The benchmarks and indicators should be limited in number, and should combine both quantitative and qualitative types of data. The indicators should include outputs to be achieved by the social development strategy; indicators to monitor the process of stakeholder participation, implementation and institutional reform;
- Establish indicators to monitor social risk and social development outcomes; and indicators to monitor impacts of the project's social development strategy. It is important to suggest mechanisms through which lessons learned from monitoring and stakeholder feedback can result in changes to improve the operation of the project. Indicators should be of such a nature that results and impacts can be disaggregated by gender and other relevant social groups;

Define transparent evaluation procedures. Depending on context, these may include a combination of methods, such as participant observation, key informant interviews, focus group discussions, census and socio-economic surveys, gender analysis, Participatory Rural Appraisal (PRA), Participatory Poverty Assessment (PPA) methodologies, and other tools. Such procedures should be tailored to the special conditions of the project and to the different groups living in the project area; Estimate resource and budget requirements for monitoring and evaluation activities, and a description of other inputs (such as institutional strengthening and capacity building) needed to carry it out.

4.6 Risk Assessment

Industrial accidents results in great personal and financial loss. Managing these accidental risks in today's environment is the concern of every industry including TPPs, because either real or perceived incidents can quickly jeopardize the financial viability of a business. Many facilities involve various manufacturing processes that have the potential for accidents which may be catastrophic to the plant, work force, environment, or public.

The main objective of the risk assessment study is to propose a comprehensive but simple approach to carry out risk analysis and conducting feasibility studies for industries and planning and management of industrial prototype hazard analysis study in Indian context.

Risk analysis and risk assessment (Figure 4-4) should provide details on Quantitative Risk Assessment (QRA) techniques used world-over to determine risk posed to people who work inside or live near hazardous facilities, and to aid in preparing effective emergency response plans by delineating a Disaster Management Plan (DMP) to handle onsite and offsite emergencies. Hence, QRA is an invaluable method for making informed risk-based process safety and environmental impact planning decisions, as well as being fundamental to any facility-siting decision-making. QRA whether, site-specific or risk-specific for any plant is complex and needs extensive study that involves process understanding, hazard identification, consequence modeling, probability data, vulnerability models/data, local weather and terrain conditions and local population data. QRA may be carried out to serve the following objectives.

- Identification of safety areas

- Identification of hazard sources
- Generation of accidental release scenarios for escape of hazardous materials from the facility
- Identification of vulnerable units with recourse to hazard indices
- Estimation of damage distances for the accidental release scenarios with recourse to Maximum Credible Accident (MCA) analysis
- Hazard and Operability studies (HAZOP) in order to identify potential failure cases of significant consequences
- Estimation of probability of occurrences of hazardous event through fault tree analysis and computation of reliability of various control paths
- Assessment of risk on the basis of above evaluation against the risk acceptability criteria relevant to the situation
- Suggest risk mitigation measures based on engineering judgement, reliability and risk analysis approaches
- Delineation / up-gradation of Disaster Management Plan (DMP).
- Safety Reports: with external safety report/ occupational safety report.

The risk assessment report may cover the following in terms of the extent of damage with resource to MCA analysis and delineation of risk mitigations measures with an approach to DMP.

- Hazard identification – identification of hazardous activities, hazardous materials, past accident records, *etc*.
- Hazard quantification – consequence analysis to assess the impacts
- Risk Presentation
- Risk Mitigation Measures
- Disaster Management Plans

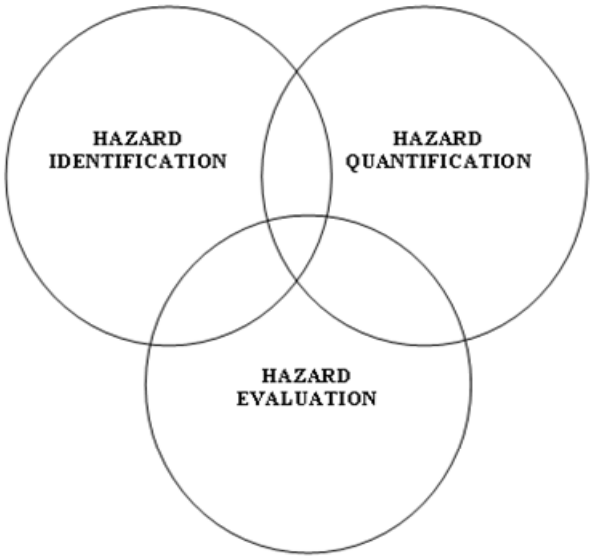


Figure 4-4: Risk Assessment – Conceptual Framework

Predictive methods for estimating risk should cover all the design intentions and operating parameters to quantify risk in terms of probability of occurrence of hazardous

events and magnitude of its consequence. Table 4-4 shows the predicted models for risk assessment.

Table 4-4: Guidance for Accidental Risk Assessment

Name	Application	Remarks for Power plants applications
EFFECT WHAZAN	Consequence Analysis for Visualization of accidental chemical release scenarios & its consequence Consequence Analysis for Visualization of accidental chemical release scenarios & its consequence	Heat load, press wave & toxic release exposure neutral gas dispersion
EGADIS	Consequence Analysis for Visualization of accidental chemical release scenarios & its consequence	Dense gas dispersion
HAZOP and Fault Tree Assessment	For estimating top event probability	Failure frequency data is required
Pathways reliability and protective system hazard analysis	For estimating reliability of equipments and protective systems	Markov models
Vulnerability Exposure models	Estimation of population exposure	Uses probit equation for population exposure
F-X and F-N curves	Individual / Societal risks	Graphical Representation

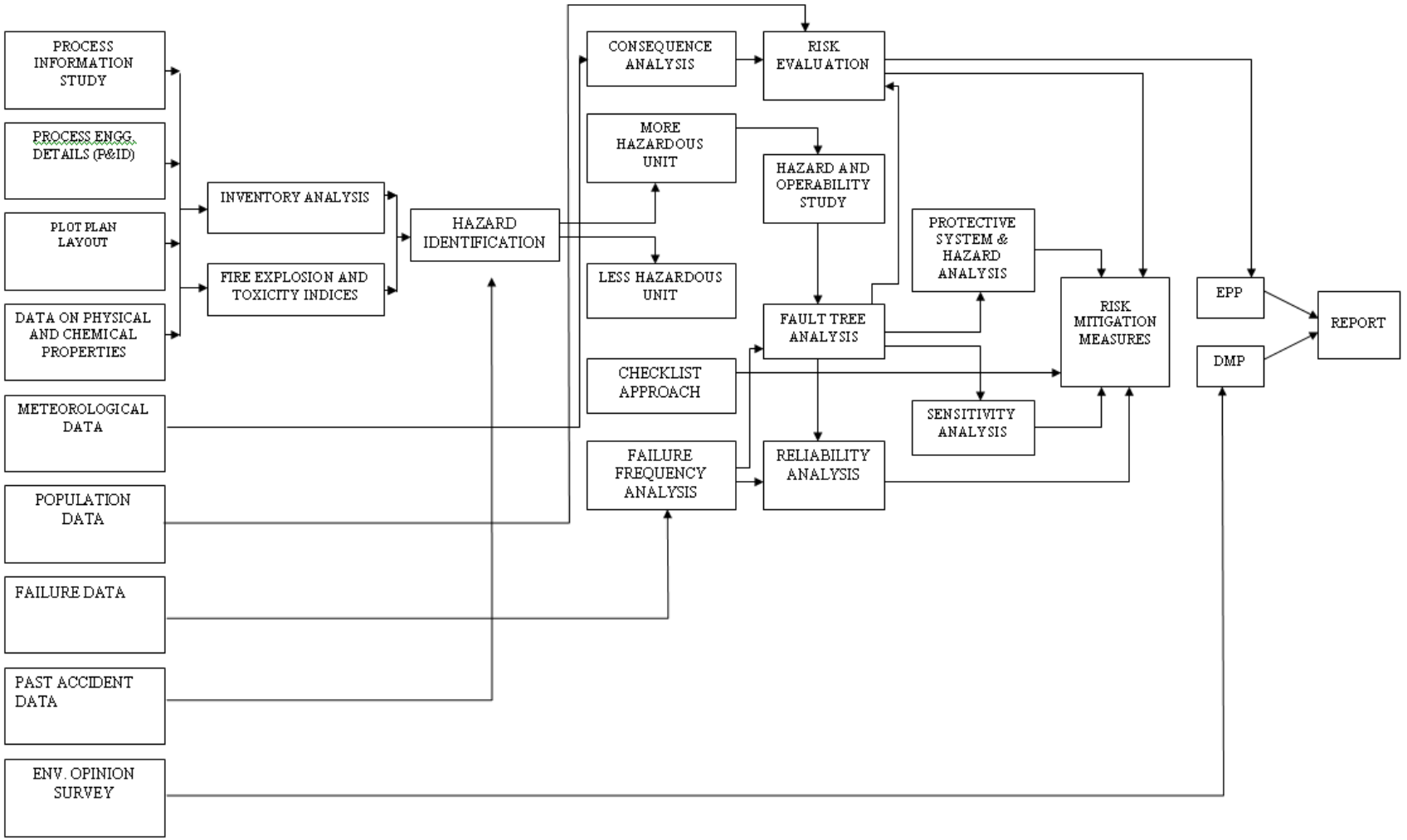


Figure 4-5: Comprehensive Risk Assessment - At a Glance

4.7 Mitigation Measures

The purpose of mitigation is to identify measures that safeguard the environment and the community affected by the proposal. Mitigation is both a creative and practical phase of the EIA process. It seeks to find the best ways and means of avoiding, minimizing and remedying impacts. Mitigation measures must be translated into action in the correct way and at the right time, if they are to be successful. This process is referred to as impact management and takes place during project implementation. A written plan should be prepared for this purpose, and includes a schedule of agreed actions. Opportunities for impact mitigation will occur throughout the project cycle.

4.7.1 Important considerations for mitigation methods

The responsibility of project proponents to 'internalize' the full environmental costs of development proposals is now widely accepted under "Polluter Pay" principle. In addition, many proponents have found that good design and impact management can result in significant savings applying the principles of cleaner production to improve their environmental performance.

- The predicted adverse environmental as well as social impacts for which mitigation measures are required should be identified and briefly summarized along with cross referencing them to the significance, prediction components of the EIA report or other documentation.
- Each mitigation measure should be briefly described with reference to the impact of significances to which it relates and the conditions under which it is required (for example, continuously or in the event of contingencies). These should also be cross-referenced to the project design and operating procedures which elaborate on the technical aspects of implementing the various measures.
- Cost and responsibilities for mitigation and monitoring should be clearly defined, including arrangements for co-ordination between the various authorities responsible for mitigation.
- The proponent can use the EMP to develop environmental performance standards and requirements for the project site as well as supply chain. An EMP can be implemented through Environment Management Systems (EMS) for the operational phase of the project.

Prior to selecting mitigation plans it is appropriate to study the mitigation alternatives for cost-effectivity, technical and socio-political feasibility. Such mitigation measures could include:

- avoiding sensitive areas such as eco-sensitive area e.g. fish spawning areas, dense mangrove areas or areas known to contain rare or endangered species
- adjusting work schedules to minimize disturbance
- engineered structures such as berms and noise attenuation barriers
- pollution control devices, such as scrubbers and electrostatic precipitators
- changes in fuel feed, manufacturing, process, technology use, or waste management practices, such as substituting a hazardous chemical with a non-hazardous one, or the re-cycling or re-use of waste materials

4.7.2 Hierarchy of elements of mitigation plan

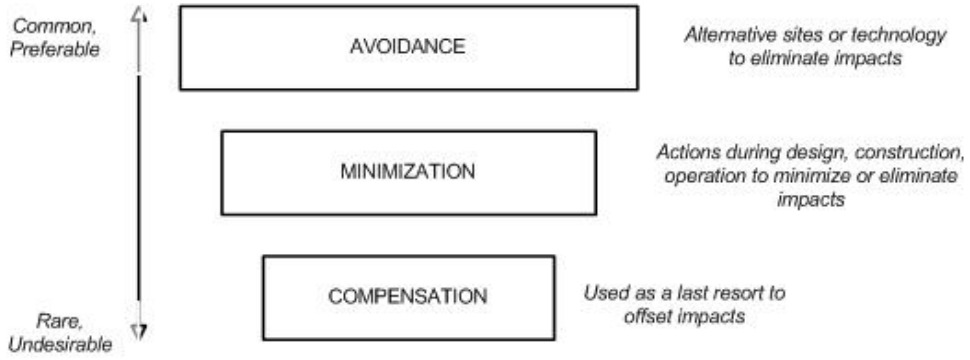


Figure 4-6: Hierarchy of Elements of Mitigation Plan

Good EIA practice requires a relevant technical understanding of the issues and the measures that work in the circumstances. The priority of selection of mitigation measures should be in the following order.

Step One: Impact avoidance

This step is most effective when applied at an early stage of project planning. It can be achieved by:

- not undertaking certain projects or elements that could result in adverse impacts
- avoiding areas that are environmentally sensitive; and
- putting in place the preventative measures to stop adverse impacts from occurring, for example, release of water from a reservoir to maintain a fisheries regime.

Step Two: Impact minimization

This step is usually taken during impact identification and prediction to limit or reduce the degree, extent, magnitude, or duration of adverse impacts. It can be achieved by:

- scaling down or relocating the proposal;
- redesigning elements of the project; and
- taking supplementary measures to manage the impacts.

Step Three: Impact compensation

This step is usually applied to remedy unavoidable residual adverse impacts. It can be achieved by:

- rehabilitation of the affected site or environment, for example, by habitat enhancement and restocking fish;
- restoration of the affected site or environment to its previous state or better, as typically required for mine sites, forestry roads and seismic lines; and
- replacement of the same resource values at another location, for example, by wetland engineering to provide an equivalent area to that lost to drainage or infill.

Important Compensation Elements

Resettlement Plans: Special considerations apply to mitigation of proposals that displace or disrupt people. Certain types of projects, such as reservoirs and irrigation schemes and public works, are known to cause involuntary resettlement. This is a contentious issue because it involves far more than re-housing people; in addition, income sources and access to common property resources are likely to be lost. Almost certainly, a resettlement plan will be required to ensure that no one is worse off than before, which may not be possible for indigenous people whose culture and lifestyle is tied to a locality. This plan must include the means for those displaced to reconstruct their economies and communities and should include an EIA of the receiving areas. Particular attention should be given to indigenous, minority and vulnerable groups who are at higher risk from resettlement.

In-kind Compensation

When significant or net residual loss or damage to the environment is likely, in kind compensation is appropriate. As noted earlier, environmental rehabilitation, restoration or replacement have become standard practices for many proponents. Now, increasing emphasis is given to a broader range of compensation measures to offset impacts and assure the sustainability of development proposals. These include impact compensation 'trading', such as offsetting CO_2 emissions by planting forests to sequester carbon.

4.7.3 Typical mitigation measures

Measures to control the impact magnitudes into acceptable limits such as green belt, better technologies, increased stack heights, alternate disposal, workers health check-ups, emergency preparedness, mock drills *etc.* are explained in the following tables.

Table 4-5: Mitigation Measures for Construction Phase

Impacts	Mitigation Steps
Erosion	▪ Windscreens, Maintenance, And Installation Of Ground Cover ▪ Installation Of Drainage Ditches ▪ Runoff And Retention Ponds ▪ Minimize Disturbances And Scarification Of The Surface.
Deforestation	▪ Plant Or Create Similar Areas ▪ Initiate A Tree Planning Program In Other Areas ▪ Donate Land To Conservationalist Groups

Table 4-6: Mitigation Measures for Operation Phase

Impacts	Mitigation steps
Dust pollution	▪ Wetting of roadways to reduce traffic dust ▪ Installation of windscreens to breakup the wind flow ▪ Burning of refuse on days when meteorological conditions provide for good mixing and dispersion
Noise pollution	▪ Heavy duty muffler systems on heavy equipment ▪ Limit certain activities such as blasting and pile driving to daylight hours
Water pollution and issues	▪ Channeling and retention of water to reduce erosion and situation ▪ Collection and treatment of sewage and organic waste

Impacts	Mitigation steps
	▪ Increased recycling and reuse of water ▪ Use of biodegradable or otherwise readily treatable additives ▪ Cooling ponds, towers and canals to reduce temperatures of cooling water discharge ▪ Neutralization and sedimentation of wastewater ▪ Dewatering of sludges and appropriate disposal of solids ▪ Use deep well injection below potable levels ▪ Construct liners of ponds and solids waste disposal ▪ Dilute water at point of discharge
Chemical discharges and spills	▪ Develop spill prevention plans ▪ Develop traps and containment system and chemically treat discharges on site
Thermal shock to aquatic organisms	▪ Use alternative heat dissipation design ▪ Dilute thermal condition by discharging water into larger receiving water body ▪ Install mechanical diffusers ▪ Cool water onsite in holding pond prior to discharge ▪ Explore opportunities to use waste heat
Biological	▪ Installation of systems to discourage nesting or perching of birds in dangerous environments ▪ Increased employee awareness to sensitive areas
Disruption of traffic	▪ Develop traffic plan that minimizes road use by workers ▪ Upgrade roads and intersections
Worker exposure to dust from ash and coal	▪ Provide dust collector equipment ▪ Maintain dust levels less than 10 mg/m^3 ▪ Monitor for free silica content ▪ Provide dust masks when levels are exceeded
Worker exposure to toxic gases leaking from the boilers	▪ Maintain boilers properly ▪ Monitor concentrations with levels not to exceed ▪ So_2 – 5 ppm ▪ Co – 5 ppm ▪ No_2 – 5 ppm
Worker exposure to excessive noise	▪ Maintain noise levels from below 90 dba ▪ Provide ear protection if in excess
Induced secondary development puts increased demand on infrastructure	▪ Provide infrastructure plan and financial support for increased demands ▪ Construct facilities to reduce demands

4.7.4 Mitigation Measure on Special Environmental Issues

Management of cooling tower & ash-pond effluents

Cooling towers result in high rates of water consumption, as well as the potential release of high temperature water containing high dissolved solids, residues of biocides, residues of other cooling system anti-fouling agents, *etc.* Recommended water management strategies include:

- Adoption of water conservation opportunities for facility cooling systems
- Use of heat recovery methods (also energy efficiency improvements) or other cooling methods to reduce the temperature of heated water prior to discharge to ensure the

discharge water temperature does not result in an increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors and assimilative capacity among other considerations;

- Minimizing use of anti-fouling and corrosion inhibiting chemicals by ensuring appropriate depth of water intake and use of screens. Least hazardous alternatives should be used with regards to toxicity, biodegradability, bioavailability, and bioaccumulation potential. Dose applied should accord with local SPCB requirements and manufacturer recommendations;
- Testing for residual biocides and other pollutants of concern should be conducted to determine the need for dose adjustments or treatment of cooling water prior to discharge.

Stormwater management

Stormwater includes any surface runoff and flows resulting from precipitation, drainage or other sources. Typically stormwater runoff contains suspended sediments, metals, petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAHs), coliform, *etc.* Rapid runoff, even of uncontaminated stormwater, also degrades the quality of the receiving water by eroding stream beds and banks. In order to reduce the need for stormwater treatment, the following options should be checked:

- Stormwater should be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge
- Surface runoff from process areas or potential sources of contamination should be prevented
- Where this approach is not practical, runoff from process and storage areas should be segregated from potentially less contaminated runoff
- Runoff from areas without potential sources of contamination be reduced (e.g. by using vegetated swales and retention ponds)
- Where stormwater treatment is deemed necessary to protect the quality of receiving water bodies, priority should be given to managing and treating the first flush of stormwater runoff where the majority of potential contaminants tend to be present
- When water quality criteria allow, stormwater should be managed as a resource, either for groundwater recharge or for meeting water needs at the facility
- Oil water separators and grease traps should be installed and maintained as appropriate at refueling facilities, workshops, parking areas, fuel storage and containment areas.
- Sludge from stormwater catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.

Sanitary wastewater management

Recommended sanitary wastewater management strategies include:

- Segregation of wastewater streams to ensure compatibility with selected treatment option (e.g. septic system which can only accept domestic sewage);
- Segregation and pre-treatment of oil and grease containing effluents (e.g. use of a grease trap) prior to discharge into sewer systems;
- If sewage from the industrial facility is to be discharged to surface water, treatment to meet national or local standards for sanitary wastewater discharges or, in their absence, the indicative guideline values applicable to sanitary wastewater discharges.
- If sewage from the industrial facility is to be discharged to either a septic system, or where land is used as part of the treatment system, treatment to meet applicable national or local standards for sanitary wastewater discharges is required.
- Sludge from sanitary wastewater treatment systems should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.

Noise mitigation

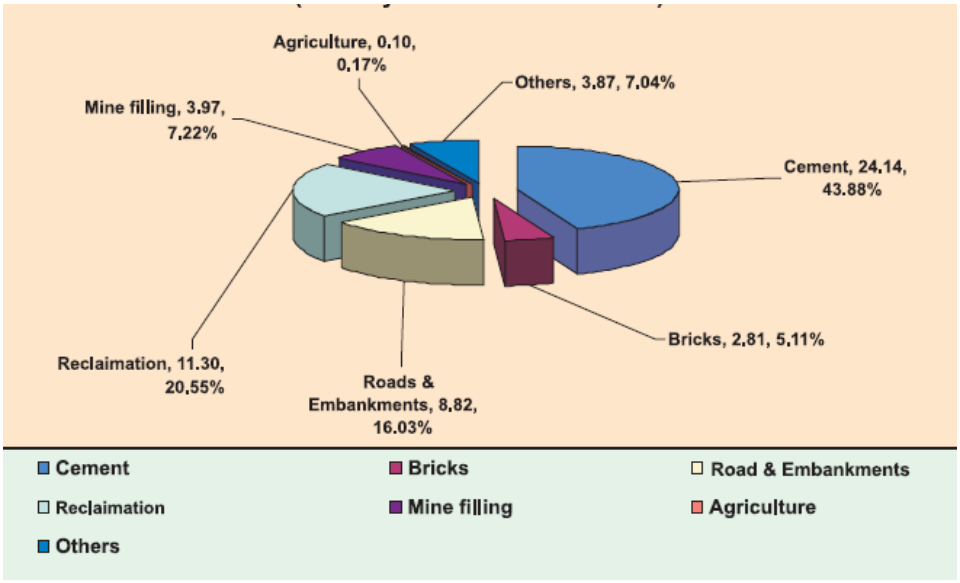
Diverse noise-control measures can be introduced to reduce immissions to a tolerable level, whereas the primary goal must be to protect the TPP staff. To the extent possible, TPPs should be located an acceptable distance from residential areas, and all appropriate noise-control measures must be applied to the respective sound sources at the planning and construction stages.

Two particularly effective measures are the use of sound absorbers to reduce flow noises and the encapsulation of machines and respective devices to reduce air-borne and structure-borne sound levels. Appropriate enclosures constitute an additional means of simultaneously reducing both the emission and immission of noise. Incidentally, enclosures also provide weather protection and are therefore used widely in TPP engineering.

Fly ash utilization plans

The targets of ash utilization are primarily governed by the MoEF Notification dated 14th September, 1999 and its amendment Notification dated 27th August, 2003 as well as Hon'ble High Court of Delhi directions vide its judgments dated 4th December, 2002, 10th March, 2004 as well as 5th August, 2004. The existing TPPs as on September, 1999 are to achieve ash utilization level of 100% in a phased manner by 2013-14 in accordance with 15 year action plan as per Notification dated 14th September, 1999 and wef the date of publication of the Notification. The new TPP commissioned subsequent to September, 1999 are to achieve ash utilization level of 100% in a phased manner as per 9 year action plan and with effect from the date of publication of the Notification dated 14th September, 1999. Besides, the MoEF has also issued an amendment Notification dated 27th August, 2003 and has extended the scope of ash utilization by various construction agencies by stipulating specific targets for those within 50 km and 50 to 100 km radial distance of the location of TPP. Construction agencies located within 50 km are to achieve ash utilization level targets of 100 percent up to August, 2005 and those located from 50 to 100 km distance are to achieve ash utilization level of 100% by August, 2007.

Figure 4-7: Fly Ash Utilization in Various Modes during 2006-07 (Mode, Quantity Utilized in Million Tonnes and Percentage) (Total Fly Ash utilized = 55.01 MT)



The options of ash utilization including the ash-based products are at developmental stage and need to be made more environment friendly by bringing in ash revolution. Some of the areas of application include:

- Brick/Block/Tiles Manufacturing
- Cement Manufacturing
- Roads and Embankment Construction
- Structural Fill for Reclaiming Low Lying Areas
- Mine-Filling
- Agriculture, Forestry and Waste-land
- Development
- Part Replacement of Cement in Mortar, Concrete and Ready Mix Concrete Hydraulic Structure (Roller Compacted Concrete)
- Ash Dyke Raising
- Building Components - Mortar, Concrete,
- Concrete Hollow Blocks, Aerated Concrete Blocks *etc.*
- Other Medium and High Value Added Products (Ceramic Tiles, Wood, Paints) Pavement Blocks, Light Weight Aggregate, Extraction of Alumina, Cenospheres, *etc.*

4.8 Environmental Management Plan

A typical EMP shall be composed of the following:

1. summary of the potential impacts of the proposal ;
2. description of the recommended mitigation measures ;
3. statement of their compliance with relevant standards ;
4. allocation of resources and responsibilities for plan implementation ;
5. schedule of the actions to be taken ;

6. programme for surveillance, monitoring and auditing ; and
7. contingency plan when impacts are greater than expected

Each of the above components are precisely discussed below:

Summary of impacts: The predicted adverse environmental and social impacts for which mitigation measures are identified in the earlier sections to be briefly summarized with cross referencing to the corresponding sections in the EIA report.

Description of mitigation measures: Each mitigation measure should be briefly described with reference to the impact to which it relates and the conditions under which it is required. These should be accompanied by, or referenced to, project design and operating procedures which elaborate on the technical aspects of implementing the various measures.

Description of monitoring programme: Environ mental monitoring refers to compliance monitoring and residual impact monitoring. Compliance monitoring refers to meeting the industry-specific statutory compliance requirements (Ref. Applicable National regulations as detailed in Chapter 3).

Residual impact monitoring refers to monitoring of identified sensitive locations with adequate number of samples and frequency. The monitoring programme should clearly indicate the linkages between impacts identified in the EIA report, measurement indicators, detection limits (where appropriate), and definition of thresholds that will signal the need for corrective actions.

Institutional arrangements: Responsibilities for mitigation and monitoring should be clearly defined, including arrangements for co-ordination between the various actors responsible for mitigation. Details should be provided w.r.t the deployment of staff (detailed organogram), monitoring network design, parameters to be monitored, analysis methods, associated equipments *etc.*

Implementation schedule and reporting procedures: The timing, frequency and duration of mitigation measure should be specified in an implementation schedule, showing links with overall project implementation. Procedures to provide information on the progress and results of mitigation and monitoring measures should also be clearly specified.

Cost estimates and sources of funds: These should be specified for both the initial investment and recurring expenses for implementing all measures contained in the EMP, integrated into the total project costs, and factored into loan negotiation.

The EMP should contain commitments that are binding on the proponent in different phases of project implementation *i.e.* pre-construction or site clearance, construction, operation, decommissioning.

4.9 Reporting

Structure of the EIA report is given in the following Table 4.7. Each task prescribed in ToR shall be incorporated appropriately in the contents in addition to the described in the Table.

Table 4-7: Structure of EIA Report

S.No	EIA Structure	Contents
1.	Introduction	▪ Purpose of the report ▪ Identification of project & project proponent ▪ Brief description of nature, size, location of the project and its importance to the country, region ▪ Scope of the study – details of regulatory scoping carried out (As per Terms of Reference)
2.	Project Description	▪ Condensed description of those aspects of the project (based on project feasibility study), likely to cause environmental effects. Details should be provided to give clear picture of the following: ▪ Type of project ▪ Need for the project ▪ Location (maps showing general location, specific location, project boundary & project site layout) ▪ Size or magnitude of operation (incl. Associated activities required by or for the project) ▪ Proposed schedule for approval and implementation ▪ Technology and process description ▪ Project description including drawings showing project layout, components of project *etc.* Schematic representations of the feasibility drawings which give information important for EIA purpose ▪ Description of mitigation measures incorporated into the project to meet environmental standards, environmental operating conditions, or other EIA requirements (as required by the scope) ▪ Assessment of New & untested technology for the risk of technological failure
3.	Description of the Environment	▪ Study area, period, components & methodology ▪ Establishment of baseline for VECs, as identified in the scope ▪ Base maps of all environmental components
4.	Anticipated Environmental Impacts & Mitigation Measures	▪ Details of Investigated Environmental impacts due to project location, possible accidents, project design, project construction, regular operations, final decommissioning or rehabilitation of a completed project ▪ Measures for minimizing and / or offsetting adverse impacts identified ▪ Irreversible and Irretrievable commitments of environmental components ▪ Assessment of significance of impacts (Criteria for determining significance, Assigning significance) ▪ Mitigation measures
5.	Analysis of Alternatives (Technology & Site)	▪ Incase, the scoping exercise results in need for alternatives: ▪ Description of each alternative ▪ Summary of adverse impacts of each alternative ▪ Mitigation measures proposed for each alternative and selection of alternative
6.	Environmental Monitoring Program	▪ Technical aspects of monitoring the effectiveness of mitigation measures (incl. Measurement methodologies, frequency, location, data analysis, reporting schedules, emergency procedures, detailed budget & procurement schedules)

S.No	EIA Structure	Contents
7.	Additional Studies	▪ Public Consultation ▪ Risk assessment ▪ Social Impact Assessment, R&R Action Plans
8.	Project Benefits	▪ Improvements in the physical infrastructure ▪ Improvements in the social infrastructure ▪ Employment potential –skilled; semi-skilled and unskilled ▪ Other tangible benefits
9.	Environmental Cost Benefit Analysis	▪ If recommended at the Scoping stage
10.	EMP	▪ Description of the administrative aspects of ensuring that mitigative measures are implemented and their effectiveness monitored, after approval of the EIA
11.	Summary & Conclusion (This will constitute the summary of the EIA Report)	▪ Overall justification for implementation of the project ▪ Explanation of how, adverse effects have been mitigated
12.	Disclosure of Consultants engaged	▪ The names of the Consultants engaged with their brief resume and nature of Consultancy rendered

4.10 Public Consultation

Public consultation refers to the process by which the concerns of local affected people and others who have plausible stake in the environmental impacts of the project or activity are ascertained.

- Public consultation is not a decision taking process, but is a process to collect views of the people having plausible stake. If the SPCB/Public agency conducting public hearing is not convinced with the plausible stake, then such expressed views need not be considered.
- All Category A and Category B1 projects require public hearing except the following:
  - Once environmental clearance is granted to an industrial estates/SEZs/ EPZs *etc.*, for a given composition (type and capacity) of industries, then individual units will not require public hearing.
  - Expansion of roads and highways, which do not involve any further acquisition of land.
  - All building/ construction projects/ area development projects/townships
  - All Category B2 projects
  - All projects concerning national defense and security or involving other strategic considerations as determined by the Central Government
- Public consultation involves two components, one is public hearing, and other one is inviting written responses/objections through Internet/by post, *etc.*, by placing the summary of EIA report on the web site.
- Public hearing shall be carried out at the site or in its close proximity, district-wise, for ascertaining concerns of local affected people.

- Project proponent shall make a request through a simple letter to the Member Secretary of the SPCB or UTPCC to arrange public hearing.
- Project proponent shall enclose with the letter of request, at least 10 hard copies and 10 soft copies of the draft EIA report including the summary EIA report in English and local language prepared as per the approved scope of work, to the concerned Authority.
- Simultaneously, project proponent shall arrange to send, one hard copy and one soft copy, of the above draft EIA report along with the summary EIA report to the following Authorities within whose jurisdiction the project will be located:
  - District magistrate(s)
  - Zilla parishad and municipal corporation
  - District industries office
  - Concerned regional office of the MoEF/SPCB
- Above mentioned Authorities except concerned prior environmental clearance Authority (MoEF/SEIAA) shall arrange to widely publicize the draft EIA report within their respective jurisdictions. They shall also make draft EIA report for inspection electronically or otherwise to the public during normal hours till the public hearing is over.
- Concerned regulatory Authority (MoEF/SEIAA/UTEIA) shall display the summary of EIA report on its website and also make full draft EIA report available for reference at a notified place during normal office hours at their head office.
- SPCB or UTPCC concerned shall make arrangements for giving publicity about the project within the State/UT and make available the summary of draft EIA report for inspection in select offices, public libraries. They shall also additionally make available a copy of the draft EIA report to the above five authorities/offices as mentioned above.
- The member secretary of the concerned SPCB or UTPCC shall finalize the date, time and exact venue for the conduct of public hearing within seven days of the date of the receipt of the draft EIA report from the project proponent and advertise the same in one major National Daily and one Regional vernacular Daily.
- A minimum notice period of 30 (thirty) days shall be provided to the public for furnishing their responses.
- No postponement of the date, time, venue of the public hearing shall be undertaken, unless some untoward emergency situation occurs and only then on the recommendation of the concerned District Magistrate the postponement shall be notified to the public through the same National and Regional vernacular dailies and also prominently displayed at all the identified offices by the concerned SPCB or UTPCC
- In the above exceptional circumstances fresh date, time and venue for the public consultation shall be decided by the Member–Secretary of the concerned SPCB or UTPCC only in consultation with the District Magistrate and notified afresh as per the procedure.
- The District Magistrate or his or her representative not below the rank of an Additional District Magistrate assisted by a representative of SPCB or UTPCC, shall supervise and preside over the entire public hearing process.

- The SPCB or UTPCC shall arrange to video film the entire proceedings. A copy of the videotape or a CD shall be enclosed with the public hearing proceedings while forwarding it to the Regulatory Authority concerned.
- The attendance of all those who are present at the venue shall be noted and annexed with the final proceedings
- There shall be no quorum required for attendance for starting the proceedings
- Every person present at the venue shall be granted the opportunity to seek information or clarifications on the project from the Applicant. The summary of the public hearing proceedings accurately reflecting all the views and concerns expressed shall be recorded by the representative of the SPCB or UTPCC and read over to the audience at the end of the proceedings explaining the contents in the vernacular language and the agreed minutes shall be signed by the District Magistrate or his or her representative on the same day and forwarded to the SPCB/UTPCC concerned.
- A statement of the issues raised by the public and the comments of the proponent shall also be prepared in the local language and in English and annexed to the proceedings.
- The proceedings of the public hearing shall be conspicuously displayed at the office of the Panchayats within whose jurisdiction the project is located, office of the concerned Zilla Parishad, District Magistrate, and the SPCB or UTPCC. The SPCB or UTPCC shall also display the proceedings on its website for general information. Comments, if any, on the proceedings, may be sent directly to the concerned regulatory authorities and the Applicant concerned.
- The public hearing shall be completed within a period of 45 (forty five) days from date of receipt of the request letter from the Applicant. Therefore the SPCB or UTPCC concerned shall send the public hearing proceedings to the concerned regulatory authority within 8(eight) days of the completion of the public hearing. The proponent may also directly forward a copy of the approved public hearing proceedings to the regulatory authority concerned along with the final EIA report or supplementary report to the draft EIA report prepared after the public hearing and public consultations.
- Upon receipt of the same, the Authority will place executive summary of the report on the website to invite responses from other concerned persons having a plausible stake in the environmental aspects of the project or activity.
- If SPCB/UTPCC is unable to conduct the public hearing in the prescribed time, the Central Government incase of Category A projects and State Government in case of Category B projects at the request of the SEIAA or project proponent can engage a public agency for conducting the public hearing process within a further period of 45 days. The respective governments shall pay the appropriate fee to the public agency for conducting public hearing.
- A public agency means a non-profit making institution/ body such as technical/academic institutions, government bodies not subordinate to the concerned Authority.
- If SPCB/Public Agency authorized for conducting public hearing informs the Authority, stating that it is not possible to conduct the public hearing in a manner, which will enable the views of the concerned local persons to be freely expressed, then Authority may consider such report to take a decision that in such particular case, public consultation may not have the component of public hearing.

- Often restricting the public hearing to the specific district may not serve the entire purpose, therefore, NGOs who are local and registered under the Societies Act in the adjacent districts may also be allowed to participate in public hearing, if they so desire.
- Confidential information including non-disclosable or legally privileged information involving intellectual property right, source specified in the application shall not be placed on the website.
- The Authority shall make available on a written request from any concerned person the draft EIA report for inspection at a notified place during normal office hours till the date of the public hearing.
- While mandatory requirements will have to be adhered to, utmost attention shall be given to the issues raised in the public hearing for determining the modifications needed in the project proposal and the EMP to address such issues.
- Final EIA report after making needed amendments, as aforesaid, shall be submitted by the applicant to the concerned Authority for prior environmental clearance. Alternatively, a supplementary report to draft EIA and EMP addressing all concerns expressed during the public consultation may be submitted.

4.11 Appraisal

Appraisal means the detailed scrutiny by the EAC or SEAC of the application and the other documents like the final EIA report, outcome of the public consultation including public hearing proceedings submitted by the applicant for grant of environmental clearance.

- The appraisal shall be made by EAC to the Central Government or SEAC to SEIAA.
- Project proponent either personally or through consultant can make a presentation to EAC/SEAC for the purpose of appraising the features of the project proposal and also to clarify the issues raised by the members of the EAC/SEAC.
- On completion of these proceedings, concerned EAC/SEAC shall make categorical recommendations to the respective Authority, either for grant of prior environmental clearance on stipulated terms & conditions, if any, or rejection of the application with reasons.
- In case EAC/SEAC needs to visit the site or obtain further information before being able to make categorical recommendations, EAC/SEAC may inform the project proponent accordingly. In such an event, it should be ensured that the process of environmental clearance is not unduly delayed to go beyond the prescribed timeframe.
- Upon the scrutiny of the final report, if EAC/SEAC opines that ToR for EIA studies finalized at the scoping stage has not been comprehensively covered by the proponent, then the project proponent may be asked to provide such information. If such information is declined by the project proponent or is unlikely to be provided early enough so as to complete the environmental appraisal within prescribed time of 60 days, the EAC/SEAC may recommend for rejection of the proposal with the same reason.
- Appraisal shall be strictly in terms of the ToR for EIA studies finalized at the scoping stage and the concerns expressed during public consultation.

- This process of appraisal shall be completed within 60 days from the receipt of the updated EIA report and EMP report, after completing public consultation.
- The EIA report will be typically examined for following:
  - Project site description supported by topographic maps & photographs – detailed description of topography, land use and activities at the proposed project site and its surroundings (buffer zone) supported by photographic evidence.
  - Clarity in description of drainage pattern, location of eco sensitive areas, vegetation characteristics, wildlife status - highlighting significant environmental attributes such as feeding, breeding and nesting grounds of wildlife species, migratory corridor, wetland, erosion and neighboring issues.
  - Description of the project site – how well the interfaces between the project related activities and the environment have been identified for the entire project cycle *i.e.* construction, operation and decommissioning at the end of the project life.
  - If it is envisaged that the project is to be closed after a specified period in case of mining projects, the interface at the closure stage also needs to be described.
  - How complete and authentic are the baseline data pertaining to flora and fauna and socio economic aspects?
  - Citing of proper references, with regard to the source(s) of baseline data as well as the name of the investigators/ investigating agency responsible for collecting the primary data.
  - How consistent are the various values of environmental parameters with respect to each other?
  - Is a reasonable assessment of the environmental and social impact made for the identified environmental issues including project affected people?
  - To what extent the proposed environmental plan will mitigate the environmental impact and at what estimated cost, shown separately for construction, operation and closure stages and also separately in terms of capital and recurring expenses along with details of agencies that will be responsible for the implementation of environmental plan/ conservation plan.
  - How well the concerns expressed/highlighted during the Public hearing have been addressed and incorporated in the EMP giving item wise financial provisions and commitments (in quantified terms)?
  - How far the proposed environmental monitoring plan will effectively evaluate the performance of the EMP? Are details for environmental monitoring plan provided in the same manner as the EMP?
  - Identification of hazard and quantification of risk assessment and whether appropriate mitigation plan has been included in the EMP?
  - Does the proposal include a well formulated time bound green belt development plan for mitigating environmental problems such as fugitive emission of dust, gaseous pollutants, noise, odour, *etc.*
  - Does EIA makes a serious attempt to guide the project proponent for minimizing the requirement of natural resources including land, water energy and other non renewable resources?
  - How well the EIA statement has been organized and presented so that the issues, their impact and environmental management strategies emerge clearly from it and how well organized was the power point presentation made before the expert committee?
  - Is the information presented in the EIA adequately and appropriately supported by maps, imageries and photographs highlighting site features and environmental attributes?

4.12 Decision-Making

The Chairperson reads the sense of the Committee and finalizes the draft minutes of the meeting, which are circulated by the Secretary to all the core members and sectoral experts invited to the meeting. Based on the response from the members, the minutes are finalized and signed by the Chairperson. This process for finalization of the minutes should be so organized that the time prescribed for various stages is not exceeded.

Approval / Rejection / Reconsideration

- The Authority shall consider the recommendations of concerned appraisal Committee and convey its decision within 45 days of the receipt of recommendations.
- If the Authority disagrees with the recommendations of the Appraisal Committee, then reasons shall be communicated to concerned Appraisal Committee and applicant with in 45 days from the receipt of the recommendations. The Appraisal Committee concerned shall consider the observations of the Authority and furnish its views on the observations within further period of 60 days. The Authority shall take a decision with in the next 30 days based on the views of appraisal Committee.
- If the decision of the Authority is not conveyed within the time, then the proponent may proceed as if the environmental clearance sought has been granted or denied by the regulatory authority in terms of the final recommendation of the concerned appraisal Committee. For this purpose, the decision of the Appraisal Committee will be public document, once the period specified above for taking the decision by the Authority is over.
- Incase of the Category B projects, application shall be received by the Member Secretary of the SEIAA and clearance shall also be issued by the same SEIAA.

If Approved

- The concerned authority (MoEF/SEIAA) will issue an Environmental Clearance for the project.
- The project proponent should make sure that the award of Environment Clearance is properly publicized in at least two local newspapers of the district or state where the proposed project is located. For instance, the executive summary of the Environmental Clearance may be published in the newspaper along with the information about the location (website/office where it is displayed for public) where the detailed Environmental Clearance is made available. The MoEF and SEIAA/UTEIAA, as the case may be, shall also place the environmental clearance in the public domain on Government Portal. Further copies of the environmental clearance shall be endorsed to the Heads of local bodies, Panchayats and Municipal bodies in addition to the relevant offices of the Government
- The Environmental Clearance will be valid from the start date to actual commencement of the production of the developmental activity.

4.13 Post-Clearance Monitoring Protocol

The MoEF, Government of India will monitor and take appropriate action under the Environment (Protection) Act, 1986, the laboratories recognized by the CPCB.

The project proponent must submit half-yearly compliance reports in respect of the stipulated prior environmental clearance terms and conditions in hard and soft copies to the regulatory authority concerned, on 1st June and 1st December of each calendar year.

All such compliance reports submitted by the project management shall be public documents. Copies of the same shall be given to any person on application to the concerned regulatory authority. The latest such compliance report shall also be displayed on the web site of the concerned regulatory authority.

The SPCB shall incorporate EIA clearance conditions into consent conditions in respect of Category A and Category B projects and in parallel monitor and enforce the same.

5. STAKEHOLDERS' ROLES AND RESPONSIBILITIES

Prior environmental clearance process involves many stakeholders *i.e.*, Central Government, State Government, SEIAA, EAC at the National Level, SEAC, the public agency, SPCB, the project proponent, and the public.

- The roles and responsibilities of the organizations involved in different stages of prior environmental clearance are given in Table 5-1.
- Organization-specific functions are listed in Table 5-2.

In this Chapter, constitution, composition, functions, *etc.*, of the Authorities and the Committees are discussed in detail.

Table 5-1: Roles and Responsibilities of Stakeholders Involved in Prior Environmental Clearance

Stage	MoEF/ SEIAA	EAC/SEAC	Project Proponent	EIA Consultant	SPCB/ Public Agency	Public and Interest Group
Screening	Receives application and takes advise of MoEF/ SEAC	Advises the MoEF/ SEIAA	Submits application (Form 1) and provides necessary information	Advises and assists the proponent by providing technical information		
Scoping	Approves the ToR, communicates the same to the project proponent and places the same in the website	Reviews the ToR, visits the proposed site, if required and recommends the ToR to the MoEF/ SEIAA	Submits the draft ToR to MoEF/SEIAA and facilitates the visit of the EAC/SEAC members to the project site	Prepares ToR		
EIA Report & Public Hearing	Reviews and forwards copies of the EIA report to SPCB /public agency for conducting public hearing		Submits detailed EIA report as per the finalized ToR Facilitates the public hearing by arranging presentation on the project, EIA and EMP – takes note of	Prepares the EIA report Presents and appraises the likely impacts and pollution control measures proposed in the public hearing	Reviews EIA report and conducts public hearing in the manner prescribed Submits proceedings and views of SPCB,	Participates in public hearings and offers comments and observations. Comments can be sent directly to SEIAA

	Places the summary of EIA report in the website Conveys objections to the project proponent for update, if any		objections and updates the EMP accordingly		to the Authority and the project proponent as well	through Internet in response to the summary placed in the website
Appraisal and Clearance	Receives updated EIA Takes advise of EAC/ SEAC, approves EIA and attaches the terms and conditions	Critically examines the reports, presentation of the proponent and appraises MoEF/ SEIAA (recommend ations are forwarded to MoEF/ SEIAA)	Submits updated EIA, EMP reports to MoEF/SEIAA. Presents the overall EIA and EMP including public concerns to EAC/SEAC	Provides technical advise to the project proponent and if necessary presents the proposed measures for mitigation of likely impacts (terms and conditions of clearance)		
Post-clearance Monitoring			Implements environmental protection measures prescribed and submits periodic monitoring results	Conducts periodic monitoring	Incorporate s the clearance conditions into appropriate consent conditions and ensures implementa tion	

Table 5-2: Organization-specific Functions

Organization	Functions
Central Government	▪ Constitutes the EAC ▪ Considering recommendations of the State Government, constitutes the SEIAA & SEAC ▪ Receives application from the project proponent in case of Category A projects or Category B projects attracting general condition ▪ Communicated the ToR finalized by the EAC to the project proponent. ▪ Receives EIA report from the project proponent and soft copy of summary of the report for placing in the website

	▪ Summary of EIA report will be placed in website. Forwards the received responses to the project proponent ▪ Engages other public agency for conducting public hearings in cases where the SPCB does not respond within time ▪ Receives updated EIA report from project proponent incorporating the considerations from the proceedings of public hearing and responses received through other media ▪ Forwards updated EIA report to the EAC for appraisal ▪ Either accepts the recommendations of EAC or asks for reconsideration of specific issues for review by the EAC. ▪ Takes the final decision – acceptance/ rejection – of the project proposal and communicates the same to the project proponent
State Government	▪ Identifies experts as per the composition specified in the Notification and subsequent guidelines to recommend to the Central Government. ▪ Extends funding support to fulfill the functions of SEIAA/SEAC ▪ Engages other public agency for conducting public hearings in cases where the SPCB does not respond within time ▪ State Governments will suitably pay the public agency for conducting such activity
EAC	▪ Reviews Form 1 and its attachments ▪ Visits site(s), if necessary ▪ Finalizes ToR and recommends to the Central Government, which in turn communicates the finalized ToR to the project proponent, if not exempted by the Notification ▪ Reviews EIA report, proceedings and appraises their views to the Central government ▪ If the Central Government has any specific views, then the EAC reviews again for appraisal
SEIAA	▪ Receives application from the project proponent ▪ Considers SEAC views for finalization of ToR ▪ Communicates the finalized ToR to the project proponent ▪ Receives EIA report from project proponent ▪ Uploads the summary of EIA report in the website in cases of Category B projects ▪ Forwards the responses received to the project proponent ▪ Receives updated EIA report from project proponent incorporating the considerations from the proceedings of public hearing and responses received through other media ▪ Forwards updated EIA report to SEAC for appraisal ▪ Either accepts the recommendations of SEAC or asks for reconsideration of specific issues for review by SEAC. ▪ Takes the final decision and communicates the same to the project proponent
SEAC	▪ Reviews Form 1 ▪ If necessary visits, site(s) for finalizing the ToR ▪ Reviews updated EIA - EMP report and ▪ Appraises the SEIAA
SPCB	▪ Receives request from project proponent and conducts public hearing in the manner prescribed. ▪ Conveys proceedings to concerned authority and project proponent
Public Agency	▪ Receives request from the respective Governments to conduct public hearing ▪ Conducts public hearing in the manner prescribed. ▪ Conveys proceedings to the concerned Authority/EAC /Project proponent

5.1 SEIAA

- SEIAA is constituted by the MoEF to take final decision regarding the acceptance/rejection of prior environmental clearance to the project proposal for all Category 'B' projects.
- The state government may decide whether to house them at the Department of Environment or at any other Board for effective operational support.
- State Governments can decide whether the positions are permanent or part-time. The Central Government (MoEF) continues to follow the model of paying fee (TA/DA, accommodation, sitting fee) to the Chairperson and the members of EAC. As such, the State Government is to fund SEIAA & SEAC and decide the appropriate institutional support for them.

A. Constitution

- SEIAA is constituted by the Central Government comprising of three members including a Chairperson and Member Secretary to be nominated by the State Government or UT Administration concerned.
- The Central Government will notify as and when the nominations (in order) are received from the State Governments, within 30 days from the date of receipt.
- The Chairperson and the non-official member shall have a fixed term of three years, from the date of Notification by the Central Government constituting the Authority.

The form used by the State Governments to submit nominations for Notification by the Central Government is provided in **Annexure XII**.

B. Composition

- Chairperson shall be an expert in the EIA process
- Member Secretary shall be a serving officer of the concerned State Government/ UT Administration familiar with the environmental laws.
- Member Secretary may be of a level equivalent to the Director, Dept. of Environment or above – a full time member.
- All the members including the Chairperson shall be the experts as per the criteria set in the Notification.
- The Government servants can only serve as the Member Secretary to SEIAA and the Secretary to SEAC. All other members including Chairperson of the SEIAA and SEAC shall not be comprised of serving Government Officers; industry representatives; and the activists.
- Serving faculty (academicians) is eligible for the membership in the Authority and/or the Committees, if they fulfill the criteria given in Appendix VI to the Notification.
- This is to clarify that the serving Government officers shall not be nominated as professional/expert member of SEIAA/SEAC/EAC.
- Professionals/Experts in the SEIAA and SEAC shall be different.

Summary regarding the eligibility criteria for Chairperson and Members of the SEIAA is given in Table 5-3.

C. Decision-making process

- The decision of the Authority shall be arrived through consensus.
- If there is no consensus, the Authority may either ask SEAC for reconsideration or may reject the approval.
- All decisions of the SEIAA shall be taken in a meeting, considering the majority

Table 5-3: SEIAA: Eligibility Criteria for Chairperson / Members / Secretary

S. No.	Attribute	Requirement			
			Members	Member Secretary	Chairperson
1	Professional qualification as per the Notification		Compulsory	Compulsory	Compulsory
2	Experience (Fulfilling any one of a, b, c)	a	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI
		b	Professional Qualification +PhD+10 years of experience in one of the expertise area mentioned in Appendix VI	Professional Qualification +PhD+10 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification +PhD+10 years of experience in one of the expertise area mentioned in the Appendix VI
		c	Professional Qualification +10 years of experience in one of the expertise area mentioned in the Appendix VI + 5 years interface with environmental issues, problems and their management	Professional Qualification +10 years of experience in one of the expertise area mentioned in the Appendix VI + 5 years interface with environmental issues, problems and their management	----------
3	Test of independence (conflict of interest) and minimum grade of the Secretary of the Authority		Shall not be a serving government officer Shall not be a person engaged in industry and their associations Shall not be a person associated with environmental activism	Only serving officer from the State Government (DoE) familiar with environmental laws not below the level of Director	Shall not be a serving government officer Shall not be a person engaged in industry and their associations Shall not be a person associated with environmental activism
4	Age		Below 67 years at the time of Notification of	As per State Government Service	Below 72 Years at the time of the

S. No.	Attribute	Requirement			
			Members	Member Secretary	Chairperson
			the Authority	Rules	Notification of the Authority
5	Other memberships in Core Committees and/or as sectoral expert		Shall not be a member in any SEIAA/EAC/SEAC	Shall not be a member in any SEIAA/EAC/SEAC	Shall not be a member in any SEIAA/EAC/SEAC
6	Tenure of earlier appointment (continuous)		Only one term before this in continuity is permitted	Not applicable	Only one term before this in continuity is permitted
7	Eminent environmental expertise with understanding on environmental aspects and impacts		Desirable	Desirable	Compulsory
8	Expertise in the environmental clearance process		Desirable	Desirable	Compulsory

Note:

1. A member after continuous membership in two terms (6 years) shall not be considered for further continuation. His/her nomination may be considered after a gap of one term (three years), if other criteria meet.

2. Chairperson/Member (core or sectoral expert) once notified may not be removed prior to the tenure of three years without cause and proper enquiry.

5.2 EAC and SEAC

EAC and SEAC are independent Committees to review each developmental activity and offer its recommendations for consideration of the Central Government and SEIAA respectively.

A. Constitution

- EAC and SEAC shall be constituted by the Central Government comprising a maximum of 15 members including a Chairperson and Secretary. In case of SEAC, the State Government or UT Administration is required to nominate the professionals/experts for consideration and Notification by the Central Government.
- The Central Government will notify as and when the nominations (in order) are received from the State Governments, within 30 days from the date of receipt.
- The Chairperson and the non-official member shall have a fixed term of three years, from the date of Notification by the Central Government.
- The Chairperson shall be an eminent environmental expert with understanding on environmental aspects and environmental impacts. The Secretary of the SEAC shall be a State Government officer, not below the level of a Director/Chief Engineer.

- The members of the SEAC need not be from the same State/UT.
- In case the State Governments/ Union Territories so desire, the MoEF can form regional EAC to serve the concerned States/Union Territories.
- State Governments may decide to their convenience to house SEAC at the Department of Environment or at SPCB or at any other department, to extend support to the SEAC activities.

B. Composition

- Secretary to EAC/SEAC shall invite a maximum of two sectoral professionals/experts with the prior approval of the Chairperson, if desired.
- The Secretary of each EAC shall be an officer of the level equivalent to or above the level of Director, the MoEF, GoI.
- The suggested model for appraisal committees is a composition of core expert members and joined by sectoral experts. This means, core group expert members will be common to all the developmental projects in a group, whereas the sectoral experts join the core group when specific sectoral project is being appraised.
- The desired composition of state or central appraisal committee for this industry include following:
  - Environmental management specialist/ environmental regulator
  - Air and Noise quality expert
  - Occupational health
  - Geology/geo-hydrology
  - Ecologist
  - Transportation specialist
  - Safety and health specialist
  - Social scientist, *etc.*

C. Decision-making

The EAC and SEAC shall function on the principle of collective responsibility. The Chairperson shall endeavour to reach a consensus in each case, and if consensus cannot be reached, the view of the majority shall prevail.

D. Operational issues

- Secretary may deal with all correspondence, formulate agenda and prepare agenda notes. Chairperson and other members may act only for the meetings.
- Chairperson of EAC/SEAC shall be one among the core group having considerable professional experience with proven credentials.
- EAC/SEAC shall meet at least once every month or more frequently, if so needed, to review project proposals and to offer recommendations for the consideration of the Authority.
- EAC/SEAC members may inspect the site at various stages *i.e.* during screening, scoping and appraisal, as per the need felt and decided by the Chairperson of the Committee.

- The respective Governments through the Secretary of the Committee may pay/reimburse the participation expenses, honorarium *etc.*, to the Chairperson and members.

i) Tenure of EAC/SEIAA/SEAC

The tenure of Authority/Committee(s) shall be for a fixed period of three years. At the end of the three years period, the Authority and the committees need to be re-constituted. However, staggered appointment dates may be adopted to maintain continuity of members at a given point of time.

ii) Qualifying Criteria for Nomination of a Member to EAC/SEIAA/SEAC

While recommending nominations and while notifying the members of the Authority and Expert Committees, it shall be ensured that all the members meet the following three criteria:

- Professional qualification
- Relevant experience/Experience interfacing with environmental management
- Absence of conflict of interest

These are elaborated subsequently.

a) Professional Qualification

The person should have at least

- 5 years of formal University training in the concerned discipline leading to a MA/MSc Degree, or
- In case of Engineering/Technology/Architecture disciplines, 4 years formal training in a professional training course together with prescribed practical training in the field leading to a B.Tech/B.E./B.Arch. Degree, or
- Other professional degree (e.g. Law) involving a total of 5 years of formal University training and prescribed practical training, or
- Prescribed apprenticeship/articleship and pass examinations conducted by the concerned professional association (e.g. MBA/IAS/IFS). In selecting the individual professionals, experience gained by them in their respective fields will be taken note of.

b) Relevant Experience

- Experience shall be related to professional qualification acquired by the person and be related to one or more of the expertise mentioned for the members of the Core group or the Sectoral Experts. Such experience should be a minimum of 15 years.
- When the experience mentioned in the foregoing sub-paragraph interfaces with environmental issues, problems and their management, the requirement for the length of the experience can be reduced to a minimum of 10 years.

c) Absence of Conflict of Interest

For the deliberations of the EAC/SEAC to be independent and unbiased, all possibilities of potential conflict of interests have to be eliminated. Therefore, serving government officers; persons engaged in industry and their associations; persons associated with the formulation of development projects requiring environmental clearance, and persons

associated with environmental activism shall not be considered for membership of SEIAA/ SEAC/ EAC.

iii) Age

Below 70 years for the members and below 72 years for the Chairperson of the SEIAA/SEAC/EAC. The applicability of the age is at the time of the Notification of the SEIAA/SEAC/EAC by the Central Government.

Summary regarding the eligibility criteria for Chairperson and Members of the EAC/ SEAC are given in Table 5-4.

Table 5-4: EAC/SEAC: Eligibility Criteria for Chairperson / Members / Secretary

S. No.	Attribute		Requirement		
			Core Members/Sectoral Expert members	Secretary	Chairperson
1	Professional qualification as per the Notification		Compulsory	Compulsory	Compulsory
2	Experience (Fulfilling any one of a, b, c)	a	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI
		b	Professional Qualification +PhD+10 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification +PhD+10 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification +PhD+10 years of experience in one of the expertise area mentioned in Appendix VI
		c	Professional Qualification +10 years of experience in one of the expertise area mentioned in the Appendix VI + 5 years interface with environmental issues, problems and their management	Professional Qualification +10 years of experience in one of the expertise area mentioned in the Appendix VI + 5 years interface with environmental issues, problems and their management	----------

S. No.	Attribute	Requirement		
		Core Members/Sectoral Expert members	Secretary	Chairperson
3	Test of independence (conflict of interest) and minimum grade of the Secretary of the Committees	Shall not be a serving government officer Shall not be a person engaged in industry and their associations Shall not be a person associated with environmental activism	In case of EAC, not less than a Director from the MoEF, Government of India Incase of SEAC, not below the level of Director/Chief Engineer from the State Government (DoE)	Shall not be a serving government officer Shall not be a person engaged in industry and their associations Shall not be a person associated with environmental activism
4	Age	Below 67 years at the time of Notification of the Committee	As per state Government Service Rules	Below 72 Years at the time of the Notification of the Committee
5	Membership in Core committees	Only one other than this nomination is permitted	Shall not be a member in other SEIAA/EAC/SEAC	Shall not be a member in any other SEIAA/EAC/SEAC
6	Membership of Sectoral Experts	Only three other than this nomination is permitted	Shall not be a member in other SEIAA/EAC/SEAC	
7	Tenure of earlier appointment (continuous)	Only one term before this in continuity is permitted	Not applicable	Only one term before this in continuity is permitted
8	Eminent environmental expertise with understanding on environmental aspects and impacts	Desirable	Not applicable	Compulsory

Note:

1. Core members are the members in EAC/SEAC, who are common for all the types of developmental activities, whereas, sectoral expert members will join for the specific developmental sectors. Core members may be limited to about 12.

2. Sectoral expert members: Sectoral Expert members are the members who join the EAC/SEAC, when corresponding sector is being reviewed/appraised. At a given sectoral review, a maximum of three sectoral expert members may join. Therefore the total number of expert members in EAC/SEAC does not exceed 15.

3. A member after continuous membership in two terms (six years) shall not be considered for further continuation. His/her nomination may be reconsidered after a gap of one term (three years), if other criteria meet.

4. Chairperson/Member (core or sectoral expert) once notified may not be removed prior to the tenure of 3 years with out cause and proper enquiry. A member after continuous membership in two terms (6 years) shall not be considered for further continuation. The same profile may be considered for nomination after a gap of three years, i.e., one term, if other criteria are meeting.

E. Other Conditions

- An expert Core Committee member of one State/UT, can have at the most another State/UT Committee membership (core or sectoral expert member), but in no case more than two Committees at a given point of time.
- Sectoral experts (not being a member in a Core Committee) can have membership in not more than four states.
- An expert member of a Committee (core or sectoral expert) shall not have membership continuously in the same committee for more than two terms, *i.e*. six years. They can be nominated after a gap of three years, *i.e*., one term. When a member of Committee has been associated with any development project, which comes for environmental clearance, he/she may not participate in the deliberations and the decisions in respect to that particular project.
- At least four members shall be present in each meeting to fulfill the quorum.
- If a member does not consecutively attend six meetings, without prior intimation to the Committee his/her membership may be terminated by the Notifying Authority. Prior information for absence due to academic pursuits, career development and national/state-endorsed programmes may be considered as genuine grounds for retention of membership.

ANNEXURE I
Mercury Emission Status and Control Technology

Mercury Emission Status & Control Technology

A growing concern in India is the release of various toxic trace elements such as mercury (Hg), arsenic (As), lead (Pb), cadmium (Cd), etc., from power plants through the disposal and dispersal of coal ash. Among the various toxic elements mercury emissions from coal based TPP are of particular concern, mercury emitted in flue gases or in flyash/bottom-ash that is disposed off in ash ponds enters the hydrological system, wherein the mercury can be methlyated. Then this methyl-mercury can then enter the human food chain, mainly through consumption of fish (Shah et al., 2008). Thus this food chain exposure pathway to mercury at high levels can harm the brain, heart, kidneys, lungs, and immune system of people of all ages.

Mercury can be emitted in three different forms: elemental (Hg0), oxidized (Hg2+) and particle bound (HgP). Upon combustion, coal flyash tends to have a higher concentration of mercury, and estimates indicate that Indian coal ash has an average mercury concentration of 0.53 mg/kg, based on measurements from a few selected power plants.

Besides Indian coal is very high in mercury contents and the following table reflect the concentrations of many trace elements in Indian as well as other typical comparable sources. The levels in Indian coal are high in comparison to other countries.

Element	Earth's Crust Average	Indian Minimum	Indian Maximum	Indian Average	British Average	US Average	Australian Average	Worldwide Average
As	2.0	0.1	23.0	5.0	18	15	3	5
Hg	0.1	0.0	2.7	0.35	--	0.18	0.1	0.012
Cd	0.15	0.0	13.0	1.3	0.4	1.3	0.1	-
Pb	16.0	0.0	46.5	15.0	38	16	10	25
Cr	200.0	5.0	90.8	70.0	33.6	15	6	10
Ni	80.0	0.0	100.0	45.0	27.9	15	15	15
Co	23.0	2.1	40.0	11.0	--	7	-	5

Table: Concentration (mg/kg) of trace elements in Indian coal and lignite, compared to other coals.

Source: (Masto et al., 2007).

Mercury contained in fuel evaporates during fuel combustion in boilers operating at temperatures above 1100 C. Some of the gas may cool and condense as it passes through the boiler and the air pollution control system. The recant measurements at an NTPC 500 MW power plant indicated that the concentration of mercury in the stack flue gas was about 2.8 +/- 0.5 $\mu g/m^3$ (Jain and Roy, 1999).

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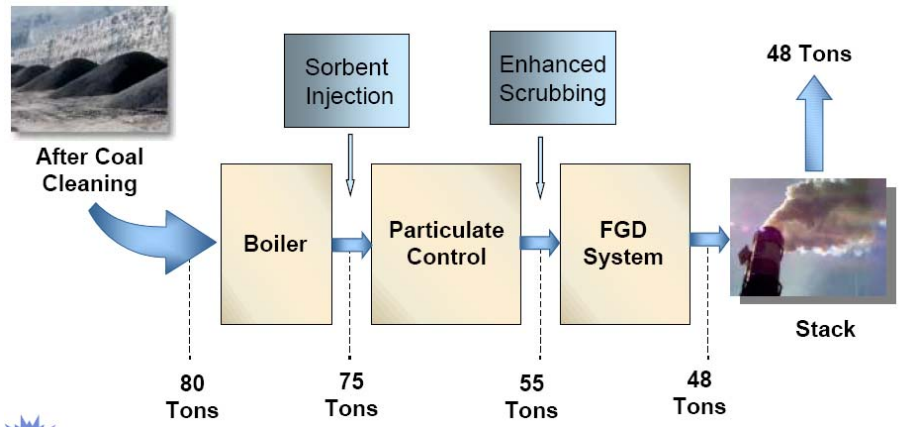
Example of Mercury Balance

Currently, there is no NAAQS for mercury, although there are consent condition necessitating monitoring of ambient and emission Hg for Greenfield TPP. Although there are no limits set at this stage for mercury emissions from power plants, there are some general guidelines available for mercury in power plant effluents.



Control Technology for Mercury Emissions

The most of mercury emissions generated during the combustion process need to be controlled by devices added on the TPP installations to remove particles and acidic gases. The most commonly used devices to remove particles from exhaust gases in electric power plants and large industrial boilers are electrostatic precipitators (ESPs) and fabric filters (FFs). Various types of flue gas desulfurization (FGDs) are in use to control sulfur dioxide emissions in some TPP plants.

Recent literature review of data from various power plants in the United States concluded that ESPs have a median mercury removal efficiency of 32% (U.S.EPA, 1997). It was also concluded that FFs are more efficient in removing mercury from the flue gas stream in power plants as part of the mercury may adsorb onto the fly ash cake collected on FFs. It was estimated that FFs have a median mercury removal efficiency of 42 (U.S. EPA, 1997). The USEPA data indicate that currently installed control devices, particularly combined systems of ESP or FFs with FGDs or SDAs can remove over 50 % of mercury from flue gases leaving the utility and also other major industrial boilers.

Fuel washing and fuel substitution are the major pre-treatment measures to reduce emissions of various pollutants from coal combustion processes, including reduction of mercury. The cleaning of coal takes place in water, in a dense medium, or in a dry medium. Physical cleaning processes are based on either the specific gravity or surface property differences between the coal and its impurities. Jigs, concentrating tables, hydro-cyclones, and froth flotation cells are common devices used in current physical coal-cleaning facilities. The removal efficiency as obserbed in USA ranged from 0 to 60 % with 21 % as average reduction.This efficiency is highly dependent on the type of coal and chloride content of the coal. Control of mercury emissions has so far not been on the forefront of pollution reduction from coal power plants in India, however, greater use of washed coals and pollution control devices in India would already help in reducing mercury emissions.Hence, there are several different options for reducing mercury emissions from power plants which are:

- Selective mining of low-mercury coals,173
- Coal washing/beneficiation – this depends on coal characteristics, but about 30-80% of mercury can be reduced by proper washing,
- Fluidized bed combustion, especially for high chlorine coals,
- Use of pollution control devices such as low-NOx burners, cold-side ESPs, bag-filters, FGD, and SCR, are also effective and
- Sorbent injection into flue gas ducts – typically, activated carbon can be injected either upstream or downstream of the ESP.

Control during Pre-treatment

Fuel washing and fuel substitution are the major pre-treatment measures to reduce emissions of various pollutants from coal combustion processes, including reduction of mercury.

Commercial coal cleaning (or beneficiation)

Commercial coal cleaning (or beneficiation) facilities are physical cleaning techniques to reduce the mineral matter and pyretic sulfur content. As a result, the product coal has a higher energy density and less variability (compared to feedstock coal) so that power plant efficiency and reliability are improved. A side benefit to these processes is that emissions of sulfur dioxide, as well as other pollutants including mercury can be reduced. The efficiency of this removal depends on the cleaning process used, type of coal, and the contaminant content of coal. Basic physical coal cleaning techniques have been commercial for over 50 years. The cleaning of coal takes place in water, in a dense medium, or in a dry medium.

Physical cleaning processes are based on either the specific gravity or surface property differences between the coal and its impurities. Jigs, concentrating tables, hydro-cyclones, and froth flotation cells are common devices used in current physical coal-cleaning facilities.

The removal efficiency ranged from 0 to 60 % with 21 % as average reduction. This efficiency is highly dependent on the type of coal and chloride content of the coal. Concerning other fuels, the cleaning of crude oil occurs mostly through the residue desulfurization (RDS). However, the content of Hg in crude oil is usually very low and RDS is an inefficient method to even lower this content.

Fuel Switching

The following options of fuel substitution are often considered in the electric utilities: switching from high- to low-sulfur coal burnt in applicable coal-based generation (including switching directly from high-sulfur to low-sulfur supplies, blending high- and low-sulfur coal, cleaning high- and medium-sulfur coal, or a combination of cleaning and blending), increasing the use of natural gas, or oil, and increasing the use of alternate fuels or importing electricity to meet base load electric generation requirements. The two latter methods are the most interesting with respect to the reduction of mercury emissions. The substitution of coal by coal bed methane to produce heat and electricity would result in decrease of emissions of various air pollutants, including mercury. But, the following action would be needed in the case of the substitution:

- the modernization of existing utility and industrial heat producing plants,
- the development of new methane burning boilers, and
- the modernization of coal mines with respect to the better exploitation of coal bed methane.

Non-conventional methods of Hg Removal

Non-conventional methods of combustion, such as fluidized bed combustion (FBC) were found to generate comparable or slightly lower emissions of mercury and other trace elements compared to the conventional power plants.

However, a long residence time of the bed material may result in increased fine particle production and thus more efficient condensation of gaseous mercury. Tests carried out in the Germany have shown that the residence time of the bed material can be regulated by

changing the operating conditions of a given plant, the reduction of combustion temperature, coal size, moisture content, and bed flow rates.

Secondary measures include technological solutions to decrease concentrations of pollutants in the flue gas. Major emphasis in this report is placed on the removal of mercury and its compounds by the application of flue gas desulfurization (FGD).

Low NOx technologies are also likely to reduce mercury emission in the exhaust gases due to the lower operating temperatures. Very limited information on this subject is rather inconclusive. While some sources indicate that the reduction can be achieved, preliminary results of staged combustion in atmospheric fluidized bed combustion (AFBC) units indicated that low NOx had only little effect on trace element emissions (Smith, 1987). It should be noted, however, that low NOx technologies are far less used compared to the FGD systems.

ANNEXURE II
A Compilation of Legal Instruments

SL. NO.	LEGAL INSTRUMENT (TYPE, REFERENCE, YEAR)	RESPONSIBLE MINISTRIES OR BODIES	CHEMICAL USE CATEGORIES/POLLUTANTS	OBJECTIVE OF LEGISLATION	RELEVANT ARTICLES/PROVISIONS
1	Air (Prevention and Control of Pollution) Act, 1981 amended 1987	Central Pollution Control Board and State Pollution Control Boards	Air pollutants from chemical industries	The prevention, control and abatement of air pollution	Section 2: Definitions Section 21: Consent from State Boards Section 22: Not to allow emissions exceeding prescribed limits Section 24: Power of Entry and Inspection Section 25: Power to Obtain Information Section 26: Power to Take Samples Section 37-43: Penalties and Procedures
2	Air (Prevention and Control of Pollution) (Union Territories) Rules, 1983	Central Pollution Control Board and State Pollution Control Boards	Air pollutants from chemical industries	The prevention, control and abatement of air pollution	Rule 2: Definitions Rule 9: Consent Applications
3	Water (Prevention and Control of Pollution) Act, 1974 amended 1988	Central Pollution Control Board and State Pollution Control Boards	Water Pollutants from water polluting industries	The prevention and control of water pollution and also maintaining or restoring the wholesomeness of water	Section 2: Definitions Section 20: Power to Obtain Information Section 21: Power to Take Samples Section 23: Power of Entry and Inspection Section 24: Prohibition on Disposal Section 25: Restriction on New Outlet and New Discharge Section 26: Provision regarding existing discharge of sewage or trade effluent Section 27: Refusal or withdrawal of consent by state boards Section 41-49: Penalties and Procedures
4	Water (Prevention and Control of Pollution) Rules, 1975	Central Pollution Control Board and State Pollution Control Boards	Water Pollutants from water polluting industries	The prevention and control of water pollution and also maintaining or restoring the wholesomeness of water	Rule 2: Definitions Rule 30: Power to take samples Rule 32: Consent Applications
5	The Environment (Protection) Act, 1986, amended 1991	Ministry of Environment and Forests, Central	All types of environmental pollutants	Protection and Improvement of the Environment	Section 2: Definitions Section 7: Not to allow emission or

		Pollution Control Board and State Pollution Control Boards			discharge of environmental pollutants in excess of prescribed standards Section 8: Handing of Hazardous Substances Section 10: Power of Entry and Inspection Section 11: Power to take samples Section 15-19: Penalties and Procedures
6	Environmental (Protection) Rules, 1986 (Amendments in 1999, 2001, 2002, 2002, 2002, 2003, 2004)	Ministry of Environment and Forests, Central Pollution Control Board and State Pollution Control Boards	All types of Environmental Pollutants	Protection and Improvement of the Environment	Rule 2: Definitions Rule 3: Standards for emission or discharge of environmental pollutants Rule 5: Prohibition and restriction on the location of industries and the carrying on process and operations in different areas Rule 13: Prohibition and restriction on the handling of hazardous substances in different areas Rule 14: Submission of environmental statement
7	Hazardous Waste (Management and Handling) Rules, 1989 amended 2000 and 2003	MoEF, CPCB, SPCB, DGFT, Port Authority and Customs Authority	Hazardous Wastes generated from industries using hazardous chemicals	Management & Handling of hazardous wastes in line with the Basel convention	Rule 2: Application Rule 3: Definitions Rule 4: Responsibility of the occupier and operator of a facility for handling of wastes Rule 4A: Duties of the occupier and operator of a facility Rule 4B: Duties of the authority Rule 5: Grant of authorization for handling hazardous wastes Rule 6: Power to suspend or cancel authorization Rule 7: Packaging, labeling and transport of hazardous wastes Rule 8: Disposal sites Rule 9: Record and returns

					Rule 10: Accident reporting and follow up Rule 11: Import and export of hazardous waste for dumping and disposal Rule 12: Import and export of hazardous waste for recycling and reuse Rule 13: Import of hazardous wastes Rule 14: Export of hazardous waste Rule 15: Illegal traffic Rule 16: Liability of the occupier, transporter and operator of a facility Rule 19: Procedure for registration and renewal of registration of recyclers and re-refiners Rule 20: Responsibility of waste generator
8	Manufacture Storage and Import of Hazardous Chemicals Rules, 1989 amended 2000	Ministry of Environment & Forests, Chief Controller of Imports and Exports, CPCB, SPCB, Chief Inspector of Factories, Chief Inspector of Dock Safety, Chief Inspector of Mines, AERB, Chief Controller of Explosives, District Collector or District Emergency Authority, CEES under DRDO	Hazardous Chemicals - Toxic, Explosive, Flammable, Reactive	Regulate the manufacture, storage and import of Hazardous Chemicals	Rule 2: Definitions Rule 4: responsibility of the Occupier Rule 5: Notification of Major Accidents Rule 7-8: Approval and notification of site and updating Rule 10-11: Safety Reports and Safety Audit reports and updating Rule 13: Preparation of Onsite Emergency Plan Rule 14: Preparation of Offsite Emergency Plan Rule 15: Information to persons likely to get affected Rule 16: Proprietary Information Rule 17: Material Safety Data Sheets Rule 18: Import of Hazardous Chemicals
9	Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	CCG, SCG, DCG, LCG and MAH Units	Hazardous Chemicals - Toxic, Explosive, Flammable, Reactive	Emergency Planning Preparedness and Response to chemical accidents	Rule 2: Definitions Rule 5: Functions of CCG Rule 7: Functions of SCG Rule 9: Functions of DCG

					Rule 10: Functions of LCG
10	Ozone Depleting	Ministry of Environment & Forests	Ozone depleting substances	Regulate the production, import, use, sale, purchase and phase-out of the ODS	Rule 2: Definitions Rule 3: Regulation of production and consumption of ozone depleting substances Rule 4: Prohibition on export to or import from countries not specified in Schedule VI Rule 5: Ozone depleting substances are to be exported to or imported from countries specified in Schedule VI under a license Rule 6: Regulation of the sale of ozone depleting substances Rule 7: Regulation on the purchase of ozone depleting substances Rule 8: Regulation on the use of ozone depleting substance Rule 9: Prohibition on new investments with ozone depleting substances Rule 10: Regulation of import, export and sale of products made with or containing ozone depleting substances Rule 11: Regulation on reclamation and destruction of ozone depleting substances Rule 12: Regulation on manufacture, import and export of compressors Rule 13: Procedure for registration, cancellation of registration and appeal against such orders Rule 14: Monitoring and reporting requirements
11	EIA Notification, 1994	MoEF, SPCB	Chemicals/pollutants expected to be generated from industrial activities	Requirement of environmental clearance before establishment of or modernization / expansion of certain type of industries/ projects.	Rule 2: Requirements and procedure for seeking environmental clearance of projects

12	Batteries (Management and Handling) Rules, 2001.	SPCB, CPCB and MoEF	Lead Acid Batteries	To control the hazardous waste generation (lead waste) from used lead acid batteries	Rule 2: Application Rule 3: Definitions Rule 4: Responsibilities of manufacturer, importer, assembler and re-conditioner Rule 5: Registration of Importers Rule 7: Responsibilities of dealer Rule 8: Responsibilities of recycler Rule 9: Procedure for registration / renewal of registration of recyclers Rule 10: Responsibilities of consumer or bulk consumer Rule 11: Responsibilities of auctioneer Rule 14: Computerization of Records and Returns
13	Public Liability Insurance Act, 1991 amended 1992	Ministry of Environment & Forests, District Collector	Hazardous Substances	To provide immediate relief to persons affected by accident involving hazardous substances	Section 2: Definitions Section 3: Liability to give relief in certain cases on principle of no fault Section 4: Duty of owner to take out insurance policy Section 7A: Establishment of Environmental Relief Fund Section 14-18: Penalties and Offences
14	Public Liability Insurance Rules, 1991 amended 1993	Ministry of Environment & Forests, District Collector	Hazardous Substances	To provide immediate relief to persons affected by accident involving hazardous substances and also for Establishing an Environmental Relief fund	Rule 2: Definitions Rule 6: Establishment of administration of fund Rule 10: Extent of liability Rule 11: Contribution of the owner to environmental relief fund
15	Factories Act, 1948	Ministry of Labour, DGFASLI and Directorate of Industrial Safety and Health/Factories Inspectorate	Chemicals as specified in the Table	Control of workplace environment, and providing for good health and safety of workers	Section 2: Interpretation Section 6: Approval, licensing and registration of factories Section 7A: General duties of the occupier Section 7B: General duties of manufacturers etc., as regards articles and substances for use in factories Section 12: Disposal of wastes and effluents

					Section 14: Dust and fume Section 36: Precautions against dangerous fumes, gases, etc. Section 37: Explosion or inflammable dust, gas, etc. Chapter IVA: Provisions relating to Hazardous processes Section 87: Dangerous operations Section 87A: Power to prohibit employment on account of serious hazard Section 88: Notice of certain accident Section 88A: Notice of certain dangerous occurrences Chapter X: Penalties and procedures
16	The Petroleum Act, 1934	Ministry of Petroleum and Natural Gas	Petroleum (Class A, B and C - as defined in the rules)	Regulate the import, transport, storage, production, refining and blending of petroleum	Section 2: Definitions Section 3: Import, transport and storage of petroleum Section 5: Production, refining and blending of petroleum Section 6: Receptacles of dangerous petroleum to show a warning Section 23-28 Penalties and Procedure
17	The Petroleum Rules, 2002	Ministry of Petroleum and Natural Gas, Ministry of Shipping (for notification of authorized ports for import), Ministry of Environment & Forests or SPCB (for clearance of establishment of loading/unloading facilities at ports) Chief Controller of	Petroleum (Class A, B and C - as defined in the rules)	Regulate the import, transport, storage, production, refining and blending of petroleum	Rule 2: Definition Chapter I part II: General Provision Chapter II: Importation of Petroleum Chapter III: Transport of Petroleum Chapter VII: Licenses

		Explosives, district authority, Commissioner of Customs, Port Conservator, State Maritime Board (Import)			
18	The Calcium Carbide Rules, 1987	Ministry of Petroleum and Natural Gas, Chief Controller of Explosives, Customs Collector, Port Conservator, DGCA, District Authority	Calcium Carbide	To regulate the import, production, storage, transportation, sale, use and handling and disposal of Calcium carbide with a view to prevent accidents	Rule 2: Definitions Chapter II: General provisions Chapter III: Importation of Carbide Chapter IV: Transportation of carbide Chapter V: Storage of carbide Chapter VI: Licensing Chapter VII: Notice of accident
19	The Explosives Act, 1884	Ministry of Commerce and Industry (Department of Explosives)	Explosive substances as defined under the Act	To regulate the manufacture, possession, use, sale, transport, export and import of explosives with a view to prevent accidents	Section 4: Definition Section 6: Power for Central government to prohibit the manufacture, possession or importation of especially dangerous explosives Section 6B: Grant of Licenses
20	The Explosive Rules, 1983	Ministry of Commerce and Industry and Chief Controller of Explosives, port conservator, customs collector, railway administration	Explosive substances as defined under the Act	To regulate the manufacture, possession, use, sale, transport, export and import of explosives with a view to prevent accidents	Rule 2: Definition Chapter II: General Provisions Chapter III: Import and Export Chapter IV: Transport Chapter V: Manufacture of explosives Chapter VI: Possession sale and use Chapter VII: Licenses
21	The Gas Cylinder Rules, 2004	Ministry of Commerce and Industry and Chief Controller of Explosives, port	Gases (Toxic, non toxic and non flammable, non toxic and flammable, Dissolved Acetylene Gas, Non toxic and flammable liquefiable gas other than LPG,	Regulate the import, storage, handling and transportation of gas cylinders with a view to prevent accidents	Rule 2: Definition Chapter II: General Provisions Chapter III: Importation of Cylinder Chapter IV: Transport of Cylinder Chapter VII: Filling and Possession

		conservator, customs collector, DGCA, DC, DM, Police (sub inspector to commissioner)	LPG		
22	The Static and Mobile Pressure Vessels (Unfired) Rules, 1981	Ministry of Commerce and Industry and Chief Controller of Explosives, port conservator, customs collector, DGCA, DC, DM, Police (sub inspector to commissioner)	Gases (Toxic, non toxic and non flammable, non toxic and flammable, Dissolved Acetylene Gas, Non toxic and flammable liquefiable gas other than LPG, LPG	Regulate the import, manufacture, design, installation, transportation, handling, use and testing of mobile and static pressure vessels (unfired) with a view to prevent accidents	Rule 2: Definition Chapter III: Storage Chapter IV: Transport Chapter V: Licenses
23	The Motor Vehicle Act, 1988	Ministry of Shipping, Road Transport and Highways	Hazardous and Dangerous Goods	To consolidate and amend the law relating to motor vehicles	Section 2: Definition Chapter II: Licensing of drivers of motor vehicle Chapter VII: Construction equipment and maintenance of motor vehicles
24	The Central Motor Vehicle Rules, 1989	Ministry of Shipping, Road Transport and Highways	Hazardous and Dangerous Goods	To consolidate and amend the law relating to motor vehicles including to regulate the transportation of dangerous goods with a view to prevent loss of life or damage to the environment	Rule 2: Definition Rule 9: Educational qualification for driver's of goods carriages carrying dangerous or hazardous goods Rule 129: Transportation of goods of dangerous or hazardous nature to human life Rule 129A: Spark arrestors Rule 130: Manner of display of class labels Rule 131: Responsibility of the consignor for safe transport of dangerous or hazardous goods Rule 132: Responsibility of the transporter or owner of goods carriage Rule 133: Responsibility of the driver

					Rule 134: Emergency Information Panel Rule 135: Driver to be instructed Rule 136: Driver to report to the police station about accident Rule 137: Class labels
25	The Mines Act 1952	Ministry of Coal and Mines	Use of toxic and inflammable gases, dust or mixtures	Safety of the mine workers	Section 2: Definitions Chapter IV: Mining operations and management of mines Chapter V: Provisions as to health and safety Chapter IX: Penalties and procedure
26	The Insecticide Act, 1968	Ministry of Agriculture and Central Insecticides Board and Registration Committee	Insecticides including fungicides and weedicides	regulate the import, manufacture, sale, transport, distribution and use of insecticides with a view to prevent risk to human beings or animals	Section 3: Definitions Section 9: Registration of Insecticides Section 13: Grant of License Section 17: Prohibition of import and manufacture of certain insecticides Section 18: Prohibition of sale, etc. of certain insecticides Section 25: Confiscation Section 26: Notification of poisoning Section 27: Prohibition of sale, etc. of insecticide for reasons of public safety Section 28: Notification of cancellation of registration, etc. Section 29: Offences and Punishment

ANNEXURE III
Environmental Standards for Liquid Effluents from Thermal Power Plants

Environmental Standards

Thermal Power Plant: Standards for Liquid Effluents

Source	Parameter	Concentration not to exceed, mg/l (except for pH & Temp.)
Condenser Cooling Water (once through higher cooling system)	pH	6.5 to 8.5
	Temperature*	Not more than 5^{o}C than the higher intake
Boiler Blowdown	Free available Chlorine	0.5
	Suspended solids	100
	Oil & grease	20
	Copper (Total)	1.0
	Iron (Total)	1.0
Cooling Tower Blowdown	Free available Chlorine	
	Zinc	1.0
	Chromium (Total)	0.2
	Phosphate	5.0
	Other corrosion inhibiting material	Limit to be established on case by case basis by Central Board in case of Union Territories and State Boards in case of States
As pond effluent	pH	6.5 to 8.5
	Suspended solids	100
	Oil & grease	20

* Limit has been revised, please see new limit at Sr. No. 66C of the document

Thermal Power Plant: Emission Standards

Generation Capacity	Pollutant	Emission limit
210 MW or more	Particulate matter	150 mg/Nm^3
Less than 210 MW	Particulate matter	300 mg/Nm^3

* Depending upon the requirement of local situation, such as protected area, the State Pollution Control Boards and other implementing agencies under the Environment (Protection) Act, 1986, may prescribe a limit of 150 mg/Nm^3, irrespective of generation capacity of the plant.

Thermal Power Plants: Stack Height/Limits

Generation Capacity	Stack Height (Metres)
500 MW and above	275
200 MW/210 MW and above to less than 500 MW	220
Less than 200 MW/210 MW	H= 14 Q 0.3 where Q is emission rate of SO2 in kg/hr, and H is Stack height in metres.

Source : EPA Notification G.S.R. 742(E), dt. 30th Aug; 1990

TEMPERATURE LIMIT FOR DISCHARGE OF CONDENSER COOLING WATER FROM THERMAL POWER PLANT

A. New thermal power plants commissioned after June 1, 1999.

New thermal power plants, which will be using water from rivers/lakes/reservoirs, shall install cooling towers irrespective of location and capacity. Thermal power plants which will use sea water for cooling purposes, the condition below will apply.

B. New projects in coastal areas using sea water.

The thermal power plants using sea water should adopt suitable system to reduce water temperature at the final discharge point so that the resultant rise in the temperature of receiving water does not exceed 7°C over and above the ambient temperature of the receiving water bodies.

C. Existing thermal power plants.

Rise in temperature of condenser cooling water from inlet to the outlet of condenser shall not be more than 10°C.

D. D. Guidelines for discharge point.

1. The discharge point shall preferably be located at the bottom of the water body at mid stream for proper dispersion of thermal discharge.

2. In case of discharge of cooling water into sea, proper marine outfall shall be designed to achieve the prescribed standards the point of discharge may be selected in consultation with concerned State Authorities/ NIO.

3. No cooling water discharge shall be permitted in estuaries or near ecologically sensitive areas such as mangroves, coal reefs/ spanning and breeding grounds of aquatic flora and fauna

Source: EPA Notification
[GSR 7, dated Dec. 22, 1998]

ENVIRONMENTAL STANDARDS FOR GAS / NAPTHA BASED THERMAL POWER PLANTS

Liquid waste discharge limit

Parameter	Maximum limit of concentration (mg/l except for pH and temperature)
pH	6.5 - 8.5
Temperature	As applicable for other thermal power plants
Free available chlorine	0.5
Suspended solids	100.0
Oil & grease	20.0
Copper (total)	1.0
Iron (total)	1.0
Zinc	1.0
Chromium (total)	0.2
Phosphate	5.0

Source : EPA Notification
[GSR 7, dt. Dec. 22, 1998]

Emission

(i) Limit for emission of NOx

(a) For existing units 150 ppm (v/v) at 15% excess oxygen.
(b) For new units with effect from 1-6-99.

Total generation of gas turbine	Limit for Stack NOx emission (v/v), at 15% excess oxygen)
(a) 400 MW and above	(i) 50 ppm for the units burning natural gas. (ii) 100 ppm for the units burning naphtha
(b) Less than 400 MW but upto 100 MW	(i) 75 ppm for the units burning natural gas (ii) 100 ppm for the units burning naphtha
(c) Less than 100 MW	100 ppm for units burning natural gas or naphtha as fuel
(d) For the plants burning gas in a conventional boiler.	100 ppm

(ii) Stack height H in m should be calculated using the formula $H= 14\ Q^{0.3}$, where Q is the emission of SO_2 in kg/hr, subject to a minimum of 30 mts.

Source : EPA Notification
[GSR 7, dt. Dec. 22, 1998]

ANNEXURE IV
Utilization of Ash by Thermal Power Plants

THE GAZETTE OF INDIA

EXTRAORDINARY

PART II – Section 3 -- Sub-section (ii)

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 14th September, 1999

S.0.763(E).- Whereas a draft notification containing certain directions was published, as required by subrule (3) of rule 5 of the Environment (Protection) Rules, 1986 under the notification of the Government of India in the Ministry of Environment and Forests number S.O. 453(E) dated 22nd May, 1998 inviting objections and suggestions from all persons likely to be affected thereby, before the expiry of the period of sixty days from the date on which the copies of the Gazette of India containing the said notification are made available to the public;

And, whereas, copies of the said Gazette were made available to the public on the same date;

And, whereas, the objections and suggestions received from the public in respect of the said draft notification have been duly considered by the Central Government;

Where as it is necessary to protect the environment, conserve top soil and prevent the dumping and disposal of fly ash discharged from coal or lignite based thermal power plants on land;

And, whereas, there is a need for restricting the excavation of top soil for manufacture of bricks and promoting the utilisation of fly ash in the manufacture of building materials and in construction activity within a specified radius of fifty kilometers from coal or lignite based thermal power plants;

And, Whereas, the Hon'ble High Court of Judicature, Delhi vide its order dated 25th August, 1999 in CWP No. 2145/99 Centre for Public Interest Litigation, Delhi v/s Union of India directed that the Central Government to publish the final notification in respect of fly ash on or before 26th October, 1999;

Now, therefore, in exercise of the powers conferred by sub-section (1), read with clause (v) of sub-section (2) of section 3 and section 5 of the Environment (Protection) Act, 1986 (29 of 1986); and in pursuance of the orders of the Hon'ble High Court, Delhi stated above, the Central Government hereby issues the following directions which shall come into force on the date of the publication of this notification, namely:-

1. **Use of fly ash, bottom ash or pond ash in the manufacture of bricks and other construction activities.-**

(1) No person shall within a radius of fifty kilometers from coal or lignite based thermal power plants, manufacture clay bricks or tiles or blocks for use in construction activities without mixing at least 25 per cent of ash (fly ash, bottom ash or pond ash) with soil on weight to weight basis. '

(2) The authority for ensuring the use of specified quantity of ash as per para (1) above shall be the concerned Regional Officer of the State Pollution Control Board or the Pollution Control Committee as the case may be. In case of non-compliance, the said authority, in addition to cancellation of consent order issued to establish the brick kiln, shall move the district administration for cancellation of mining lease. The cancellation of mining lease shall be decided after due hearing. To enable the said authority to verify the actual use of ash, the thermal power plant shall maintain month-wise records of ash made available to each brick kiln.

(3) In case of non-availability of ash from thermal power plant in sufficient quantities as certified by the said power plant, the stipulation under para (1) shall be suitably modified (waived/ relaxed) by the concerned State/Union Territory Government.

(4) Each coal or lignite based thermal power plant shall constitute a dispute settlement committee which shall include the General Manager of the thermal power plant and a representative of All India Brick and Tile Manufacture's Federation (AIBTMF). Such a committee shall ensure unhindered loading and transport of ash without any undue loss of time. Any unresolved dispute shall be dealt with by a State/Union Territory level committee to be set up by State/Union Territory Government comprising Member Secretary of the State Pollution Control Board/Pollution Control Committee, representatives of Ministry of Power in the State/Union Territory Government and a representative of AIBTMF.

2. Utilisation of ash by Thermal Power Plants.

All coal or lignite based thermal power plants shall utilise the ash generated in the power plants as follows: -

(1) Every coal or lignite based thermal power plant shall make available ash, for at least ten years from the date of publication of this notification, without any payment or any other consideration, for the purpose of manufacturing ash-based products such as cement, concrete blocks, bricks, panels or any other material or for construction of roads, embankments, dams, dykes or for any other construction activity.

(2) Every coal or lignite based thermal power plant commissioned subject to environmental clearance conditions stipulating the submission of an action plan for full utilisation of fly ash shall, within a period of nine years from the publication of this notification, phase out the dumping and disposal of fly ash on land in accordance with the plan. Such an action plan shall provide for thirty per cent of the fly ash utilisation, within three years from the publication of this notification with further increase in utilisation by atleast ten per cent points every year progressively for the next six years to enable utilisation of the entire fly ash generated in the power plant atleast by the end of ninth year. Progress in this regard shall be reviewed after five years.

(3) Every coal or lignite based thermal power plant not covered by para (2) above shall, within a period of fifteen years from the date of publication of this notification, phase out the utilisation of fly ash in accordance with an action plan to be drawn up by the power plants. Such action plan shall provide for twenty per cent of fly ash utilisation within three years from the date of publication of this notification, with further increase in utilisation every year progressively for the next twelve years to enable utilisation of the entire fly ash generated in the power plant.

(4) All action plans prepared by coal or lignite based thermal power plants in accordance with sub-para (2) and (3) of para 2 of this notification, shall be submitted to the Central Pollution Control Board/Committee and concerned, State Pollution Control Board/Committee and concerned regional office of the Ministry of Environment and Forests within a period of six months from the date of publication of this notification.

(5) The Central and State Government Agencies, the State Electricity Boards, the National Thermal Power Corporation and the management of the thermal power plants shall facilitate in making available land, electricity and water for manufacturing activities and provide access to the ash lifting area for promoting and setting up of ash-based production units in the proximity of the area where ash is generated by the power plant.

(6) Annual implementation report providing information about the compliance of provisions in this notification shall be submitted by the 30th day of April every year to the Central Pollution Control Board, concerned State Pollution Control Board/Committee and the concerned Regional Office of the Ministry of Environment and Forests by the coal or lignite based thermal power plants.

3. Specifications for use of ash-based products.-

(1) Manufacture of ash-based products such as cement, concrete blocks, bricks, panels or any other material or the use of ash in construction activity such as in road laying, embankments or use as

landfill to reclaim low lying areas including back filling in abandoned mines or pitheads or for any other use shall be carried out in accordance with specifications and guidelines laid down by the Bureau of Indian Standards, Indian Bureau of Mines, Indian Road Congress, Central Building Research institute, Roorkee, Central Road Research Institute, New Delhi, Building Materials and Technology Promotion Council, New Delhi, Central Public Works Department, State Public Works Departments and other Central and State Government agencies.

(2) The Central Public Works Department, Public Works Departments in the State/Union Territory Governments, Development Authorities, Housing Boards, National Highway Authority of India and other construction agencies including those in the private sector shall also prescribe the use of ash and ash-based products in their respective schedules of specifications and construction applications, including appropriate standards and codes of practice, within a period of four months from the publication of this notification.

(3) All local authorities shall specify in their respective building bye-laws and regulations the use of ash and ash-based products and construction techniques in building materials, roads, embankments or for any other use within a period of four months from the date of publication of this notification.

[F. No. 16-2/95-HSMD]

V RAJAGOPALAN, Jt.. Secy.

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New De1hi, the 27th August 2003.

S.O. 979 (E):- Whereas a draft of certain amendments to the Government of India in the Ministry of Environment and Forests notification number S.O.763 (E) dated 14th September, 1999 (hereinafter referred to as the said notification) which the Central Government proposes to make under sub-section (1) and clause (v) of sub-section (2) of section 3 of the Environment (Protection) Act, 1986 (29 of 1986) read with clause (d) of sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986, were published in the Gazette of India, Extraordinary, Part II, Section 3, Sub-section (ii) dated the 6th November, 2002 *vide* S.O. 1164 (E), dated the 5th November, 2002 inviting objections and suggestions from all persons likely to be affected thereby before the expiry of sixty days from the date on which copies of the Gazette containing the said draft amendments were made available to the public.

And, whereas copies of the said Gazette were made available to the public on 27th November 2002;

And, whereas all the objections and suggestions received from all persons likely to be affected thereby in respect of the said draft notification have been duly considered by the Central Government;

Now, therefore, in exercise of the powers conferred by sub-section (1) and clause (v) of sub-section (2) of section 3 of the Environment (Protection) Act, 1986 (29 of 1986) read with clause (d) of sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986, the Central Government hereby makes the following amendments to the said notification, namely: -

AMENDMENTS

1. In the said notification, in the preamble, for the words "fifty kilometers", the words "one hundred kilometres" shall be substituted.

2. In the said notification, in paragraph 1, -

(a) in sub-paragraph (1), for the words "fifty kilometers", the words "one hundred kilometres" shall be substituted;

(b) after sub-paragraph (1), the following sub- paragraphs shall be inserted, namely: -

"(1A) Every construction agency engaged in the construction of buildings within a radius of fifty to one hundred kilometres from a coal or lignite based thermal power plant shall use fly ash bricks or blocks or tiles or clay fly ash bricks or cement fly ash bricks or blocks or similar products or a combination or aggregate of them in such construction as per the following minimum percentage (by volume) of the total bricks, blocks and tiles, as the case may be, used in each construction project, namely:-

(i) 25 per cent by 31st August 2004;

(ii) 50 per cent by 31st August 2005;

(iii) 75 per cent by 31st August, 2006; and

(iv) 100 per cent by 31st August 2007.

In respect of construction of buildings within a radius of 50 kilometres from a coal or lignite based thermal power plant the following minimum per centage (by volume) of use of bricks, blocks and tiles shall apply: -

(i) 50 per cent by 31st August 2004;

(ii) 100 per cent by 31st August 2005.

(1B) The provisions of sub-paragraph (1A) shall be applicable to all construction agencies such as Housing Boards and those in the private sector builders of apartments, hotels, resorts and cottages and the like. It shall be the responsibility of the construction agencies either undertaking the construction or approving the design or both to ensure compliance of the provisions of sub-paragraph (1A) and to submit such returns as may be called for and compliance reports to the State Government or Union territory Administration";

(c) for sub-paragraph (2), the following sub-paragraphs shall be substituted, namely: -

" (2) The authority for ensuring the use of specified quantity of ash as per sub-paragraph (1) shall be the concerned Regional Officer of the State Pollution Control Board or the Pollution Control Committee, as the case may be.

(2A) The concerned State Government shall be the enforcing and monitoring authority for ensuring compliance of the provisions of sub-paragraph (lA).";

(d) in sub-paragraph (3), for the words, brackets and figure "under para (1)" the words, brackets and figure "under sub-paragraph (1)" shall be substituted;

(e) after sub-paragraph (3), the following sub-paragraphs shall be inserted, namely: -

"(3A) A decision on the application for manufacture of fly ash bricks, block, and tiles and similar other fly ash based products shall be taken within thirty days from the date of receipt of the application by the competent authority. A decision on consent to establish the brick kiln shall be taken by the Pollution Control Board or the Pollution Control Committee, as the case may be, within a period of thirty days from the date of receipt of application by it.

(3B) In case of non-compliance of the provisions of sub-paragraph (1) of paragraph 1, the competent authority, in addition to cancellation of consent order issued to establish the brick kiln, shall move the district administration for cancellation of the mining lease.

(3C) All authorities sanctioning or renewing any land, soil or clay mining lease shall not grant such lease or extension of lease or renewal to clay brick, block or tile manufacturing unit within a radius of

one hundred kilometres of the coal or lignite based thermal power plant in cases where the manufacturer does not mix a minimum of 25 per cent by weight of fly ash or pond ash in the manufacture of bricks or blocks or tiles. The cancellation of mining lease shall be decided by the district administration after giving the holder of such lease an opportunity of being heard. To enable the competent authority to verify the actual use of ash, the thermal power plant shall maintain month-wise records of ash made available to each brick kiln.

(3 D) It shall be sufficient compliance of this notification if within twelve months from the date of issue of this notification, manufacturers of clay bricks, blocks and tiles located within a radius of 50 to 100 kilometres of a coal or lignite based thermal power plant comply with the provisions of sub-paragraphs (1) and (2).".

(f) in sub-paragraph (4), after brackets and letters "(AIBTMF)", the words "or a representative of local brick kiln owners association, federation, group." shall be inserted;

(g) after sub-paragraph (4), the following sub-paragraphs shall be inserted, namely: -

"(5) No agency, person or organization shall, within a radius of 100 kilometres of a thermal power plant undertake construction or approve design for construction of roads or flyover embankments in contravention of the guidelines/ specifications issued by the Indian Road Congress (IRC) as contained in IRC specification No. SP: 58 of 2001. Any deviation from this direction can only be agreed to on technical reasons if the same is approved by Chief Engineer (Design) or Engineer-in-Chief of the concerned agency or organization or on production of a certificate of "Pond ash not available" from the thermal power plant(s) (TPPs) located within 100 kilometres of the site of

construction. This certificate shall be provided by the TPP within two working days from the date of making a request for ash.

(6) Soil required for top or side covers of embankments of roads or flyovers shall be excavated from the embankment site and if it is not possible to do so, only the minimum quantity of soil required for the purpose shall be excavated from soil borrow area. In either case, the topsoil should be kept or stored separately. Voids created due to soil borrow area shall be filled up with ash with proper compaction and covered with topsoil kept separately as above. This would be done as an integral part of embankment project within the time schedule of the project.

(7) No agency, person or organization shall within a radius of 100 kilometres of a coal or lignite based thermal power plant allow reclamation and compaction of low-lying areas with soil. Only pond ash shall be used for compaction. They shall also ensure that such reclamation and compaction is done in accordance with the bye-laws, regulations and specifications laid down by the authorities mentioned in sub-paragraph (3) of paragraph 3.".

3. In the said notification, in paragraph 2,

(a) for the marginal heading "**Utilisation of ash by Thermal Power Plants**", the marginal heading '**Responsibilities of Thermal Power Plants"** shall be substituted;

(b) for the opening words, "All coal or lignite based thermal power plants shall utilise the ash generated in the power plants as follows: -", "Every coal or lignite based thermal power plant shall take the following steps to ensure the utilisation of ash generated by it, namely: -";

(c) in sub- paragraph (1), -

(i) after the words “products such as cement, concrete blocks, bricks, panels”, the words “or a combination thereof” shall be inserted;

(ii) the following shall be added at the end, namely: -

“ The thermal power plants have to ensure availability of fair quantity of ash to each user including brick kilns.”;

4. In the said notification, after paragraph 2, the following paragraph shall be inserted, namely: -

“2A. Utilization of fly ash for reclamation of sea.

“Subject to the rules made under the Environment (Protection) Act, 1986, (29 of 1986) reclamation of sea shall be a permissible method of utilization of fly ash.”.

5. In the said notification, in paragraph 3, the following sub-paragraphs shall be inserted, namely: -

“(2A) All agencies including the Central Public Works Department and State Government agencies concerned with utilization of fly ash for construction purposes shall, within three months from the 1st day of September, 2003 make provisions for the use of fly ash and fly ash based bricks, blocks or tiles or aggregates of them in the schedule of approved materials and rates.

(2B) All agencies undertaking construction of roads or fly over bridges including Ministry of Road Transport and Highways (MORTH), National Highways Authority of India (NHAI), Central Public Works Department (CPWD), State Public Works Departments and other State Government Agencies, shall, within three months from the 1st day of September, 2003 -

a. make provisions in their tender documents, schedules of approved materials and rates as well as technical documents, including those relating to soil borrow area or pit as per sub-paragraph (7) of paragraph 1; and

b. make necessary specifications/guidelines for road or fly over embankments that are not covered by the specifications laid down by the Indian Road Congress (IRC).” .

[F.No.16-2/95-HSMD]
(Dr. V. Rajagopalan)
Joint Secretary to the Govt. of India

Footnote. - The principal notification was published in the Gazette of India, Part II, Section 3, sub-section (ii) *vide S*.O.763 (E) dated 14.9.1999.

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ANNEXURE V
MoEF Draft Notification S.O.513 (E) – Utilization of Fly Ash

MINISTRY OF ENVIRONMENT AND FORESTS
NOTIFICATION

New Delhi, the 3rd April, 2007

S.O. 513(E).—The following draft of a notification, which the Central Government proposes to issue, in supersession of the existing notification number S.O.763(E) dated the 14th September, 1999 of the Government of India in the Ministry of Environment and Forests, relating to restrictions on the excavation of top soil for manufacture of bricks and promoting the utilisation of fly ash in the manufacture of building materials and in construction activity is hereby published, as required under sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986, for the information of all persons likely to be affected thereby; and notice is hereby given that the said draft notification will be taken into consideration by the Central Government on or after the expiry of sixty days from the date on which copies of the Gazette containing this notification are made available to the public.

Any person interested in filing any objection(s) or suggestion(s) on the proposed draft notification may do so in writing to the Secretary, Ministry of Environment and Forests, Paryavaran Bhawan, CGO Complex, Lodi Road, New Delhi -110 003, within the said period of sixty days.

DRAFT NOTIFICATION

Whereas, it is necessary to protect the environment, through conserving the top soil, and other non-renewable resources used in the construction activities, through proper utilisation of fly ash, bottom ash and pond ash, generated from coal and lignite based thermal power plants;

Whereas as per the notification S.O. 763(E) dated the 14-9-1999 the progress of the implementation of the provisions of the said notification has been reviewed;

Whereas the review indicated while the generation of ash increased from about 89 million tonnes in 1999-2000 to about 112 million tonnes in 2005-2006 and the utilisation increased from 13 million tonnes to 51 million tonnes;

Whereas every year about 65 to 75 million tonnes of ash continue to remain unutilised and dumped in ash ponds and the quantity of ash in ash ponds has increased from about 450 million tonnes in 1999-2000 to about 900 million tonnes in 2005-2006;

Whereas the land area under active ash ponds is about 16,000 hectares and needs to be put to gainful use;

Whereas the concerned Central and State Governments and their agencies have already laid down specifications for ash and ash based products;

Whereas the brick kiln owners have represented against compulsory mixing of prescribed quantity of ash with clay on account of difficulties in meeting the cost of transportation;

Whereas the quantity of ash utilised by brick kilns in the past was limited to 0.7 million tonnes in 2004-2005 and 1.14 million tonnes in 2005-2006 and constitute only a small percentage of ash utilised;

Whereas the plans for generation of power envisages setting up of large coal based thermal power plants, which, together with existing plants expected to generate about 150 to 170 million tonnes of ash per year by the end of the 11th Five Year Plan, which need to be properly utilised in order to avoid unnecessary extraction of top soil and other materials for construction activities;

Whereas the Central Government is of the opinion that in view of the increased ash generation, there is a need to accelerate the pace of utilisation of fly ash, bottom ash and pond ash;

Now, therefore, in exercise of the powers conferred by Sub-section (1), read with clause (v) of Sub-section (2) of Section 3 and Section 5 of the Environment (Protection) Act, 1986 (29 of 1986), and in supersession of the Government of India in the Ministry of Environment and Forests number S.O. 763(E) dated the 14th September, 1999 published in the Gazette of India, Part II, Section 3, Sub-section (ii) dated 14th September, 1999, except as respects things done or omitted to be done before such supersession, the Central Government hereby issues the following directions which shall come into force on and from the date of publication of the final notification, namely:

1. **Use of fly ash in construction activities:**

(1) After twelve months from the date of publication of this notification, every person engaged in any activity involving building construction shall use buildings materials composed wholly or partly of fly ash (hereafter, the term "fly ash" will refer to fly ash, bottom ash, and pond ash), instead of the corresponding materials made wholly of constructional materials such as clay, top soil, limestone, sand and such other material, wherever the former, on competitive tendering for delivery at the construction site, costs the same or less than the latter, and has not been

found to be technically infeasible for the intended use.

Explanation 1: "Technically infeasible" is to be determined by one or more laboratories to be designated by the Director General, Council of Scientific and Industrial Research.

Explanation 2: "Building materials" in this context refers to bricks, tiles, cement, blocks and similar products or a combination or aggregate of these.

(2) It shall be the responsibility of all persons and/ or the agencies, either undertaking construction, or preparing, or approving the design to ensure compliance of the provisions of sub-paragraph (1).

(3) The authority for monitoring and enforcing the actual implementation of sub-paragraph (1) above in the construction shall be the concerned local body or development authorities or any other building plan approval or completion certification authority.

(4) All financial institutions, which fund construction activities, shall include a clause in their loan agreement requesting compliance with sub-paragraph (1) above.

(5) No person or agency engaged in road (including highways and fly overs) construction may use borrow material excavated from the "right of way" of the road for the construction of road embankments. All construction of road embankments will use fly ash, or municipal inerts, unless:

(a) the cost of the fly ash or municipal inerts delivered at the construction site is more than twenty-five per cent higher than the equivalent quantity of soil extracted from other than the "right of way" for embankment use, in which case such soil may be used for the road embankment; or

(b) a designated technical authority of the Indian Roads Congress certifies that the use of fly ash or municipal inerts at the location for the intended purpose is technically infeasible;

(c) For the top and side covers, soil, other than soil extracted from the "right of way" may be used, notwithstanding (a) above;

(6) No person or agency shall undertake reclamation and compaction of low-lying areas with soil. Only pond ash shall be used for reclamation or compaction. They shall also ensure that such reclamation and compaction is done in accordance with the byelaws, regulations and specifications laid down by the authorities mentioned in sub-paragraph (3) above.

2. **Responsibilities of Thermal Power Plants.**— Owners of Coal or lignite based thermal power plants (including captive and/ or cogeneration plants based on coal or lignite),

(a) may dispose of fly ash through competitive bids to the best advantage of the owners.

Explanation: In case, the bids are all negative, *i.e.* the bidders require payment to accept the fly ash for use in accordance with this notification, "best advantage" would mean least payment required bid by the bidders.

(b) shall not at any time store more than three months ash generation in their storage and/ or ash ponds. In case the quantity of fly ash already in storage and/or ash ponds on and from the date of this notification exceeds three months generation, the same shall be disposed of in accordance with sub-paragraph 1(1) above within a maximum period of five years from the date of issue of this notification.

(c) shall maintain a record of all sale and/or disposal of the fly ash.

(d) shall submit annual compliance report, including record of sale and/or disposal of the fly ash as stipulated in sub-paragraph (c) above by the thirtieth day of April every year to the concerned State Pollution Control Board or Committee.

3. **Specifications for use of ash-based products/ responsibility of other agencies:**

(1) Manufacture of all ash-based products shall be carried out in accordance with specifications and guidelines laid down by the Bureau of Indian Standards, Indian Bureau of Mines, Indian Road Congress, Central Building Research Institute, Roorkee, Central Road Research Institute, New Delhi, Building Materials and Technology Promotion Council, New Delhi, Central Public Works Department, State Public Works Departments and other Central and State Government agencies, as applicable.

(2) All Government agencies including the Central Public Works Department and State Government agencies concerned with construction activities shall make provisions for the use of fly ash based products or aggregates of them in the schedule of approved materials and rates.

(3) Central Electricity Authority while formulating norms for land requirement per Mega Watt of installed capacity of thermal power plants shall ensure that the area for ash storage be restricted to a maximum of three months ash generation.

(4) All agencies undertaking construction of roads or fly over bridges including Department of Road Transport and Highways, National Highways Authority of India (NHAI), Central Public Works Department (CPWD), State Public Works Departments and other State Government Agencies shall make appropriate provisions in their tender documents, schedules of approved materials and rates, as well as technical documents, including those relating to soil borrow area or pit as per sub-paragraph (5) of paragraph 1.

(5) All local bodies or development authorities shall specify in their respective building bye-laws and regulations the use of ash and ash-based products and construction techniques in building materials, roads, embankments or for any other use.

[F. No. 9-8/2005-HSMD]

R. ANANDAKUMAR, Adviser

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Annexure VI
Form 1 (Application Form for Obtaining EIA Clearance)

FORM 1

(I) Basic Information

Name of the Project:

Location / site alternatives under consideration:

Size of the Project: *

Expected cost of the project:

Contact Information:

Screening Category:

- *Capacity corresponding to sectoral activity (such as production capacity for manufacturing, mining lease area and production capacity for mineral production, area for mineral exploration, length for linear transport infrastructure, generation capacity for power generation etc.,)*

(II) Activity

1. **Construction, operation or decommissioning of the Project involving actions, which will cause physical changes in the locality (topography, land use, changes in water bodies, etc.)**

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
1.1	Permanent or temporary change in land use, land cover or topography including increase in intensity of land use (with respect to local land use plan)		
1.2	Clearance of existing land, vegetation and buildings?		
1.3	Creation of new land uses?		
1.4	Pre-construction investigations e.g. bore houses, soil testing?		
1.5	Construction works?		

1.6	Demolition works?		
1.7	Temporary sites used for construction works or housing of construction workers?		
1.8	Above ground buildings, structures or earthworks including linear structures, cut and fill or excavations		
1.9	Underground works including mining or tunneling?		
1.10	Reclamation works?		
1.11	Dredging?		
1.12	Offshore structures?		
1.13	Production and manufacturing processes?		
1.14	Facilities for storage of goods or materials?		
1.15	Facilities for treatment or disposal of solid waste or liquid effluents?		
1.16	Facilities for long term housing of operational workers?		
1.17	New road, rail or sea traffic during construction or operation?		
1.18	New road, rail, air waterborne or other transport infrastructure including new or altered routes and stations, ports, airports etc?		
1.19	Closure or diversion of existing transport routes or infrastructure leading to changes in traffic movements?		
1.20	New or diverted transmission lines or pipelines?		
1.21	Impoundment, damming, culverting, realignment or other changes to the hydrology of watercourses or aquifers?		
1.22	Stream crossings?		
1.23	Abstraction or transfers of water form ground or surface waters?		
1.24	Changes in water bodies or the land surface affecting drainage or run-off?		

1.25	Transport of personnel or materials for construction, operation or decommissioning?		
1.26	Long-term dismantling or decommissioning or restoration works?		
1.27	Ongoing activity during decommissioning which could have an impact on the environment?		
1.28	Influx of people to an area in either temporarily or permanently?		
1.29	Introduction of alien species?		
1.30	Loss of native species or genetic diversity?		
1.31	Any other actions?		

2. **Use of Natural resources for construction or operation of the Project (such as land, water, materials or energy, especially any resources which are non-renewable or in short supply):**

S.No.	Information/checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
2.1	Land especially undeveloped or agricultural land (ha)		
2.2	Water (expected source & competing users) unit: KLD		
2.3	Minerals (MT)		
2.4	Construction material – stone, aggregates, and / soil (expected source – MT)		
2.5	Forests and timber (source – MT)		
2.6	Energy including electricity and fuels (source, competing users) Unit: fuel (MT), energy (MW)		
2.7	Any other natural resources (use appropriate standard units)		

3. Use, storage, transport, handling or production of substances or materials, which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health.

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
3.1	Use of substances or materials, which are hazardous (as per MSIHC rules) to human health or the environment (flora, fauna, and water supplies)		
3.2	Changes in occurrence of disease or affect disease vectors (e.g. insect or water borne diseases)		
3.3	Affect the welfare of people e.g. by changing living conditions?		
3.4	Vulnerable groups of people who could be affected by the project e.g. hospital patients, children, the elderly etc.,		
3.5	Any other causes		

4. Production of solid wastes during construction or operation or decommissioning (MT/month)

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
4.1	Spoil, overburden or mine wastes		
4.2	Municipal waste (domestic and or commercial wastes)		
4.3	Hazardous wastes (as per Hazardous Waste Management Rules)		

4.4	Other industrial process wastes		
4.5	Surplus product		
4.6	Sewage sludge or other sludge from effluent treatment		
4.7	Construction or demolition wastes		
4.8	Redundant machinery or equipment		
4.9	Contaminated soils or other materials		
4.10	Agricultural wastes		
4.11	Other solid wastes		

5. Release of pollutants or any hazardous, toxic or noxious substances to air (Kg/hr)

S.No.	**Information/Checklist confirmation**	**Yes/No**	**Details thereof (with approximate quantities/rates, wherever possible) with source of information data**
5.1	Emissions from combustion of fossil fuels from stationary or mobile sources		
5.2	Emissions from production processes		
5.3	Emissions from materials handling including storage or transport		
5.4	Emissions from construction activities including plant and equipment		
5.5	Dust or odours from handling of materials including construction materials, sewage and waste		

5.6	Emissions from incineration of waste		
5.7	Emissions from burning of waste in open air (e.g. slash materials, construction debris)		
5.8	Emissions from any other sources		

6. Generation of Noise and Vibration, and Emissions of Light and Heat:

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data with source of information data
6.1	From operation of equipment e.g. engines, ventilation plant, crushers		
6.2	From industrial or similar processes		
6.3	From construction or demolition		
6.4	From blasting or piling		
6.5	From construction or operational traffic		
6.6	From lighting or cooling systems		
6.7	From any other sources		

7. Risks of contamination of land or water from releases of pollutants into the ground or into sewers, surface waters, groundwater, coastal waters or the sea:

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
7.1	From handling, storage, use or spillage of hazardous materials		
7.2	From discharge of sewage or other effluents to water or the land (expected mode and place of discharge)		
7.3	By deposition of pollutants emitted to air into the land or into water		
7.4	From any other sources		
7.5	Is there a risk of long term build up of pollutants in the environment from these sources?		

8. Risk of accidents during construction or operation of the Project, which could affect human health or the environment

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
8.1	From explosions, spillages, fires etc from storage, handling, use or production of hazardous substances		
8.2	From any other causes		
8.3	Could the project be affected by natural disasters causing environmental damage (e.g. floods, earthquakes, landslides, cloudburst etc)?		

9. Factors which should be considered (such as consequential development) which could lead to environmental effects or the potential for cumulative impacts with other existing or planned activities in the locality

S. No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
9.1	Lead to development of supporting. lities, ancillary development or development stimulated by the project which could have impact on the environment e.g.: • Supporting infrastructure (roads, power supply, waste or waste water treatment, etc.) • housing development • extractive industries • supply industries • other		
9.2	Lead to after-use of the site, which could havean impact on the environment		
9.3	Set a precedent for later developments		
9.4	Have cumulative effects due to proximity to other existing or planned projects with similar effects		

(III) Environmental Sensitivity

S.No.	Areas	Name/ Identity	Aerial distance (within 15 km.) Proposed project location boundary
1	Areas protected under international conventions, national or local legislation for their ecological, landscape, cultural or other related value		

2	Areas which are important or sensitive for ecological reasons - Wetlands, watercourses or other water bodies, coastal zone, biospheres, mountains, forests		
3	Areas used by protected, important or sensitive species of flora or fauna for breeding, nesting, foraging, resting, over wintering, migration		
4	Inland, coastal, marine or underground waters		
5	State, National boundaries		
6	Routes or facilities used by the public for access to recreation or other tourist, pilgrim areas		
7	Defence installations		
8	Densely populated or built-up area		
9	Areas occupied by sensitive man-made land uses *(hospitals, schools, places of worship, community facilities)*		
10	Areas containing important, high quality or scarce resources *(ground water resources, surface resources, forestry, agriculture, fisheries, tourism, minerals)*		
11	Areas already subjected to pollution or environmental damage. *(those where existing legal environmental standards are exceeded)*		
12	Areas susceptible to natural hazard which could cause the project to present environmental problems (*earthquakes, subsidence, landslides, erosion, flooding or extreme or adverse climatic conditions*)		

(IV). Proposed Terms of Reference for EIA studies

ANNEXURE VII
Pre-Feasibility Report

PRE-FEASIBILITY REPORT

Environmental Aspects

- Details of Ecologically-sensitive areas like tropical forests, biosphere reserves, national park, sanctuaries, important lakes, endangered species of flora & fauna and distance from site etc.
- Places of archaeological importance, river, streams, Estuary, sea, hills/mountains etc.
- Places of historical, cultural, religious or tourist importance, defence installation
- Location details

    - State/District/Village ,
    - Longitude & Latitude
    - Nearest town & distance, nearby industries (cement, power etc)
    - Approach to Site
    - Rail: Nearest Rail Head & Distance
    - Road: Existing Highway/roads distance from site
    - Distance from nearest airport (existing/proposed)
    - Distance from big cities.
    - Distance from nearest waterways
    - Constraints if any to approach site particularly for construction materials, plants and equipments etc. and indicate requirement of bridges etc.
- Land Availability

    - Extent of land available for Plant, Township, Ash Disposal etc.
    - Land use pattern (agricultural, barren, forest etc.
    - Incase of agricultural land, whether irrigated/non irrigated, number of crops
    - Land ownership (Govt. Pvt., tribal, non-tribal etc.)
    - Prevailing land cost details
    - Estimation of population affected, Homestead Oustees, Land Ownership Details

Project Details

- Topography of the area
- Ground profile and levels Permanent features
- Soil Condition Soil investigation results
- Site Data: Whether the site is flood prone & HFL of the site
- Existence of mines and present & future development activity/proposal
- Drainage patterns
- Water Information to be furnished by owner
- Source of Circulating/Consumptive water
- Location in relation to River/Canal/Dam, water availability and quality
- Lean season water availability and allocation source in case main source not perennial.
- Approved water allocation quota (Drinking, Irrigation and Industrial use) and surplus availability
- Inter-State Issue, if any
- Requirement of construction of Dam/barrage storage etc. if any and its location.
- Feasible ways of bringing water to site indicating constraints if any.
- Type of cooling system
- Fuel–Coal-Coal blocks proposed to be allocated for mining. Source of coal & distance: Availability(probable mines, parameters, production programme, cost details)

- Transportation arrangement contemplated: Fuel Transportation
- The feasibility of availability of corridor for the MGR system for pithead sites, approximate lengths equipment & cost details. If transportation contemplated through railway network then surplus carrying capacity available, future expansion proposal including programme.
- New facilities needed
- Proposed Ash Disposal/Utilization
- Requirement of land for ash pond.
- Source of construction water and potable water
- Source of construction power & start up power
- Source of availability of construction material like sand, brick, stone chips, borrow earth etc.
- Proximity to infrastructure facilities (Hospital, Schools, Residential accommodation)available nearby
- Location & vicinity plan identifying the areas proposed for power plant, colony & ash disposal

Techno-Economic Feasibility Aspects

- Land availability & its development
- General Layout
- Rehabilitation & Resettlement issue
- Access to site for Transportation of equipments/construction machinery, material etc
- Water availability for cooling & consumptive use
- Fuel availability and its transportation
- Environmental and forest aspects
- Power evacuation
- Ultimate plant capacity, which could be set up

Technical Profile of the Project

- Technical parameters of the plant & equipment.
- Meteorological data like temp., humidity, rainfall, wind pressure & wind direction.
- Seismological studies of project specific design seismic parameters.
- Project implementation:-Schedule showing various activities.
- Power evacuation and associated transmission system.

Justification of the Project

- Current Demand Scenario of the product
- Alternatives to meet the demand and
- Post Project scenario on Residual Demand

Power Project(s) Capacity

- How much electricity can be produced
- Sustainability of Fuel Supply and quality
- Optimization of Power Plant Capacity

Site Selection

- Options considered for sites

- Basis of site selection and analysis
- Infrastructure availability at selected site
- Power demand around the selected site
- Scope of Geo-technical studies

Future Prospects

- Ascertain the costs and benefits of the proposed project for project life
- De-rated capacities and efficiencies
- Technical and logistic constraints/ requirements of project sustainability

Project Design/Technology

- Analysis of all available technologies such as combined cycle, super critical plans,
- Analysis of various possible configurations for each technology or a combination of these technologies from available manufactures
- Document broad specifications for the proposed power plant(s) including but not limited to:
  - Plant Outputs and Heat Rates along with Heat Flow Diagrams for each alternative
  - Electrical equipment, I&C equipment, DCS equipment with redundancy
  - Balance of Plant equipment
  - General Plant Layout

Details of Socio-economic Consequences

- Importance of the proposed product for Quality-of-Life
- Corporate Responsibilities & Status of Compliance
- Employments and infrastructure added in the district of locations
- Status of land availability , current and post project land use variation
- R&R status compliance requirements and broad approach

Power Transmission Studies

- Power transmission studies including but not limited to preparation of power evacuation plan based on system study results in accordance national transmission system planning criteria

  - Grid Stations
  - Linking with the National Grid
  - Stability Analysis; including transient and static stability, system voltage
  - Load flow and power flow studies
  - Prepare technical specifications for transmission system

Cost Estimates

- Cost estimates (separating foreign exchange and local currencies)
- Rate Analysis
- Fuel Pricing
- Power Tariff
- Bill of quantities

- Annual operation and maintenance cost
- Physical and price contingencies
- List and cost of works necessary to implement sub-projects

Project Schedule

- Outline project implementation and procurement arrangement including contract packaging and a project implementation schedule.

Economic and Financial Analysis

- Economic analysis
- Financial analysis
- Identify all risks to project revenue & costs and conduct relevant sensitivity analysis
- Internal rate of return
- B/C ratio
- Prepare financing plan for the sub-projects, considering prospective co-financing and appropriate counterpart funds for local currency expenditures
- Identify the specific sources and projections of revenue from the project, to indicate financial liability of project

The above listing is not exhaustive. Thus the proponent may provide additional necessary information, felt appropriate, to include in the pre-feasibility study report in support of selecting the site for the proposed developmental activities. The Concerned EAC/SEAC during scrutiny, may specifically ask for any additional information/ data required to substantiate the requirement to prescribe the ToR for EIA studies. However, it is to make clear that all the required further information by EAC/SEAC shall be mentioned in one single letter, within the prescribed time.

ANNEXURE VIII
Types of Monitoring and Network Design Considerations

TYPES OF MONITORING AND NETWORK DESIGN CONSIDERATIONS

A. Types of Monitoring

Monitoring refers to the collection of data using a series of repetitive measurements of environmental parameters (or, more generally, to a process of systematic observation). The environmental quality monitoring programme design will be dependent upon the monitoring objectives specified for the selected area of interest. The main types of EIA monitoring activities are:

- Baseline monitoring is the measurement of environmental parameters during the pre-project period for the purpose of determining the range of variation of the system and establishing reference points against which changes can be measured. This leads to the assessment of the possible (additional available) assimilative capacity of the environmental components in pre-project period w.r.t. the standard or target level.
- Effects monitoring is the measurement of environmental parameters during project construction and implementation to detect changes which are attributable to the project to provide the necessary information to:
  - verify the accuracy of EIA predictions; and
  - determine the effectiveness of measures to mitigate adverse effects of projects on the environment.
  - Feedback from environmental effect monitoring programs may be used to improve the predictive capability of EIAs and also determine whether more or less stringent mitigation measures are needed
- Compliance monitoring is the periodic sampling or continuous measurement of environmental parameters to ensure that regulatory requirements and standards are being met.

Compliance and effects monitoring occurs during the project construction, operation, and abandonment stages. The resources and institutional set-up should be available for the monitoring at these stages. To control the environmental hazards of construction as specified in the EIA, a monitoring program shall be established to ensure that each mitigation measure is effectively implemented. There are numerous potential areas for monitoring during operations.

The scope of monitoring topics discussed in this chapter is limited to Baseline and Effects monitoring. In addition, this chapter will also discuss the Compliance monitoring during the construction phase. Post-project monitoring requirements are discussed in the EMP

Before any field monitoring tasks are undertaken there are many institutional, scientific, and fiscal issues that must be addressed in the implementation of an environmental monitoring program. Careful consideration of these issues in the design and planning stages will help avoid many of the pitfalls associated with environmental monitoring programs. Although these issues are important but the discussions here are confined to the monitoring network design component.

B. Network Design

Analysis of Significant Environmental Issues

At the outset of planning for an environmental monitoring network, the EIA manager may not know exactly what should be monitored, when monitoring should begin, where it should monitor, which techniques should be employed, and who should take responsibility for its conduct. Because there are usually a number of objective decisions associated with network design to be made. It is important to start with an analysis of environmental issues. The scoping phase of EIA is designed to identify and focus the major issues. Scoping should provide a valuable source of information on the concerns that need to be addressed by the monitoring network design. These are project specific as well as specific to the environmental setting of the location where the project is proposed to be located.

Hence, the network designs are associated with questions like:

- What are the expected outputs of the monitoring activity?
- Which problems do we need to address to? *etc*.

Defining the output will influence the design of the network and optimize the resources used for monitoring. It will also ensure that the network is specially designed to optimize the information on the problems at hand.

What to Monitor?

The question of what to monitor is associated with the identification of VEC

VECs are the qualitative or quantitative environmental values the country desire to protect and preserve in our environment. The environmental values are what we ultimately are trying to protect, or are striving for, with respect to the environment. Examples of environmental values are contaminant-free fish, or sustainable fisheries in our endeavor of Ecology, *etc.*.

The choice of VECs is related to the perceived significant impact on the project implementation on important environmental components. In general, the significance or importance of environmental components is judged based on:

- legal protection provided (Ex: rare and endangered species);
- political or public concerns (Ex: resource use conflicts and sustainable development);
- scientific judgment (Ex: ecological importance); or
- commercial or economic importance.

However, in addition to their economic, social, political or ecological significance, the chosen VEC should also have unambiguous operational ease, be accessible to prediction and measurement; and be susceptible to hazard. Once the VECs are defined, the VECs may be directly measured (for example, extent of habitat for an endangered species). In cases where it is impossible or impractical to directly measure the VECs, the chosen measurement endpoints or environmental indicators must correspond to, or be predictive of assessment endpoints.

The chosen environmental indicators must be: 1) measurable; 2) appropriate to the scale of disturbance/ contamination; 3) appropriate to the impact mechanism; 4) appropriate and proportional to temporal dynamics; 5) diagnostic; and 6) standardized; as well as have: 1) a low natural variability; 2) a broad applicability; and 3) an existing data series.

Where, How and How Many Times to Monitor?

These are the other components of monitoring network design. These questions are best answered based on local field conditions, capacity and resources available, prevailing legal and regulatory priorities *etc*. For this screening or reconnaissance surveys of the study area are also necessary. This may also include some simple inexpensive measurements and assimilative/ dispersion modeling. The data will give some information on the prevailing special and temporal variations, and the general background air pollution in the area. The number of monitoring stations and the indicators to be measured at each station in the final permanent network may then be decided upon as based on the results of the screening study as well as on the knowledge of the sources of the proposed development and prevailing local environmental/meteorological conditions. The best possible definition of the air pollution problem, together with the analysis of the resources: personnel, budget and equipment available, represent the basis for the decision on the following questions:

- What spatial density (number) of sampling stations is required? How many samples are needed and during what period (sampling (averaging) time and frequency)?
- Where should the stations be located?
- What kind of equipment should be used?
- What additional background information is needed?
  - meteorology
  - topography
  - population density
  - emission sources and emission rates
  - effects and impacts
- How will the data be made available/communicated?

C. Site Selection

When considering the location of individual samplers, it is essential that the data collected are representative for the location and type of area without the undue influence from the immediate surroundings. In any measurement point in the study area the total ambient concentration is the representative of:

- natural background concentration,
- regional background,
- impact of existing large regional sources such as Industrial emissions and other power plants.

To obtain the information about the importance of these different contributions it is therefore necessary to locate monitoring stations so that they are representative for different impacts. In addition to the ambient pollution data, one would often need other data governing the variations such as meteorological data for air pollution, to identify and quantify the sources contributing to the measurements.

ANNEXURE IX
Guidance for Assessment of Baseline Components and Attributes

GUIDANCE FOR ASSESSMENT OF BASELINE COMPONENTS AND ATTRIBUTES*

Attributes	Sampling		Measurement Method	Remarks	Applications to Thermal Power Plants
	Network	Frequency			
A. Air					
▪ Meteorological ▪ Wind speed ▪ Wind direction ▪ Dry bulb temperature ▪ Wet bulb temperature ▪ Relative humidity ▪ Rainfall ▪ Solar radiation ▪ Cloud cover	Minimum 1 site in the project impact area requirements Other additional site(s) are require depending upon the model applied or site sensitivities	Min: 1 hrly observations from continuous records	Mechanical / automatic weather station Rain gauge As per IMD As per IMD	IS 5182 Part 1-20 Sit-specific primary data is essential Secondary data from IMD, New Delhi for the nearest IMD station	Meteorological observations are guided by the site sensitivities and/or model used. For example ISCST model one location is acceptable whereas for AIRMOD vertical temperature profile (two height observations) is also required.
Pollutants ▪ SPM ▪ RPM ▪ SO_2 ▪ NO_2 ▪ CO ▪ H_2S* ▪ $NH*_3$ ▪ HC* ▪ Fluoride* ▪ Pb*	10 to 15 locations in the project impact area	24 hrly twice a week 8 hrly twice a week 24 hrly twice a week	▪ Gravimetric (High – Volume) ▪ Gravimetric (High – Volume with Cyclone) ▪ EPA Modified West & Gaeke method ▪ Arsenite Modified Jacob & Hochheiser ▪ NDIR technique ▪ Methylene-blue	**Monitoring Network** ▪ Minimum 2 locations in upwind side, more sites in downwind side / impact zone ▪ All the sensitive receptors	Parameters & frequency are defined in ToR for EIA studies based on raw material (type of fuel) & process technology, location-nature/activities within of air basin. For example TPP located on a pit-head or power

Attributes	Sampling		Measurement Method	Remarks	Applications to Thermal Power Plants
	Network	Frequency			
▪ VOC-PAH* ▪ Mercury* (parametres are given in ToR for EIA studies based on nature of project, raw material & process technology, location-nature/activities within of air)			▪ Nessler's Method ▪ Infra Red analyzer ▪ Specific lon meter	need to be covered **Measurement Methods** As per CPCB standards for NAQM, 1994	generation in the impact zone is high (more than 10000MWs) then mercury, VOC, O_3 should be included
B. Noise					
Hourly equivalent noise levels	Same as for Air Pollution along with others Identified in study area	At lest one day continuous in each season on a working and non-working day	Instrument : Sensitive Noise level meter (preferably recording type)	Min: IS: 4954-1968 as adopted by CPCB	For TPP projects DG sets, turbines, pumps, crushers, coal & material handing process are important sources of noise
Hourly equivalent noise levels	Inplant (1.5 m from machinery or high emission processes)	Same as above for day and night	Instrument : Noise level metre	CPCB / OSHA	
Hourly equivalent noise levels	Highways (within 500 metres from the road edge)	Same as above for day and night	Instrument : Noise level meter	CPCB / IS : 4954-1968	
Peak particle velocity	150- 200m from blast site	Based on hourly observations	PPV meter		Very important source during construction phase of certain project locations

Attributes	Sampling		Measurement Method	Remarks	Applications to Thermal Power Plants
	Network	Frequency			
C. Water					
Parameters for water quality ▪ Ph, temp, turbidity, magnesium hardness, total alkalinity, chloride, sulphate, nitrate, fluoride, sodium, potassium salinity ▪ Total nitrogen, total phosphorus, DO, BOD, COD, Phenol ▪ Heavy metals ▪ Total coliforms, faecal coliforms ▪ Phyto plankton ▪ Zooplankton ▪ Fish & other aquatic flora & fauna (parameters are given in ToR for EIA studies based on nature of project, raw material & process technology, location-nature/activities within of air basin)	Set of grab samples during pre and post-monsoon for ground and surface water for the whole study zone. For lab. Analysis the samples should be preserved for transport safe	Diurnal and season-wise	Samples for water quality should be collected and analyzed as per: IS: 2488 (Part 1-5) methods for sampling and testing of industrial effluents Standard methods for examination of water and waste water analysis published by American Public Health Association. International standard practices for benthos and aquatic flora & fauna		Parameters are defined in ToR for EIA studies based on power generation technology and location-nature/activities within the study area and nature of waste water receiving body-river, lake, coast discharges etc. For example TPP located in coast zone (waste water discharged through ocean out-falls), the coastal water quality and health of costal flora and fauna all along coast line with extended impacted zone need to be monitored. Besides the requirements of Water Quality

Attributes	Sampling		Measurement Method	Remarks	Applications to Thermal Power Plants
	Network	Frequency			
					Model should also be addressed
For Surface Water Bodies					
▪ Total Carbon ▪ PH ▪ Dissolved Oxygen ▪ Biological Oxygen ▪ Demand ▪ Free NH_4 ▪ Boron ▪ Sodium Absorption ratio ▪ Electrical Conductivity	Monitoring locations should include up-stream, on site, down stream of proposed discharge point. Besides sampling should cover width of the river in case water quality modeling is proposed. Standard methodology for collection of surface water (BIS standards) At least one grab sample per location per season	Yield & impact on water sources to be measured during critical season River Stretch within project area be divided in grids (say 1 km length and 1/3 width) and samples should be from each grid at a time when the wastewater discharged by other sources of pollution is expected to be maximum	Samples for water quality should be collected and analyzed as per: IS: 2488 (Part 1-5) methods for sampling and testing of industrial effluents Standard methods for examination of water and wastewater analysis published by American Public Health Association.	Historical data should be collected from relevant offices such as central water commission, state and central ground water board, Irrigation dept.	For two surface water (rivers and lakes)bodies besides water quality parameters as mentioned above, the location specific network design will also be guided by the model used. For rivers and lakes QUEL2E should suffice which require relatively less information even for two dimensional model applications.
Parameters for wastewater characterization					
▪ Temp, colour, odour, turbidity, TSS, TDS	Implant Source depending upon	Different operational cycles as well as raw	Samples for water quality should be	All plant sources categorized as:	Although waste water

Attributes	Sampling		Measurement Method	Remarks	Applications to Thermal Power Plants
	Network	Frequency			
▪ PH , alkalinity as CaCO3, p value, M value, tatal hardness as CaCO3, chloride as cl, sulphate as S04, Nitrate as NO3, Floride as F, Phosphate as P04, Chromium as Cr (Hexavalent, total) Ammonical Nitrogen as N, TKN, % sodium, BOD at 20 C, COD, DO, total residual chlorine as Cl2, oil and grease, sulphide, phenolic compound	the different waste streams the parameters can be optimized Grab and composite sampling representing avg of different process operations as well as worst emission scenario should be represented	material variations should be reflected in the analysis	collected and analyzed as per: IS: 2488 (Part 1-5) methods for sampling and testing of industrial effluents Standard methods for examination of water and wastewater analysis published by American Public Health Association.	▪ Different Process waste streams as well as run-off conditions ▪ ETP wastewater ▪ Domestic/ sanitary wastewater	characteristics of TPP emissions are not very critical but still high temperature emissions from cooling tower may impact the aquatic biota (particularly in coastal area and lacks. For impact assessment the required water quality modeling should be performed
D. Land Environment					
▪ Soil ▪ Particle size distribution ▪ Texture ▪ pH ▪ Electrical conductivity ▪ Caution exchange capacity ▪ Alkali metals ▪ Sodium Absorption Ratio (SAR) ▪ Permeability ▪ Porosity	One surface sample from each landfill and/or hazardous waste site (if applicable) and prime villages, (soil samples be collected as per BIS specifications) in the study area	Season-wise	Collected and analyzed as per soil analysis reference book, M.I.Jackson and soil analysis reference book by C.A. Black	The purpose of impact assessment on soil (land environment) is to assess the significant impacts due to leaching of wastes or accidental releases and contaminating	In the case of TPP the impact sites of leaching from ass-pond, coal dumps or accidental spillage of hazardous wastes/oils are important

Attributes	Sampling		Measurement Method	Remarks	Applications to Thermal Power Plants
	Network	Frequency			
Landuse / Landscape					
▪ Location code ▪ Total project area ▪ Topography ▪ Drainage (natural) ▪ Cultivated, forest plantations, water bodies, roads and settlements	At least 20 points along with plant boundary and general major land use categories in the study area. `	Drainage once in the study period and land use categories from secondary data (local maps) and satellite imageries	▪ Global positioning system ▪ Topo-sheets ▪ Satellite Imageries ▪ (1:25,000) ▪ Satellite Imageries ▪ (1:25,000)	Drainage within the plant area and surrounding is very important for storm water impacts. From land use maps sensitive receptors (forests, parks, mangroves etc.) can be identified	General remarks are also pertinent for power plants
Solid Waste					
Quantity: ▪ Based on waste generated from per unit production ▪ Per capita contribution ▪ Collection, transport and disposal system ▪ Process Waste ▪ Quality (oily, chemical, biological)	For green field unites it is based on secondary data base of earlier plants.	Process wise or activity wise for respective raw material used. Domestic waste depends upon the season also	Guidelines IS 9569 : 1980 IS 10447 : 1983 IS 12625 : 1989 IS 12647 : 1989 IS 12662 (PTI) 1989		
Quality: ▪ General segregation into biological/organic/inert/hazar	Grab and Composite samples	Process wise or activity wise for respective raw material used. Domestic waste depends upon the	Analysis IS 9334 : 1979 IS 9235 : 1979		

Attributes	Sampling		Measurement Method	Remarks	Applications to Thermal Power Plants
	Network	Frequency			
dous ▪ Loss on heating ▪ pH ▪ Electrical Conductivity ▪ Calorific value, metals etc.		season also	IS 10158 : 1982		
Hazardous Waste					
▪ Permeability And porosity ▪ Moisture pH ▪ Electrical conductivity ▪ Loss on ignition ▪ Phosphorous ▪ Total nitrogen ▪ Caution exchange capacity ▪ Particle size distribution ▪ Heavy metal ▪ Ansonia ▪ Fluoride	Grab and Composite samples. Recyclable components have to analyzed for the recycling requirements	Process wise or activity wise for respective raw material used.	Analysis IS 9334 : 1979 IS 9235 : 1979 IS 10158 : 1982	Impacts of hazardous waste should be performed critically depending on the waste characteristics and place of discharge. For land disposal the guidelines should be followed and impacts of accidental releases should be assessed	Although Power plants do not involve very critical hazardous waste problem but still chlorine storage, oil leakages are important considerations
E. Biological Environment Aquatic					
▪ Primary productivity ▪ Aquatic weeds ▪ Enumeration of ▪ phytoplankton, zooplankton	Considering probable impact, sampling points and number of	Season changes are very important	Standards techniques (APHA et. Al. 1995, Rau and Wooten 1980) to be followed	Seasonal sampling for aquatic biota	Impacts of Power Plant emissions depends on the fuel use/technology and

Attributes	Sampling		Measurement Method	Remarks	Applications to Thermal Power Plants
	Network	Frequency			
and benthos ▪ Fisheries ▪ Diversity indices ▪ Trophic levels ▪ Rare and endangered species ▪ Sanctuaries / closed areas / Coastal regulation zone (CRZ) ▪ Terrestrial ▪ Vegetation – species, list, economic importance, forest produce, medicinal value ▪ Importance value index (IVI) of trees ▪ Wild animals	samples to be decided on established guidelines on ecological studies based on site eco-environment setting within 10/25 km radius from the proposed site Samples to collect from upstream and downstream of discharge point, nearby tributaries at down stream, and also from dug wells close to activity site		for sampling and measurement	One season for terrestrial biota, in addition to vegetation studies during monsoon season Preliminary assessment Microscopic analysis of plankton and meiobenthos, studies of macrofauna, aquatic vegetation and application of indices, viz. Shannon, similarity, dominance IVI etc Point quarter plot-less method (random sampling) for terrestrial vegetation survey.	local ecology within the study area. Location is vital for example for costal location impacts of emissions of PM, SO2, NOx on costal ecology should be studied. For large Coal based plant (or plant located on pit head/ within large generation complex) impact of Hg emissions on aquatic and terrestrial flora are vital

Attributes	Sampling		Measurement Method	Remarks	Applications to Thermal Power Plants
	Network	Frequency			
Avifauna ▪ Rare and endangered species ▪ Sanctuaries / National park / Biosphere reserve	For forest studies, chronic as well as short-term impacts should be analyzed warranting data on micro climate conditions			Secondary data to collect from Government offices, NGOs, published literature Plankton net Sediment dredge Depth sampler Microscope Field binocular	
F. Socio Economic					
▪ Demographic structure ▪ Infrastructure resource base ▪ Economic resource base ▪ Health status: Morbidity pattern ▪ Cultural and aesthetic attributes	Socio-economic survey is based on proportionate, stratified and random sampling method	Different impacts occurs during construction and operational phases of the project	Primary data collection through R&R surveys (if require) or community survey are based on personal interviews and questionnaire	Secondary data from census records, statistical hard books, toposheets, health records and relevant official records available with Govt. agencies	

* Project Specific

ANNEXURE X
Sources of Secondary Data Collection

Annexure XA: Potential Sources of Data For EIA

	Information	Source
	Air Environment	
1.	Meteorology- Temperature, Rainfall, Humidity, Inversion, Seasonal Wind rose pattern (16 point compass scale), cloud cover, wind speed, wind direction, stability, mixing depth	⑨ Indian Meteorology Department, Pune
2.	Ambient Air Quality- 24 hourly concentration of SPM, RPM, SO_2, NO_x, CO	⑨ Central Pollution Control Board (CPCB), ⑨ State Pollution Control Board (SPCB), ⑨ Municipal Corporations ⑨ Ministry of Environment and Forests (MoEF) ⑨ State Department of Environment (DoEN)
	Water Environment	
3.	Surface water- water sources, water flow (lean season), water quality, water usage, Downstream water users Command area development plan Catchment treatment plan	⑨ Central Water Commission (CWC), ⑨ Central Pollution Control Board (CPCB), ⑨ State Pollution Control Board (SPCB), Central Water and Power Research Institute (CWPRS), Pune ⑨ State Irrigation Department ⑨ Hydel Power generation organizations such as NHPC, State SEBs
4.	Ground Water- groundwater recharge rate/withdrawal rate, ground water potential groundwater levels (pre monsoon, post monsoon), ground water quality, changes observed in quality and quantity of ground water in last 15 years	⑨ Central Ground Water Board (CGWB) ⑨ Central Ground Water Authority (CGWA) ⑨ State Ground Water Board (SGWB) ⑨ National Water Development Authority (NWDA)
5.	Coastal waters- water quality, tide and current data, bathymetry	⑨ Department of Ocean Development, New Delhi ⑨ State Maritime Boards ⑨ Naval Hydrographer's Office, Dehradun ⑨ Port Authorities ⑨ National Institute of Oceanography (NIO), Goa
	Biological Environment	
6.	Description of Biological Environment- inventory of flora and fauna in 7 km radius, endemic species, endangered species, Aquatic Fauna, Forest land, forest type and density of vegetation, biosphere, national parks, wild life sanctuaries, tiger reserve, elephant reserve, turtle nesting ground, core zone of biosphere reserve, habitat of migratory birds, routes of migratory birds	⑨ District Gazetteers ⑨ National Remote Sensing Agency (NRSA), Hyderabad ⑨ Forest Survey of India, Dehradun ⑨ Wildlife Institute of India ⑨ World Wildlife Fund ⑨ Zoological Survey of India ⑨ Botanical Survey of India ⑨ Bombay Natural History Society, (BNHS), Mumbai ⑨ State Forest Departments ⑨ State Fisheries Department ⑨ Ministry of Environment and Forests ⑨ State Agriculture Departments ⑨ State Agriculture Universities
	Land Environment	
7.	Geographical Information-Latitude, Longitude, Elevation (above MSL)	⑨ Toposheets of Survey of India, Pune ⑨ National Remote Sensing Agency (NRSA), Hyderabad ⑨ Space Application Centre (SAC), Ahmedabad

	Information	Source
8.	Nature of Terrain, topography map indicating contours (1:2500 scale)	⑨ Survey of India Toposheets ⑨ National Remote Sensing Agency (NRSA), Hyderabad ⑨ State Remote Sensing Centre, ⑨ Space Application Centre (SAC), Ahmedabad
9.	Hydrogeology- Hydrogeological report (in case of ground water is used/area is drought prone/wastewater is likely to discharged on land) Geomorphological analysis (topography and drainage pattern) Geological analysis (Geological Formations/Disturbances- geological and structural maps, geomorphological contour maps, structural features, including lineaments, fractures, faults and joints) Hydrogeological analysis (disposition of permeable formations, surface-ground water links, hydraulic parameter determination etc) Analysis of the natural soil and water to assess pollutant absorption capacity	⑨ NRSA, Hyderbad ⑨ Survey of India Toposheets ⑨ Geological Survey of India ⑨ State Geology Departments ⑨ State Irrigation Department ⑨ Department of Wasteland Development, Ministry of Rural Areas ⑨ National Water Development Authority (NWDA)
10.	Nature of Soil, permeability, erodibility classification of the land	⑨ Agriculture Universities ⑨ State Agriculture Department ⑨ Indian Council for Agriculture Research ⑨ State Soil Conservation Departments ⑨ National Bureau of Soil Survey and Landuse Planning ⑨ Central Arid Zone Research Institute (CAZRI), Jodhpur
11.	Landuse in the project area and 10 km radius of the periphery of the project	⑨ Survey of India- Toposheets ⑨ All India Soil and Landuse Survey; Delhi ⑨ National Remote Sensing Agency (NRSA), Hyderabad ⑨ Town and County Planning Organisation ⑨ State Urban Planning Department ⑨ Regional Planning Authorities (existing and proposed plans) ⑨ Village Revenue Map- District Collectorate ⑨ Directorate of Economics and Statistics-State Government ⑨ Space Application Centre, Ahmedabad
12.	Coastal Regulation Zones- CRZMP, CRZ classification, Demarcation of HTL and LTL*	⑨ Urban Development Department ⑨ State Department of Environment ⑨ State Pollution Control Board ⑨ Space Application Centre* ⑨ Centre for Earth Sciences Studies, Thiruvanthapuram* ⑨ Institute of Remote Sensing, Anna University Chennai* ⑨ Naval Hydrographer's Office, Dehradun* ⑨ National Institute of Oceanography, Goa* ⑨ National Institute of Ocean Technology, Chennai ⑨ Centre for Earth Science Studies

* *Agencies authorized for approval of demarcation of HTL and LTL*

	Information	Source
	Social	
13.	Socioeconomic - population, number of houses and present occupation pattern within 7 km from the periphery of the project	⑨ Census Department ⑨ District Gazetteers- State Government ⑨ District Statistics- District Collectorate ⑨ International Institute of Population Sciences, Mumbai (limited data) ⑨ Central Statistical Organisation
14.	Monuments and heritage sites	District Gazetteer Archeological Survey of India, INTACH District Collectorate Central and State Tourism Department State Tribal and Social Welfare Department
	Natural Disasters	
15.	Seismic data (Mining Projects)- zone no, no of earthquakes and scale, impacts on life, property existing mines	⑨ Indian Meteorology Department, Pune ⑨ Geological Survey of India
16.	Landslide prone zone, geomorphological conditions, degree of susceptibility to mass movement, major landslide history (frequency of occurrence/decade), area affected, population affected	⑨ Space Application Centre
17.	Flood/cyclone/droughts- frequency of occurrence per decade, area affected, population affected	⑨ Natural Disaster Management Division in Department of Agriculture and Cooperation ⑨ Indian Meteorological Department
	Industrial	
18.	Industrial Estates/Clusters, Growth Centres	⑨ State Industrial Corporation ⑨ Industrial Associations ⑨ State Pollution Control Boards ⑨ Confederation Indian Industries (CII) ⑨ FICCI
19.	Physical and Chemical properties of raw material and chemicals (Industrial projects); fuel quality	⑨ Material and Safety Data Sheets ⑨ ENVIS database of Industrial Toxicological Research Centre, Lucknow ⑨ Indian Institute Petroleum
20.	Occupational Health and Industrial Hygiene- major occupational health and safety hazards, health and safety requirements, accident histories	⑨ Central Labour Institute, Mumbai ⑨ Directorate of Industrial Safety ⑨ ENVIS Database of Industrial Toxicological Research Centre, Lucknow ⑨ National Institute of Occupational Health, Ahmedabad
21.	Pollutant release inventories (Existing pollution sources in area within 10 km radius)	⑨ Project proponents which have received EC and have commenced operations
22.	Water requirement (process, cooling water, DM water, Dust suppression, drinking, green belt, fire service)	⑨ EIA Reports ⑨ National and International Benchmarks

Annexure XB: Summary of Available Data with Potential Data Sources for EIA

	Agency	Information Available
1.	Archaeological Survey of India Department of Culture Government of India Janpath, New Delhi - 110011 Asi@del3.vsnl.net.in	⑨ Inventory of monuments and sites of national importance- Listing and documentation of monuments according to world heritage, pre historic, proto historic and secular, religious places and forts
2.	Botanical Survey Of India P-8, Brabourne Road Calcutta 700001 Tel#033 2424922 Fax#033 2429330 Email: envis@cal2.vsnl.net.in. . RO - Coimbatore, Pune, Jodhpur, Dehradun, Allahabad, Gantok, Itanagar, Port Blair	⑨ Photodiversity documentation of flora at National, State and District level and flora of protected areas, hotspots, fragile ecosystems, sacred groves etc ⑨ Identification of threatened species including endemics, their mapping, population studies ⑨ Database related to medicinal plants, rare and threatened plant species ⑨ Red data book of Indian plants (Vol 1,2, and 3) ⑨ Manual for roadside and avenue plantation in India
3.	Bureau of Indian Standards Manak Bhawan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002 Tel#3230131, 3233375, 3239402 (10 lines) Fax : 91 11 3234062, 3239399, 3239382 Email- bis@vsnal.com	⑨ Bureau of Indian Standards Committees on Earthquake Engineering and Wind Engineering have a Seismic Zoning Map and the Wind Velocity Map including cyclonic winds for the country
4.	Central Water Commission (CWC) Sewa Bhawan, R.K.Puram New Delhi - 110066 cmanoff@niccwc.delhi.nic.in RO- Bangalore, Bhopal, Bhubaneshwar, Chandigarh, Coimbatore/Chennai, Delhi, Hyderabad, Lucknow, Nagpur, Patna, Shillong, Siliguri and Vadodara	⑨ Central Data Bank -Collection, collation and Publishing of Hydrological, Hydrometeorological, Sediment and Water Quality data-. ⑨ Basin wise Master Plans ⑨ Flood atlas for India ⑨ Flood Management and Development and Operation of Flood Forecasting System- CWC operate a network of forecasting stations Over 6000 forecasts are issued every year with about 95% of the forecasts within the permissible limit. ⑨ Water Year Books, Sediment Year Books and Water Quality Year Books. ⑨ Also actively involved in monitoring of 84 identified projects through National, State and Project level Environmental Committees for ensuring implementation of environmental safeguards
5.	Central Ground Water Board (HO) N.H.IV, New CGO Complex, Faridabad - 121001 RO - Guwahati, Chandigarh, Ahemadabad, Trivandrum, Calcutta, Bhopal, Lucknow, Banglore, Nagpur, Jammu, Bhubneshwar, Raipur, Jaipur, Chennai, Hyderabad, Patna	⑨ surveys, exploration, monitoring of ground water development

[16] *Based on web search and literature review*

6.	Central Pollution Control Board Parivesh Bhawan, CBD-cum-Office Complex East Arjun Nagar, DELHI - 110 032 INDIA E-mail : cpcb@alpha.nic.in	⑨ National Air Quality Monitoring Programme ⑨ National River Water Quality Monitoring Programme- Global Environment Monitoring , MINARS ⑨ Zoning Atlas Programme ⑨ Information on 17 polluting category industries (inventory, category wise distribution, compliance, implementation of pollution control programmes
7.	Central Arid Zone Research Institute, Jodhpur Email : cazri@x400.nicgw.nic.in Regional Centre at Bhuj in Gujarat	⑨ AGRIS database on all aspects of agriculture from 1975 to date ⑨ Also have cell on Agriculture Research Information System; ⑨ Working on ENVIS project on desertification ⑨ Repository of information on the state of natural resources and desertification processes and their control ⑨ The spectrum of activities involves researches on basic resource inventories; monitoring of desertification, rehabilitation and management of degraded lands and other areas
8.	Central Inland Capture Fisheries Research Institute, Barrackpore-743101, Tel#033-5600177 Fax#033-5600388 Email : cicfri@x400.nicgw.nic.in	⑨ Data Base on Ecology and fisheries of major river systems of India. Biological features of commercially important riverine and estuarine fish species. Production functions and their interactions in floodplain wetlands. ⑨ Activities - Environmental Impact Assessment for Resource Management ; Fisheries Resource surveys
9.	Central Institute of Brackish Water Aquaculture 141, Marshalls Road, Egmore , Chennai - 600 008, Tel# 044-8554866, 8554891, Director (Per) 8554851 Fax#8554851,	⑨ Repository of information on brackish water fishery resources with systematic database of coastal fishery resources for ARIS ⑨ Agricultural Research Information System (ARIS) database covers State wise data on soil and water quality parameters, land use pattern, production and productivity trends, ⑨ Social, economic and environmental impacts of aquaculture farming, ⑨ Guidelines and effluent standards for aquaculture farming
10.	Central Marine Fisheries Research Institute (CMFRI), Cochin	⑨ Assessing and monitoring of exploited and un-exploited fish stocks in Indian EEZ ⑨ Monitoring the health of the coastal ecosystems, particularly the endangered ecosystems in relation to artisanal fishing, mechanised fishing and marine pollution ⑨ The institute has been collecting data on the catch and effort and biological characteristics for nearly half a century based on scientifically developed sampling scheme, covering all the maritime States of the country ⑨ The voluminous data available with the institute is managed by the National Marine Living Resources Data Centre (NMLRDC)
11.	Central Water and Power Research Station, Pune Tel#020-4391801-14; 4392511; 4392825 Fax #020-4392004,4390189	⑨ Numerical and Physical models for hydro-dynamic simulations
12.	Central Institute of Road Transport, Bhosari, Pune 411 026, India. Tel : +91 (20) 7125177, 7125292, 7125493, 7125494	⑨ Repository of data on all aspects of performance of STUs and a host of other related road transport parameters

13.	Department of Ocean Development	⑨ Assessment of environment parameters and marine living resources (primary and secondary) in Indian EEZ (Nodal Agency NIO Kochi) ⑨ Stock assessment, biology and resource mapping of deep sea shrimps, lobsters and fishes in Indian EEZ (Nodal agency-Fisheries Survey of India) ⑨ Investigations of toxical algal blooms and benthic productivity in Indian EEZ (Nodal agency- Cochin University of Science and technology) ⑨ Coastal Ocean Monitoring and Prediction System (COMAP) - monitoring and modelling of marine pollution along entire Indian coast and islands. Parameters monitored are temp, salinity, DO, pH, SS, BOD, inorganic phosphate, nitrate, nitrite, ammonia, total phosphorus, total nitrite, total organic carbon, petroleum hydrocarbons, pathogenic vibros, pathogenic E.coli, shigella, salmonella, heavy metals (Cd, Hg, Pb) and pesticide residues (DDT, BHC, Endosulfan). Monitoring is carried out along the ecologically sensitive zones and urban areas (NIO Mumbai- Apex coordinating agency). ⑨ Sea Level Measurement Programe (SELMAM)- sea level measurement at selected stations (Porbandar, Bombay, Goa, Cochin, Tuticorin, Madras, Machilipatnam, Visakhapatnam, Paradeep, Calcutta and Kavaratti (Lakshadweep Island)) along Indian coast and islands using modern tide gauges ⑨ Detailed coastal maps through Survey of India showing contour at 1/2 a metre interval in the scale of 1:25000. (Nellore- Machhalipatnam work already over) ⑨ Marine Data Centre (MDC) IMD for Ocean surface meteorology, GSI for marine geology, SOI for tide levels, Naval Hydrographic Office for bathymetry, NIO Goa for physical chemical and biological oceanography, NIO Mumbai for marine pollution, CMFRI for coastal fisheries, Institute of Ocean Management Madras for coastal geomorphology ⑨ DOD has setup Indian National Centre for Ocean Information Services (INCOIS) at Hyderabad for generation and dissemination of ocean data products (near real time data products such as sea surface temperature, potential fishing zones, upwelling zones, maps, eddies, chlorophyll, suspended sediment load etc). MDC will be integrated with INCOIS ⑨ Integrated Coastal and Marine Area Management (ICMAM) programme - GIS based information system for management of 11 critical habitats namely Pichavaram, Karwar, Gulf of Mannar, Gulf of Khambat, Gulf of Kutch, Malvan, Cochin, Coringa mangroves, Gahirmata, Sunderbans and Kadamat (Lakshadeep) ⑨ Wetland maps for Tamil Nadu and Kerala showing the locations of lagoons, backwaters, estuaries, mudflats etc (1:50000 scale) ⑨ Coral Reef Maps for Gulf of Kachch, Gulf of Mannar, Andaman and Nicobar and Lakshadeep Islands (1:50,000 scale) indicating the condition of corals, density etc
14.	Environment Protection Training and Research Institute Gachibowli, Hyderabad - 500 019, India Phone: +91-40-3001241, 3001242, 3000489 Fax: +91-40- 3000361 E-mail: info@eptri.com	⑨ Environment Information Centre- has appointed EPTRI as the Distributed Information Centre for the Eastern Ghats region of India. EIC Collaborates with the Stockholm Environment Institute Sweden Database on Economics of Industrial Pollution Prevention in India Database of Large and Medium Scale Industries of Andhra Pradesh Environmental Status of the Hyderabad Urban Agglomeration Study on 'water pollution-health linkages' for a few Districts of A.P

		⑨ Environment Quality Mapping Macro level studies for six districts in the State of Andhra Pradesh Micro level studies for two study zones presenting the permissible pollutant load and scoping for new industrial categories Zonation of the IDA, Parwada which helped APIIC to promote the land for industrial development Disaster management plan for Visakhapatnam Industrial Bowl Area
15.	Forest Survey of India (FSI) Kaulagarh Road, P.O., IPE Dehradun - 248 195 Tel# 0135-756139, 755037, 754507 Fax # 91-135-759104 E-Mail : fsidir@nde.vsnl.net.in fsihq@nde.vsnl.net.in RO- Banglore, Calcutta, Nagpur and Shimla	⑨ State of Forest Report (Biannual) ⑨ National Forest Vegetation Map (Biannual exercise) (on 1: 1 million scale) ⑨ Thematic mapping on 1:50,000 scale depicting the forest type, species composition, crown density of forest cover and other landuse National ⑨ Basic Forest Inventory System ⑨ Inventory survey of non forest area ⑨ Forest inventory report providing details of area estimates, topographic description, health of forest, ownership pattern, estimation of volume and other growth parameters such as height and diameter in different types of forest, estimation of growth, regeneration and mortality of important species, volume equation and wood consumption of the area studied
16.	Geological Survey of India 27 Jawaharlal Nehru Road, Calcutta 700 016, India Telephone +91-33-2496941 FAX 91-33-2496956 gsi_chq@vsnl.com	⑨ Environmental hazards zonation mapping in mineral sector ⑨ Codification of base line information of geo-environmental appreciation of any terrain and related EIA and EMP studies ⑨ Lineament and geomorphological map of India on 1:20,000 scale. ⑨ Photo-interpreted geological and structural maps of terrains with limited field checks.
17.	Indian Council of Agriculture Research, Krishi Bhawan, New Delhi, Tel#011-338206 – ICAR complex, Goa- Agro metrology – Central Arid Zone Research Institute- Agro forestry – Central Soil salinity Research Institute, – Indian Institute of Soil Science – Central Soil and Water Conservation Research and Training Institute – National Bureau of Soil Survey and Landuse Planning	⑨ A total of 80,000 profiles at 10 kms grid across the country were analyzed to characterize the soils of India. ⑨ Detailed soil maps of the Country (1:7 million), State (1:250,000) and districts map (1:50,000) depicting extent of degradation (1:4.4 millions) have been prepared. ⑨ Thematic maps depicting soil depth, texture drainage, calcareousness, salinity, pH, slope and erosion have been published ⑨ Agro-climate characterization of the country based on moisture, thermal and sunshine regimes ⑨ Agro-ecological zones (20) and sub-zones (60) for the country were delineated based on physiography, soils, climate, Length of Growing Period and Available Water Content, and mapped on 1:4.4 million scale. ⑨ Digitization of physiography and soil resource base on 1:50,000 scale for 14 States have been completed. ⑨ .Soil fertility maps of N,P,K,S and Zn have also been developed ⑨ Water quality guidelines for irrigation and naturally occurring saline/sodic water ⑨ Calibration and verification of ground water models for predicting water logging and salinity hazards in irrigation commands
18.	Indian Bureau of Mines Indira Bhawan, Civil Lines Nagpur Ph no - 0712-533 631, Fax- 0712-533 041	⑨ National mineral inventory for 61 minerals and mineral maps ⑨ Studies on environmental protection and pollution control in regard to the mining and mineral beneficiation operations ⑨ Collection, processing and storage of data on mines, minerals and mineral-based industries, collection and maintenance of world mineral intelligence, foreign mineral legislation and other related matters

19.	Indian Meteorology Department Shivaji nagar, Pune 41100 RO- Mumbai, Chennai, Calcutta, New Delhi, Nagpur, Guwahati	⑨ Meteorological data ⑨ Background air quality monitoring network under Global Atmospheric Watch Programme (operates 10 stations) ⑨ Seismicity map, seismic zoning map; seismic occurrences and cyclone hazard monitoring; list of major earthquakes ⑨ Climatological Atlas of India , Rainfall Atlas of India and Agroclimatic Atlas of India ⑨ Monthly bulletin of Climate Diagnostic Bulletin of India ⑨ Environmental Meteorological Unit of IMD at Delhi to provide specific services to MoEF
20.	INTACH Natural Heritage, 71 Lodi Estate, New Delhi-110 003 Tel. 91-11-4645482, 4632267/9, 4631818, 4692774, 4641304 Fax : 91-11-4611290 E-mail : nh@intach.net	⑨ Listing and documentation of heritage sites identified by municipalities and local bodies (Listing excludes sites and buildings under the purview of the Archaeological Survey of India and the State Departments of Archaeology)
21.	Industrial Toxicology Research Centre Post Box No. 80, Mahatma Gandhi Marg, Lucknow-226001, Phone: +91-522-221856,213618,228227; Fax : +91-522 228227 Email: itrc@itrcindia.org	⑨ Activities include health survey on occupational diseases in industrial workers, air and water quality monitoring studies, ecotoxicological impact assessment, toxicity of chemicals, human health risk assessment ⑨ Five databases on CD-ROM in the area of environmental toxicology viz: TOXLINE, CHEMBANK, POISINDEX, POLTOX and PESTBANK. The Toxicology Information Centre provides information on toxic chemicals including household chemicals ⑨ ENVIS centre and created a full-fledged computerized database (DABTOC) on toxicity profiles of about 450 chemicals
22.	Indian Institute of Forest Management Post Box No. 357, Nehru Nagar Bhopal - 462 003 Phone # 0755-575716, 573799, 765125, 767851 Fax # 0755-572878	⑨ Consultancy and research on joint forest management (Ford Foundation, SIDA, GTZ, FAO etc)
23.	Indian Institute of Petroleum Mohkampur , Dehradun, India, 248005 0135- 660113 to 116 0135- 671986	⑨ Fuel quality characterisation ⑨ Emission factors
24.	Ministry of Environment and Forest	⑨ Survey of natural resources ⑨ National river conservation directorate ⑨ Environmental research programme for eastern and western ghats ⑨ National natural resource management system ⑨ Wetlands conservation programme- survey, demarcation, mapping landscape planning, hydrology for 20 identified wetlands National ⑨ wasteland identification programme
25.	Mumbai Metropolitan Regional Development Authority	⑨ Mumbai Urban Transport Project ⑨ Mumbai Urban Development Project ⑨ Mumbai Urban Rehabilitation Project ⑨ Information on MMR; statistics on councils and corporations Regional ⑨ Information Centre- Basic data on population, employment, industries and other sectors are regularly collected and processed

26.	Municipal Corporation of Greater Mumbai	⑨ Air Quality Data for Mumbai Municipal Area ⑨ Water quality of lakes used for water supply to Mumbai
27.	Ministry of Urban Development Disaster Mitigation and Vulnerability Atlas of India Building Materials & Technology Promotion Council G-Wing,Nirman Bhavan, New Delhi-110011 Tel: 91-11-3019367 Fax: 91-11-3010145 E-Mail: bmtpc@del2.vsnl.net.in	⑨ Identification of hazard prone area ⑨ Vulnerability Atlas showing areas vulnerable to natural disasters ⑨ Land-use zoning and design guidelines for improving hazard resistant construction of buildings and housing ⑨ State wise hazard maps (on cyclone, floods and earthquakes)
28.	Natural Disaster Management Division in Department of Agriculture and Cooperation	⑨ Weekly situation reports on recent disasters, reports on droughts, floods, cyclones and earthquakes
29.	National Bureau Of Soil Survey & Land Use Planning P.O. Box No. 426, Shankar Nagar P.O., Nagpur-440010 Tel#91-712-534664,532438,534545 Fax#:91-712-522534 RO- Nagpur, New Delhi, Banglore, Calcutta, Jorhat, Udaipur	⑨ NBSS&LUP Library has been identified as sub centre of ARIC (ICAR) for input to AGRIS covering soil science literature generated in India ⑨ Research in weathering and soil formation, soil morphology, soil mineralogy, physicochemical characterisation, pedogenesis, and landscape-climate-soil relationship. ⑨ Soil Series of India- The soils are classified as per Soil Taxonomy. The described soil series now belong to 17 States of the country. ⑨ Landuse planning- watershed management, land evaluation criteria, crop efficiency zoning ⑨ Soil Information system is developed state-wise at 1:250,000 scale. Presently the soil maps of all the States are digitized, processed and designed for final output both digital and hardcopy. The thematic layers and interpreted layers of land evaluation (land capability, land irrigability and crop suitability), Agro-Ecological Zones and soil degradation themes are prepared. ⑨ Districts level information system is developed for about 15 districts at 1: 50, 000 scale. The soil information will be at soil series level in this system. Soil resource inventory of States, districts water-sheds (1:250,000; 1:50,000; 1:10,000/8000)
30.	National Institute of Ocean Technology, Velacherry-Tambaram main road Narayanapuram Chennai, Tamil Nadu Tel#91-44-2460063 / 2460064/ 2460066/ 2460067 Fax#91-44-2460645	⑨ Waste load allocation in selected estuaries (Tapi estuary and Ennore creek) is one the components under the Integrated Coastal and Marine Area Management (ICMAM) programme of the Department of Ocean Development ICMAM is conducted with an IDA based credit to the Government of India under the Environmental Capacity Building project of MoEF (waste assimilation capacity of Ennore creek is over) ⑨ Physical oceanographic component of Coastal & Ocean monitoring Predictive System (COMAPS) a long term monitoring program under the Department of Ocean Development ⑨ Identification of suitable locations for disposal of dredge spoil using mathematical models & environmental criteria ⑨ EIA Manual and EIA guidelines for port and harbour projects
31.	National Institute of Oceanography, Goa RO- Mumbai, Kochi	⑨ Coastal Ocean Monitoring and Predictions(COMAP)-Monitoring of coastal waters for physicochemical and biological parameters including petroleum hydrocarbons, trace metals, heavy metals, and biomass of primary (phytoplankton) and secondary (zooplankton, microbial and benthic organisms) ⑨ Marine Biodiversity of selected ecosystem along the West Coast of India

32.	National Botanical Research Institute, Post Box No 436 Rana Pratap Marg Lucknow- 226001, Tel: (+91) 522 271031-35 Fax: (+91) 522 282849, 282881 Lucknow	⑨ Dust filtering potential of common avenue trees and roadside shrubs has been determined, besides studies have also been conducted on heavy-metals accumulation potential of aquatic plants supposedly useful as indicators of heavy metal pollution in water bodies and capable of reducing the toxic metals from water bodies. ⑨ Assessment of bio-diversity of various regions of India
33.	National Geophysical Research Institute, Uppal Road, Hyderabad Telephone:0091-40-7171124, FAX:0091-40-7171564	⑨ Exploration, assessment and management of ground water resources including ground water modelling and pollution studies
34.	National Environmental Engineering Research Institute, Nagpur RO- Mumbai, Delhi, Chennai, Calcutta, Ahmedabad, Cochin, Hyderabad, Kanpur	⑨ National Air Quality Monitoring (NAQM) for CPCB ⑨ Database on cleaner technologies of industrial productions
35.	National Hydrology Institute, Roorkee RO- Belgaum (Hard Rock Regional Centre), Jammu (Western Himalayan Regional Centre), Guwahati (North Eastern Regional Centre), Kakinada (Deltaic Regional Centre), Patna (Ganga Plains North Regional Centre), and Sagar (Ganga Plains South)	⑨ Basin studies, hydrometeorological network improvement, hydrological year book, hydrological modelling, regional flood formulae, reservoir sedimentation studies, environmental hydrology, watershed development studies, tank studies, and drought studies.
36.	National Institute Of Urban Affairs, India Habitat Centre, New Delhi	⑨ Urban Statistics Handbook
37.	National Institute of Occupational Health Meghaninagar, Ahmedabad RO- Banglore, Calcutta	⑨ epidemiological studies and surveillance of hazardous occupations including air pollution, noise pollution, agricultural hazards, industrial hazards in organised sectors as well as small scale industries, carcinogenesis, pesticide toxicology, etc ⑨ WHO collaborative centre for occupational health for South East Asia region and the lead institute for the international programme on chemical safety under IPCS (WHO)
38.	NRSA Data Centre Department of Space, Balanagar, Hyderabad 500 037 Ph- 040-3078560 3078664 sales@nrsa.gov.in	⑨ Satellite data products (raw data, partially processed (radiometrically corrected but geometrically uncorrected), standard data (radiometrically and geometrically corrected), geocoded data(1:50,000 and 1:25000 scale), special data products like mosaiced, merged and extracted) available on photographic (B?W and FCC in form of film of 240 mm X 240mm or enlargements/paper prints in scale varying between 1:1M and 1:12500 and size varying between 240mm and 1000mm) and digital media (CD-ROMs, 8 mm tapes)
39.	Rajiv Gandhi National Drinking Water Mission	⑨ Database for groundwater using remote sensing technology (Regional Remote Sensing Service Centre involved in generation of ground water prospect maps at 1:50,000 scale for the State of Kerala, Karnataka, AP, MP and Rajasthan for RGNDWM)
40.	Space Application Centre Value Added Services Cell (VASC) Remote Sensing Application Area Ahmedabad 380 053 079-676 1188	⑨ National Natural Resource Information System ⑨ Landuse mapping for coastal regulation zone (construction setback line) upto 1:12500 scale ⑨ Inventory of coastal wetlands, coral reefs, mangroves, seaweeds ⑨ Monitoring and condition assessment of protected coastal areas

	Fax- 079-6762735	⑨ Wetland mapping and inventory ⑨ Mapping of potential hotspots and zoning of environmental hazards ⑨ General geological and geomorphological mapping in diverse terrain ⑨ Landslide risk zonation for Tehre area
41.	State Pollution Control Board	⑨ State Air Quality Monitoring Programme ⑨ Inventory of polluting industries ⑨ Identification and authorization of hazardous waste generating industries ⑨ Inventory of biomedical waste generating industries ⑨ Water quality monitoring of water bodies receiving wastewater discharges ⑨ Inventory of air polluting industries ⑨ Industrial air pollution monitoring ⑨ Air consent, water consent, authorization, environment monitoring reports
42.	State Ground Water Board	
43.	Survey of India	⑨ Topographical surveys on 1:250,000 scales, 1:50,000 and 1:25,000 scales ⑨ Digital Cartographical Data Base of topographical maps on scales 1:250,000 and 1:50,000 ⑨ Data generation and its processing for redefinition of Indian Geodetic Datum ⑨ Maintenance of National Tidal Data Centre and receiving/ processing of tidal data of various ports. ⑨ Coastal mapping along the Eastern coast line has been in progress to study the effect of submergence due to rise in sea-level and other natural phenomenon. Ground surveys have been completed for the proposed coastal region and maps are under printing. ⑨ District planning maps containing thematic information (135 maps) have been printed out of 249 maps covering half the districts of India. Districts planning maps for remaining half of the area are being processed by National Atlas and Thematic Mapping Organisation (NATMO)
44.	Town and Country Planning Organisation	⑨ Urban mapping - Thematic maps and graphic database on towns (under progress in association with NRSA and State town planning department)
45.	Wildlife Institute of India Post Bag No. 18, Chandrabani Dehradun - 248 001, Uttaranchal Tel#0135 640111 -15, Fax#0135 640117 email : wii@wii .	⑨ Provide information and advice on specific wildlife management problems. ⑨ National Wildlife Database
46.	Zoological Survey of India Prani Vigyan Bhawan 'M' Block, New Alipore Calcutta - 700 053 Phone # 91-33-4786893, 4783383 Fax # 91-33-786893 RO - Shillong, Pune, Dehradun, Jabalpur, Jodhpur, Chennai, Patna, Hyderabad, Canning, Behrampur, Kozikode, Itanagar, Digha, Port Bliar, Solan	⑨ Red Book for listing of endemic species ⑨ Survey of faunal resources

ANNEXURE XI
Impact Prediction Tools

Table 1: Choice of Methods for Impact Prediction: Air Environment

Model	Application	Remarks	Remarks for Power plants Applications
ISCST 3	Appropriate for point, area and line sources Application for flat or rolling terrain Transport distance up to 50 km valid Computes for 1 hr to annual averaging periods	Can take up to 99 sources Computes concentration on 600 receptors in Cartesian on polar coordinate system Can take receptor elevation Requires source data, meteorological and receptor data as input.	ISCST3 is appropriate for TPP located in both simple terrain, where the terrain features are all lower in elevation than the top of the stack of the source, and in complex terrain, where terrain elevations rise to heights above the stack top. The meteorological data required to run ISCST3 includes mixing heights, wind direction, wind velocity, temperature, atmospheric stability and anemometer height.
AERMOD with AERMET	Settling and dry deposition of particles; Building wake effects (excluding cavity region impacts); Point, area, line, and volume sources; Plume rise as a function of downwind distance; Multiple point, area, line, or volume sources; Limited terrain adjustment; Long-term and short-term averaging modes; Rural or urban modes; Variable receptor grid density; and Actual hourly meteorology data	Can take up to 99 sources Computes concentration on 600 receptors in Cartesian on polar coordinate system Can take receptor elevation Requires source data, meteorological and receptor data as input.	AERMOD, is a state-of-art and steady-state plume dispersion model for assessment of pollutant concentrations from a variety of sources. AERMOD simulates transport and dispersion from multiple points, area, or volume sources based on an up-to-date characterization of the atmospheric boundary layer. Sources may be located in rural or urban areas, and receptors may be located in simple or complex terrain. AERMOD accounts for building near-wake and far-wake effects (i.e., plume downwash) using the PRIME wake effect model. The AERMOD model employs hourly sequential meteorological data to estimate concentrations for averaging times ranging from one hour to one year. The AERMET module is the meteorological preprocessor for the AERMOD program. Output includes surface meteorological observations and parameters and vertical profiles of several

Model	Application	Remarks	Remarks for Power plants Applications
			atmospheric parameters. AERMET is a general purpose meteorological preprocessor for organizing available meteorological data into a format suitable for use by the AERMOD air quality dispersion model
PTMAX	Screening model applicable for a single point source Computes maximum concentration and distance of maximum concentration occurrence as a function of wind speed and stability class	Require source characteristics No met data required Used mainly for ambient air monitoring network design	
PTDIS	Screening model applicable for a single point source Computes maximum pollutant concentration and its occurrences for the prevailing meteorological conditions	Require source characteristics Average met data (wind speed, temperature, stability class etc.) required Used mainly to see likely impact of a single source	
MPTER	Appropriate for point, area and line sources applicable for flat or rolling terrain Transport distance up to 50 km valid Computes for 1 hr to annual averaging periods Terrain adjustment is possible	Can take 250 sources Computes concentration at 180 receptors up to 10 km Requires source data, meteorological data and receptor coordinates	
CTDM PLUS (Complex Terrain Dispersion Model)	Point source steady state model, can estimate hrly average concentration in isolated hills/ array of hills	Can take maximum 40 Stacks and computes concentration at maximum 400 receptors Does not simulate calm met conditions Hill slopes are assumed not to exceed 15 degrees Requires sources, met and terrain characteristics and receptor details	
UAM (Urban Airshed Model)	3-D grid type numerical simulation model Computes O_3 concentration short term episodic conditions lasting for 1 or 2 days resulting from NOx and VOCs Appropriate for single urban area having significant O_3 problems		
RAM (Rural Airshed Model)	Steady state Gaussian plume model for computing concentration of relatively stable pollutants for 1 hr to 1	Suitable for flat terrains Transport distance less than 50 km.	

Model	Application	Remarks	Remarks for Power plants Applications
	day averaging time Application for point and area sources in rural and urban setting		
CRESTER	Applicable for single point source either in rural or urban setting Computes highest and second highest concentration for 1hr, 3hr, 24hr and annual averaging times Tabulates 50 highest concentration for entire year for each averaging times	Can take up to 19 Stacks simultaneously at a common site. Unsuitable for cool and high velocity emissions Do not account for tall buildings or topographic features Computes concentration at 180 receptor, circular wing at five downwind ring distance 36 radials Require sources, and met data	
OCD (Offshore and coastal Dispersion Model)	It determines the impact of offshore emissions from point sources on the air quality of coastal regions It incorporates overwater plume transport and dispersion as well as changes that occur as the plume crosses the shore line Most suitable for overwater sources shore onshore receptors are below the lowest shore height	Requires source emission data Require hrly met data at offshore and onshore locations like water surface temperature; overwater air temperature; relative humidity etc.	
FDM (Fugitive Dust Model)	Suitable for emissions from fugitive dust sources Source may be point, area or line (up to 121 source) Require particle size classification max. up to 20 sizes Computes concentrations for 1 hr, 3hr, 8hr, 24hr or annual average periods	Require dust source particle sizes Source coordinates for area sources, source height and geographic details Can compute concentration at max. 1200 receptors Require met data (wind direction, speed, Temperature, mixing height and stability class) Model do not include buoyant point sources, hence no plume rise algorithm	
RTDM (Rough Terrain Diffusion Model)	Estimates GLC is complex/rough (or flat) terrain in the vicinity of one or more co-located point sources Transport distance max. up to 15 km to up to 50 km Computes for 1 to 24 hr. or annual ave5rage concentrations	Can take up to 35 co-located point sources Require source data and hourly met data Computes concentration at maximum 400 receptors Suitable only for non reactive gases Do not include gravitational	

Model	Application	Remarks	Remarks for Power plants Applications
		effects or depletion mechanism such as rain/ wash out, dry deposition	
CDM(Climatologically Dispersion Model)	It is a climatologically steady state GPM for determining long term (seasonal or annual) Arithmetic average pollutant concentration at any ground level receptor in an urban area	Suitable for point and area sources in urban region, flat terrain Valid for transport distance less than 50 km Long term averages: One month to one year or longer	
PLUVUE-II (Plume Visibility Model)	Applicable to assess visibility impairment due to pollutants emitted from well defined point sources It is used to calculate visual range reduction and atmospheric discoloration caused by plumes It predicts transport, atmospheric diffusion, chemical, conversion, optical effects, and surface deposition of point source emissions.	Require source characteristics, met data and receptor coordinates & elevation Require atmospheric aerosols (back ground & emitted) characteristics, like density, particle size Require background pollutant concentration of SO_4, NO_3, NOx, NO_2, O_3, SO_2 and deposition velocities of SO_2, NO_2 and aerosols	
MESO-PUFF II (Meso scale Puff Model)	It is a Gaussian, Variable trajectory, puff superposition model designed to account fro spatial and temporal variations in transport, diffusion, chemical transformation and removal mechanism encountered on regional scale. Plume is modeled as a series of discrete puffs and each puff is transported independently Appropriate for point and area sources in urban areas Regional scale model.	Can model five pollutants simultaneously (SO2, SO4, NOx, HNO3 and NO3) Require source characteristics Can take 20 point sources or 5 area source For area source – location, effective height, initial puff size, emission is required Computes pollutant concentration at max. 180 discrete receptors and 1600 (40 x 40) grided receptors Require hourly surface data including cloud cover and twice a day upper air data (pressure, temp, height, wind speed, direction) Do not include gravitational effects or depletion mechanism such as rain/ wash out, dry deposition	

Table 2: Choice of Methods for Impact Modeling: Noise Environment

Model	Application
FHWA (Federal Highway Administration)	Noise Impact due to vehicular movement on highways
Dhwani	For predictions of impact due to group of noise sources in the industrial complex (multiple sound sources)
Hemispherical sound wave propagation Air Port	Fore predictive impact due to single noise source For predictive impact of traffic on airport and rail road

Table 3: Choice of Methods for Impact Modeling: Water Environment

Model	Application	Remarks
QUAL-II E	Wind effect is insignificant, vertical dispersive effects insignificant applicable to streams Data required Deoxygenation coefficients, re-aeration coefficients for carbonaceous, nitrogenous and benthic substances, dissolved oxygen deficit	Steady state or dynamic model
	The model is found excellent to generate water quality parameters Photosynthetic and respiration rate of suspended and attached algae	
	Parameters measured up to 15 component can be simulated in any combination, e.g. ammonia, nitrite, nitrate, phosphorous, carbonaceous BOD, benthic oxygen demand, DO, coliforms, conservative substances and temperature	
DOSAG-3, USEPA:(1-D) RECEIV–II, USEPA	Water quality simulation model for streams & canal A general Water quality model	Steady-state
Explore–I, USEPA	A river basin water quality model	Dynamic, Simple hydrodynamics
HSPE, USEPA	Hydrologic simulation model	Dynamic, Simple hydrodynamics
RECEIVE-II, USEPA	A general dynamic planning model for water quality management	
Stanford watershed model	This model simulates stream flows once historic precipitation data are supplied The major components of the hydrologic cycle are modeled including interception, surface detention, overland inflow, groundwater, evapo-transpiration and routing of channel flows, temperature, TDS, DO, carbonaceous BOD coliforms, algae, zooplanktons, nitrite, nitrate, ammonia, phosphate and conservative substances can be simulated	
Hydrocomp model	Long-term meteorological and wastewater characterization data is used to simulate stream flows and stream water quality	Time dependant (Dynamic)
Stormwater	Runoff is modeled from overland flow, through surface	Time Dependent

Model	Application	Remarks
Management model (SWMM)	channels, and through sewer network Both combined and separate sewers can be modeled. This model also enables to simulate water quality effects to stormwater or combined sewer discharges. This model simulates runoff resulting from individual rainfall events.	
Battelle Reservoir model	Water body is divided into segments along the direction of the flow and each segment is divided into number of horizontal layers. The model is found to generate excellent simulation of temperature and good prediction of water quality parameters. The model simulates temperature, DO, total and benthic BOD, phytoplankton, zooplankton, organic and inorganic nitrogen, phosphorous, coliform bacteria, toxic substances and hydrodynamic conditions.	Two Dimensional multi-segment model
TIDEP (Turbulent diffusion temperature model reservoirs)	Horizontal temperature homogeneity Coefficient of vertical turbulent diffusion constant for charge of area with depth negligible coefficient of thermal exchange constant Data required wind speed, air temperature, air humidity, net incoming radiation, surface water temperature, heat exchange coefficients and vertical turbulent diffusion coefficients.	Steady state model
BIOLAKE	Model estimates potential fish harvest from a take	Steady state model
Estuary models/ estuarial Dynamic model	It is simulates tides, currents, and discharge in shallow, vertically mixed estuaries excited by ocean tides, hydrologic influx, and wind action Tides, currents in estuary are simulated	Dynamic model
Dynamic Water Quality Model	It simulates the mass transport of either conservative or non-conservative quality constituents utilizing information derived from the hydrodynamic model Bay-Delta model is the programme generally used. Up to 10 independent quality parameters of either conservative or non-conservative type plus the BOD-DO coupled relationship can be handled	Dynamic model
HEC -2	To compute water surface profiles for stead7y, gradually: varying flow in both prismatic & non- prismatic channels	
SMS	Lake circulation, salt water intrusion, surface water profile simulation model	Surface water Modelling system Hydrodynamic model
RMA2	To compute flow velocities and water surface elevations	Hydrodynamic analysis model
RMA4	Solves adjective-diffusion equations to model up to six non-interacting constituents	Constituent transport model
SED2D-WES	Model simulates transport of sediment	Sediment transport model
HIVEL2D	Model supports subcritical and supercritical flow analysis	A 2-dimensional hydrodynamic model
MIKE-II, DHI	Model supports, simulations of flows, water quality, and sediment transport in estuaries, rives, irrigation systems, channels & other water bodies	Professional Engineering software package

Table 4: Choice of Methods for Impact Modeling: Land Environment

Model	Application	Remarks
Digital Analysis Techniques	Provides land use / land cover distribution	
Ranking analysis for soil suitability criteria	Provides suitability criteria for developmental conversation activities	Various parameters viz. depth, texture, slope, erosion status, geomorphology, flooding hazards, GW potential, land use etc. are used.

Table 5: Choice of Methods for Impact Modeling: Biological Environment

Name	Relevance	Application	Remarks
Flora			
Sample plot methods	Density and relative density Density and relative dominance	Average number of individuals species per unit area Relative degree to which a species predominates a community by its sheer numbers, size bulk or biomass	The quadrant sampling technique is applicable in all types of plant communities and for the study of submerged, sessile (attached at the base) or sedentary plants
	Frequency and relative frequency importance value	Plant dispersion over an area or within a community	Commonly accepted plot size: 0.1 m^2- mosses, lichens & other mat-like plants
		Average of relative density, relative dominance and relative frequency	0.1 m^2- herbaceous vegetation including grasses
			10.20 m^2 – for shrubs and saplings up to 3m tall, and
			100 m^2 – for tree communities
Transects & line intercepts methods	Cover	Ratio of total amount of line intercepted by each species and total length of the line intercept given its cover	This methods allows for rapid assessment of vegetation transition zones, and requires minimum time or equipment of establish
	Relative dominance	It is the ratio of total individuals of a species and total individuals of all species	Two or more vegetation strata can be sampled simultaneously
Plot-less sampling methods	Mean point plant Mean area per plant	Mean point – plant distance Mean area per plant	Vegetation measurements are determined from points rather than being determined in an area with boundaries
	Density and relative density		Method is used in grass-land and open shrub and tree communities

Name	Relevance	Application	Remarks
	Dominance and relative dominance		It allows more rapid and extensive sampling than the plot method
	Importance value		Point-quarter method is commonly used in woods and forests.
Fauna			
Species list methods	Animal species list	List of animal communities observed directly	Animal species lists present common and scientific names of the species involved so that the faunal resources of the area are catalogued
Direct Contact Methods	Animal species list	List of animals communities observed directly	This method involves collection, study and release of animals
Count indices methods (Roadside and aerial count methods)	Drive counts Temporal counts	Observation of animals by driving them past trained observers	Count indices provide estimates of animal populations and are obtained from signs, calls or trailside counts or roadside counts
	Call counts	Count of all animals passing a fixed point during some stated interval of time	These estimates, through they do not provide absolute population numbers, Provide an index of the various species in an area
			Such indices allow comparisons through the seasons or between sites or habitats
Removal methods	Population size	Number of species captured	Removal methods are used to obtain population estimates of small mammals, such as, rodents through baited snap traps
Market capture methods	Population size estimate (M)	Number of species originally marked (T) Number of marked animals recaptured (t) and total number of animals captured during census (n) $N = nT/t$	It involves capturing a portion of the population and at some later date sampling the ratio of marked to total animals caught in the population

Table 6: Choice of Methods for Impact Predictions: Biological Environment

Name	Application	Remarks
Extrapolative Methods	A prediction is made that is consistent with past and present socio-economic data, e.g. a prediction based on the linear extrapolation of current trends	
Intuitive Forecasting (Delphi techniques)	Delphi technique is used to determine environmental priorities and also to make intuitive predictions through the process of achieving group consensus	Conjecture Brainstorming Heuristic programming Delphi consensus
Trend extrapolation and correlation	Predictions may be obtained by extrapolating present trends Not an accurate method of making socio-economic forecasts, because a time series cannot be interpreted or extrapolated very far into the future with out some knowledge of the underlying physical, biological, and social factors	Trend breakthrough precursor events correlation and regression
Metaphors and analogies	The experience gained else where is used to predict the socio-economic impacts	Growth historical simulation commonsense forecasts
Scenarios	Scenarios are common-sense forecasts of data. Each scenario is logically constructed on model of a potential future for which the degrees of "confidence" as to progression and outcome remain undefined	Common-sense
Dynamic modeling (Input-Out model)	Model predicts net economic gain to the society after considering all inputs required for conversion of raw materials along with cost of finished product	
Normative Methods	Desired socio-economic goals are specified and an attempt is made to project the social environment backward in time to the present to examine whether existing or planned resources and environmental programmes are adequate to meet the goals	Morphological analysis technology scanning contextual mapping - functional array - graphic method Mission networks and functional arrays decision trees & relevance trees matrix methods scenarios

ANNEXURE XII

Form through which the State Governments/Administration of the Union Territories Submit Nominations for SEIAA and SEAC for the Consideration and Notification by the Central Government

Form for Nomination of a professional/expert as Chairperson / Member / Secretary of the SEIAA / EAC / SEAC						
1	Name (in block letters)					
2	Address for communication					
3	Age & Date of Birth (Shall be less than 67 years for the members and 72 years for the Chairman)					
4	Area of Expertise (As per Appendix VI)					
5	Professional Qualifications (As per Appendix VI)	Qualification(s)		University	Year of passing	Percentage of marks
6	Work experience (High light relevant experience as per Appendix VI)	Position	Years of association			Nature of work. If required, attach separate sheets
			From	to	Period in years	
7	Present position and nature of job	Serving Central / State Government Office?			Yes/No	
		Engaged in industry or their associations?			Yes/No	
		Associated with environmental activism?			Yes/No	
		If no is the answer for above three, please specify the present position and name of the organization				
8	Whether experienced in the process of prior environmental clearance?	Yes/No. If yes, please specify the experience in a separate sheet (Please restrict to 500 words)				
9	Whether any out-standing expertise has been acquired?	Yes/ No If yes, please provide details in a separate sheet (Please restrict to 500 words).				
10	Any other relevant information?	May like to attach separate sheets (Research projects, consultancy projects, publications, memberships in associations, trainings undergone, international exposure cum experience etc.)				

The Government of……is pleased to forward the Nomination of Dr./Sh. ……..…. for the position of Chairperson / Member / Secretary of the SEIAA / SEAC / EAC to the Ministry of Environment & Forests, the Government of India for the Notification.

(Authorized Signature with Seal)

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