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वहाँ है खुशहाली ।।

Ministry of Environment & Forests
GOVERNMENT OF INDIA, NEW DELHI

Environmental Impact Assessment Guidance Manual for NUCLEAR POWER PLANTS, NUCLEAR FUEL REPROCESSING PLANTS AND NUCLEAR WASTE MANAGEMENT PLANTS

Prepared by

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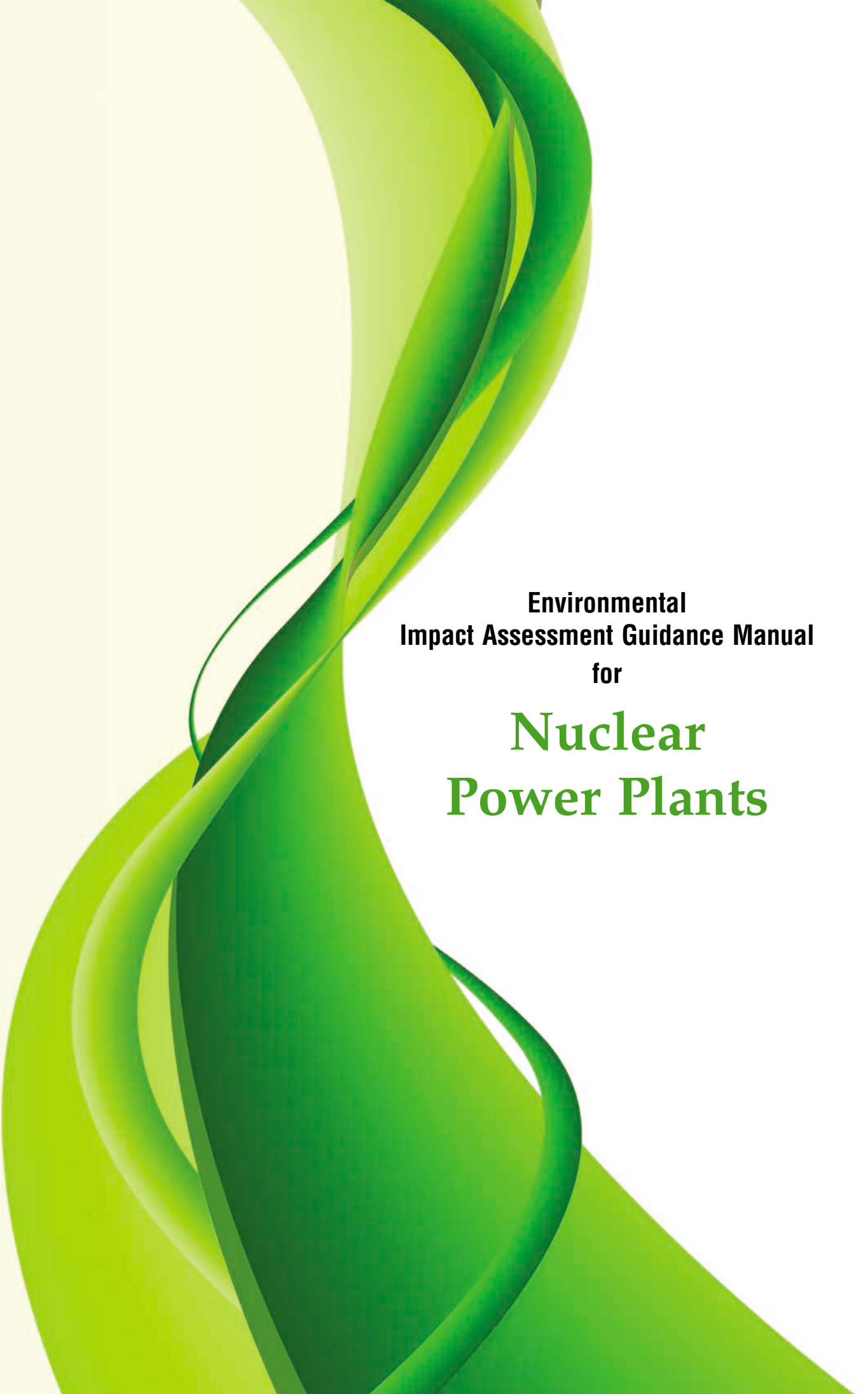
March 2010



Environmental
Impact Assessment Guidance Manual
for

Nuclear Power Plants

Foreword

The EIA Notification 2006 not only reengineered the entire EC process specified under the EIA Notification 1994 but also highlighted the need to introduce specific sectors/categories under the sectors such as Industry and Infrastructure and also introduced new sectors such as Construction to be brought in the ambit of the EC process based on their extent of impacts on environment. The EIA Notification 2006 has notified 39 developmental sectors, which require prior environmental clearance. Based on the capacity, the Projects have been categorised into Category A or B which has been further categorised as B1 or B2. The Ministry of Environment and Forests (MOEF) has so far constituted 25 State level Environmental Impact Assessment Authorities (SEIAs) and State Expert Appraisal Committees (SEACs) to appraise B category projects.

The need for Sector specific manuals and guidelines for appraisal of projects under the EIA Notification 2006 has been felt for some time with a view to bringing clarity in the EC process consists of Screening, Scoping, Public Consultation and Appraisal for the purpose of granting and expediting environmental clearance. This need was further reinforced after the constitution of various SEIAs and SEACs in the various States, who were assigned this task for the first time. It was also felt that Manuals on each Sector would help in standardisation of the quality of appraisal and in reducing inconsistencies between SEACs/SEIAAs in granting ECs for similar projects in different States.

The MOEF at the first instance decided to bring out EIA Sector Specific Manuals for 37 developmental projects and the preparation of EIA Manuals of ten of these Sectors was assigned to Administrative Staff College of India (ASCI), Hyderabad.

1. Mining
2. Mineral Beneficiation
3. Ports & Harbours
4. Airports
5. (A) Building Construction
5. (B) Townships
6. Asbestors
7. Highways
8. Coal Washery
9. Aerial Ropeways
10. Nuclear Power Plants, Nuclear Fuel Processing Plants and Nuclear Waste Management Plants

The Manual for the sectors contain Model TOR of that Sector, technological options and processes for a cleaner production and waste minimisation, wherever applicable, monitoring of environmental quality, related regulations, and procedure of obtaining EC if linked to other clearances for eg., CRZ, etc.

The draft Manuals were uploaded on the MOEF website and comments/responses received were considered and finalised. Since the environmental clearance process itself is a dynamic one dependent on developmental needs, technologies available and standards for cleaner environment for a sustainable development, these manuals would require regular updation in the future. I hope the Manuals in their present form are of use and we would appreciate receiving responses from various stakeholders for further improvements that could be taken up in the future.

I congratulate the entire team in the Administrative Staff College of India, Hyderabd, experts of the sectors who were involved in the preparation of the Manuals, members of the Core and Peer Committees of various sectors and various Resource persons whose inputs were indeed valuable in the preparation and finalisation of the Manuals.

(JAIRAM RAMESH)
MINISTER OF STATE FOR ENVIROMENT & FORESTS

5th May 2010

Siripurapu K. Rao
M.A. (Cantab), Ph.D. (Cantab)
DIRECTOR GENERAL

asci
Leadership through Learning

Acknowledgements

Environmental Impact Assessment (EIA) is a planning tool generally accepted as an integral component of sound decision-making. EIA is to give the environment its due place in the decision-making process by clearly evaluating the environmental consequences of the proposed activity before action is taken. Early identification and characterization of critical environmental impacts allow the public and the government to form a view about the environmental acceptability of a proposed developmental project and what conditions should apply to mitigate or reduce those risks and impacts.

Environmental Clearance (EC) for certain developmental projects has been made mandatory by the Ministry of Environment & Forests through its Notification issued on 27.01.1994 under the provisions of Environment (Protection) Act, 1986. Keeping in view a decade of experience in the Environmental Clearance process and the demands from various stakeholders, the Ministry of Environment and Forests (MoEF) issued revised Notification on EC process in September 2006 and amended it in December 2009.It was considered necessary by MoEF to make available EIA guidance manuals for each of the development sector.

Accordingly, at the instance of the MoEF, the Administrative Staff College of India,College of India, with the assistance of experts, undertook the preparation of sector specific Terms of Reference (TOR) and specific guidance manual for Nuclear power plants. I wish to thank **Mr. J. M. Mauskar,** IAS, Additional Secretary, Govt. of India MoEF for his continuing support during the preparation of the manuals. I wish to place on record also my sincere thanks to **Dr. B. Sengupta**, former Member Secretary, Central Pollution Control Board and Chairman of the Core Committee for his help in the preparation of the manuals. His suggestions helped us a great deal in improving the technical quality of the manuals. **Mr. M. Parabrahmam**, Former advisor MoEF and Chairman of the Peer Committee II for this project, has given constant guidance to the ASCI project team. His vast experience has been immensely helpful in preparing these manuals. I would like to thank the officials of the Ministry, **Dr. Nalini Bhat** and **Dr. T. Chandini,** for coordinating the project from the Ministry side and for providing guidance whenever needed My thanks are also due to **Dr. S. K. Agarwal** of MoEF for the valuable inputs they had given during our interactions with the officials at Delhi and Hyderabad.

I thank **Dr. U. C. Mishra,** Former Director, Health Safety and Environment Group, BARC, resource person, who, drawing on his vast experience in the sector, prepared the EIA guidance manual on **Nuclear Power Plants, Nuclear Fuel Reprocessing Plants and Nuclear Waste Management Plants** along with **Dr. Valli Manickam**, Member of Faculty of ASCI. The efforts put in by both of them are commendable.

I would like to thank **Dr. A.R. Reddy, Ex-Director Defence Science Lab., Jodhpur, Dr. R.K. Gurg, Ex.CMD, IREL Ltd., Mumbai** and Shri H.S. Kushwaha, Director, Health, Safety & Environment Group **BARC,** Mumbai and his colleagues for their comments and suggestions in the preparation of this manual. I hope the manual would be useful to the community at large and to the experts working in the area, in particular.

27 March, 2010

S.K. Rao

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ABBREVIATIONS

AERB	–	Atomic Energy Regulatory Board
ASCI	–	Administrative Staff College of India
BDBA	–	Beyond Design Based Accidents
BARC	-	Bhabha Atomic Research Centre
CGWB	–	Central Ground Water Board
CPCB	–	Central Pollution Control Board
CRZ	–	Coastal Regulation Zone
CSR	–	Corporate Social Responsibility
DBA	–	Design Basis Accident
DMP	–	Disaster Management Plan
EAC	-	Expert Appraisal Committee
EC	–	Environmental Clearance
EIA	–	Environmental Impact Assessment
EML	–	Environmental Monitoring Laboratory
EMP	–	Environmental Management Plan
ETP	–	Effluent Treatment Plant
FBR	–	Fast Breeder Reactor
HEPA	–	High Efficiency Particulate Air Filter
HLW	-	High Level Waste
IA	–	Impact Assessment
ILW	-	Intermediate Level Waste
LLW	-	Low Level Waste
LWR	–	Light Water Reactors
MoEF	–	Ministry of Environment and Forests
NETP	–	Nuclear Effluent Treatment Plant
NFRP	–	Nuclear Fuel Reprocessing Plant
NPP	–	Nuclear Power Plant
NSDF	-	Near Surface Disposal Facility
NWIP	–	Nuclear Waste Immobilization Plant
NWTP	–	Nuclear Waste Treatment Plant
PHWR	–	Pressurized Heavy Water Reactors
QA / QC	–	Quality Assurance / Quality Control
R O	–	Regional offices
R&R	–	Rehabilitation and Resettlement
SEAC	–	State Expert Appraisal Committee
SPCB	–	State Pollution Control Board
SSSF	-	Solid Storage & Surveillance Facility
STP	–	Sewage Treatment Plant
TECSPECS	–	Technical Specifications
TLD	–	Thermo Luminescence Dosimeter
TOR	–	Terms of Reference
VWP	–	Vitrified Waste Product

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ABOUT THE MANUAL

Environmental Impact Notification S.O.1533 (E), dtd.14th September 2006 as amended 2009, issued under Environment (Protection) Act 1986, has made it mandatory to obtain prior environmental clearance (EC) for scheduled development projects. The notification has classified projects under two categories A & B. Category A projects (including expansion and modernization of existing projects) require clearance from Ministry of Environment and Forest (MoEF), Govt. of India (GoI) and for category B from State Environmental Impact Assessment Authority (SEIAA), constituted by Govt. of India

The existing Environmental Impact Assessment manual of MoEF is common for all the sectors requiring prior environmental clearance. Considering the diversity in all the sectors related to infrastructure and industrial development, MoEF launched a programme for development of sector specific EIA guidance manual. The EIA guidance manual will help the project proponent and consultant in the preparation of EIA report. It also helps the regulatory authority while reviewing the report and also the public to be aware of the related environmental issues. This EIA guidance manual accordingly addresses their related environmental concern for the specific sector – **Nuclear power plants, nuclear fuel reprocessing plants and nuclear waste management plants**. The sector specific manual consists of twelve chapters, which correspond to the generic structure as per the EIA Notification.

Chapter 1: Introduction

This chapter includes need for EIA report, the steps in the EC process, general information on Nuclear Power Plants, Nuclear Fuel Reprocessing Plants and Nuclear Waste Treatment Plants, brief description of the project and the site, importance for the country and the region, cost and regulatory issues, if any.

Chapter 2: Project Description

In this chapter the proponent should furnish detailed description of the proposed project/s, such as the type of the project, capacity giving process and the equipment, project location, layout, project activities during construction and operational phases, land requirement and availability, utilities (power and water supply) and infrastructure facilities such as roads, railways, housing and other requirements. If the project site is near a sensitive area it is to be mentioned clearly why an alternative site could not be considered. The project implementation schedule, estimated cost of development as well as operation etc should be also included.

Chapter 3: Analysis of Alternatives (Technology & site)

This chapter gives details of various alternatives from preliminary evaluation both in respect of location of the project site envisaged and technologies to be deployed, in case the initial scoping exercise considers such a need.

Chapter 4: Description of Environment

This chapter should give the details of the baseline environmental data. The baseline data includes historical data on climates, cyclone, floods, and seismicity etc. and primary data on air, water, soil quality, biological environment and socio-economic conditions. The methodology followed in the collection and analysis of the data must also be described. The selection criteria adopted/ reasons for the location of sampling station(s) should be mentioned. The baseline data on

radioactivity in air, water and soil, food items collected by the site Environmental Monitoring Laboratory (EML) should be included.

Chapter 5: Anticipated Environmental Impact and Mitigation Measures

This chapter describes the anticipated impacts on the environment and their mitigation measures. The methods of assessment of impacts including studies carried out, modeling techniques adopted to assess the impacts where pertinent should be elaborated in this chapter. It should give the details of the impacts on the baseline parameters, both during the construction and operation phases and suggest mitigation measures to be implemented by the proponent. It should also cover mitigation measures of all identified impacts to meet the norms.

Chapter 6: Environmental Monitoring Programme

This chapter covers the environmental monitoring program. It should also include the details and effectiveness of mitigation measures (including measurement methodologies, data analysis, reporting schedules, emergency procedures, detailed budget & procurement schedules).

Chapter 7: Additional Studies

This chapter should cover details of the additional studies to be carried out/required in addition to those specified in the TOR and the risk assessment and disaster management plan along with the efforts made for conservation of natural resources. Details of the public consultation, feedback and action plan to address the issues raised should be included.

Chapter 8: Project Benefits

This chapter should cover benefits accruing to the locality, neighbourhood, region and nation as a whole. It should bring out details of benefits by way of improvements in the physical infrastructure, social infrastructure, employment potential and other tangible and intangible benefits.

Chapter 9: Environmental Cost Benefit Analysis

This chapter is on Environmental Cost Benefit Analysis of the project if suggested during the scoping stage of the project.

Chapter 10: Environmental Management Plan

This chapter should comprehensively present the Environmental Management Plan (EMP), which includes the administrative and technical setup, summary matrix of EMP, the cost involved to implement the EMP, both during the construction and operational phases and provision made towards the same in the cost estimates of project construction and operation. This chapter should also describe the proposed post-monitoring scheme as well as inter-organizational arrangements for effective implementation of the environmental management system as a whole.

Chapter 11: Summary and Conclusions

This chapter forms the summary of the full EIA report condensed to a maximum of ten A-4 size pages. It should provide overall justification for implementation of the project and should explain how the adverse effects have been effectively mitigated.

Chapter 12: Disclosure of Consultants Engaged

This chapter should include the names of the consultants engaged with their brief resume and types of consultancies rendered in the Environmental Management System proposed by the proponent.

The contents of the manual are to be considered as version 1.0 (2010). The Ministry as per the requirements will take up an updating/revision of the manual. In case of interpretation of any question related to law, the provisions of the original laws and the Rules made thereunder with various Government directions/resolutions will have to be read and followed. In case of amendment to the original Act/Rules/Notifications made thereunder, the provisions as amended from time to time shall be applicable. Any obligations of international conventions, where GoI is a signatory and accepted for implementation are also to be followed.

1 INTRODUCTION

1.0 Preamble

Environment plays a vital role in overall development of a country. Recognizing the importance of environmental protection and sustainable development, the Ministry of Environment and Forest (MoEF), Government of India had formulated policies and procedures governing industrial and other developmental activities to prevent indiscriminate exploitation of the natural resources and to promote integration of environmental concerns at every stage in developmental projects. The purpose of Environmental Impact Assessment (EIA) is to give the environment its due place in the decision-making process by clearly evaluating the environmental consequences of the proposed activity before action is taken. Early identification and characterization of critical environmental impacts allows the public and the government to form a view about the environmental acceptability of a proposed developmental project and what conditions should apply to mitigate or reduce risks and impacts.

The Ministry of Environment & Forest made Environmental Clearance (EC) for certain developmental projects mandatory through its notification issued on 27.01.1994 under the provisions of Environment (Protection) Act, 1986. The process of conducting public hearing was also made mandatory for certain developmental projects through its notification issued on 10.04.1997.

Keeping in view the experience gained in the environmental clearance process, the MoEF, in terms of the notification dated 14.09.2006, directed that any new project(s) or activities or expansion or modernization of an existing project(s) or activities listed in the schedule to this notification should be undertaken in any part of India only after prior environmental clearance from the Central Government (Ref. 1). The categorization of the developmental projects / activities is specified in the EIA notification 2006. The EC clearance process for new projects in category A will comprise of three stages–scoping, public consultation and appraisal.

1.1Environmental Clearance Process

The environmental clearance process for all projects in Category A will comprise of a maximum of three stages with no threshold limit, as there is no screening for this category of projects. These three stages in sequential order are:

Stage (1)- Scoping

'Scoping' refers to the process by which the EAC in the case of Category 'A' projects or activities, including applications for expansion and/or modernization and/or change in product mix of existing projects or activities, determine detailed and comprehensive TOR addressing all relevant environmental concerns for the preparation of an EIA report in respect of the project or activity for which prior environmental clearance is sought. The EAC concerned shall determine the TOR on the basis of information furnished in the prescribed application Form 1 including TOR proposed by the applicant, a site visit by a sub-group of EAC concerned only if considered necessary by the EAC concerned and other information that may be available with the EAC concerned.

Stage (2)- Public consultation

After carrying out EIA study, the project proponent should submit the report to the SPCB for arranging public consultations. "Public consultation" refers to the process by which the concerns of local affected persons and others who have plausible stake in the environmental impacts of the project or activity are ascertained with a view to taking into account all the material concerns in the project or activity design as appropriate. All Category 'A' projects or activities shall undertake Public consultation, except as provided in para 7 (i) III stage (3) – Public Consultation in MoEF's notification dt. 14.09.2006.

Stage (3)- Appraisal

Detailed scrutiny by the EAC of the application and other document like the Final EIA report, outcome of the public consultations including public hearing proceedings, submitted by the applicant to the regulatory authority concerned for grant of EC.

Project Activity	Category With Threshold Limit		General Conditions
	A	B	
1(e) Nuclear power projects and processing of nuclear fuel	All projects		

- The projects involving clearance under Coastal Regulation Zone Notification, 1991 shall submit with the application a CRZ map duly demarcated by one of the authorized agencies, showing the project activities, w.r.t. C.R.Z (at the stage of TOR) and the recommendations of the State Coastal Zone Management Authority (at the stage of EC). Simultaneous action shall also be take to obtain the requisite clearance under the provisions of the CRZ notification, 1991 for the activities to be located in the CRZ
- The projects to be located within 10km of the National Parks, Sanctuaries, Biosphere Reserves, Migratory corridors of wild animals, the project proponent shall submit the map duly authenticated by Chief Wildlife Warden showing these features vis-à-vis the project location and the recommendations or comments of the Chief Wildlife Warden thereon (at the stage of EC)
- All correspondence with the Ministry of Environment & Forests including submission "of application for TOR/Environmental Clearance, subsequent clarifications, as may be required from time to time, participation in the EAC meeting on behalf of the project proponent shall be made by the authorized signatory only. The authorized signatory should also submit a document in support of his claim of being an authorized signatory for the specific project"

Ref:- EIA amendment 2009

Flow-chart depicting these stages in obtaining the prior environmental clearance for Nuclear power projects are presented in Fig.1.1

The objective of the EIA Notification, 2006 together with amendments of Dec, 2009 is to set procedures of environmental clearance before establishment of the project. The suitability of site proposed for a proposed development is one of primary concerns in according environmental clearance to a project.

Once environmental clearance is accorded by MoEF, their regulatory control is limited to ensuring that stipulations made in the clearance, if any, are followed by the proponent of the project. However, the regulatory control of AERB starts from site selection to decommissioning of the project. Other regulatory authorities like MoEF, SPCB will monitor the conditions given in the clearance / consent / HW authorization letter. The controls and regulations are aimed at radiation exposure controls and ensure safety of site personnel, population living around the plant, flora and fauna.

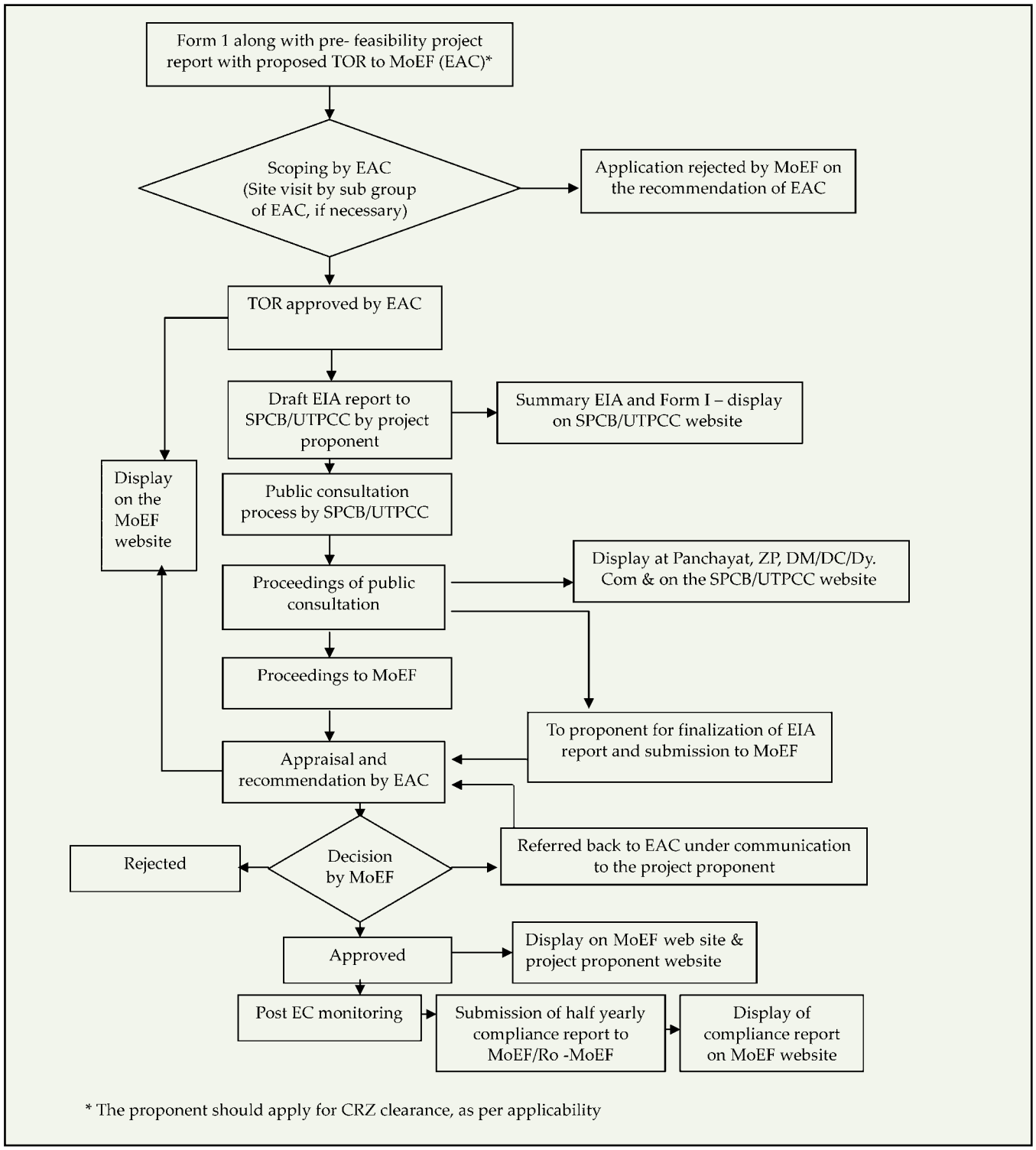


Figure 1.1 Prior Environmental Clearance Process for category A projects

The EIA report should incorporate the page numbers of various chapters, sections and sub-sections, tables, appendices, drawings and figures etc., with titles under the heading 'Contents'.

1.2 Validity of Environmental Clearance

The environmental clearance granted for nuclear power sector is valid for a period of five years. The regulatory authority concerned may extend this validity period by a maximum period of five years.

1.3 Post Environmental Clearance Monitoring

In case of category A projects, it shall be mandatory for the project proponent to make public the environmental clearance granted for their project along with the environmental conditions and safeguards at their cost by prominently advertising it at least in two local newspapers of the district or state where the project is located and in addition, this shall also be displayed in the project proponent's website permanently.

The Project management should submit half-yearly compliance reports in respect of the stipulated prior environmental clearance terms and conditions on 1st June and 1st December of each calendar year. All such reports should be public documents.

1.4 Transferability of Environmental Clearance

A prior environmental clearance granted for a specific project or activity to an applicant may be transferred during its validity to another person legally or organization entitled to undertake the project or activity on application by the transferor or the transferee with a written "no objection" by the transferor, to, and by the regulatory authority concerned on the same terms and conditions under which the prior environmental clearance was initially granted, and for the same validity period.

1.5 Generic Structure of Environmental Impact Assessment Document

In terms of the EIA notification of the MoEF dated 14th September 2006, the generic structure of the EIA document should be as under:

- Introduction
- Project Description
- Analysis of Alternatives (Technology and site)
- Description of the Environment
- Anticipated Impacts & Mitigation Measures
- Environmental Monitoring Programme
- Additional Studies
- Project Benefits
- Environmental Cost Benefit Analysis
- Environmental Management Plan
- Summary and Conclusion
- Disclosure of Consultants engaged

1.6 Terms of Reference (TOR) for Preparation of EIA Report for Nuclear Power Projects and Other Related Activities

Terms of Reference (TOR) for the nuclear projects and other related activities is prepared and attached as **Annexure 1** to this document. In addition, the proponent is required to identify specific issues, if any, pertinent to the project site and include those issues also in the TOR for preparation of EIA and EMP reports upon approval of the TOR by the Expert Appraisal Committee.

1.7 General Information on Nuclear Power Plants, Nuclear Fuel Reprocessing Plants and Nuclear Waste Management Plants

All the nuclear plants given below are similar to other types of industrial plants as far as construction phase is concerned. They present air, water, soil and noise pollution concerns. However, after becoming operational, their main environmental impact could be due to radioactivity discharged into air and water. Both these discharges are authorized and regulated by the Atomic Energy Regulatory Board. Nuclear power plants (NPP's), once they go operational, do not produce any conventional pollutants except for some air emissions from diesel generator sets. However, operation of Nuclear Fuel Reprocessing Plants (NFRP) may give rise to some conventional air pollutants emission. All the limits for radioactivity discharges and radiation dose are authorized and regulateded by AERB, and those for conventional chemical pollutants by CPCB / MoEF.

Nuclear Power Plant All plants of Indian design, so far are of Pressurized Heavy Water Type (PHWR) using natural uranium as fuel, heavy water as moderator and primary coolant and ordinary water as secondary coolant. All details of the plant and its main sub-system should be provided in the EIA report. Site selection details (Ref. 2) are given in Annexure 2 and construction norms are as per AERB guidelines given in Annexure 3.

Nuclear Fuel Reprocessing Plant It is essentially a radio-chemical plant in which spent fuel is brought into solution by dissolving it in nitric acid for extraction of Plutonium and Uranium. During this process, radioactive waste streams get generated and depending upon the level of radioactivity, these aqueous streams are categorized as "High Level Waste (HLW), 'Intermediate Level Waste' (ILW) and' Low Level Waste' (LLW). HLW's are initially stored in underground Stainless Steel Tanks for decay of short lived radionuclides and subsequently vitrified in dedicated WIP. The ILW and LLW are treated in Nuclear Effluent Treatment Plant (NETP) before their discharge. The concentrates after treatment are immobilized and disposed in Near Surface Disposal Facility (NSDF).

Most of the operations in such plants are remote controlled due to high levels of radioactivity. Gaseous effluents are discharged through stacks of around 100 meters. The discharge limits are given by AERB such that the dose at fence post is within the authorized limit given by AERB (1mSv/year).

Nuclear Waste Management Plants (NWMP): These plants are of two types. First type is Effluent Treatment Plant (ETP) in which liquid effluents are chemically treated and its effluents containing low activity are diluted and discharged to water body. Solid wastes of low and intermediate activity are converted to solid concrete blocks so that there is no leaching to ground water. These are stored in near surface storage site in the plant. High level wastes are converted to glass and filled in double-walled Stainless Steel containers, to minimize chances of leakage to underground

water. These too are stored at site and are water cooled. Both these fixing processes are done in Waste Immobilization Plants. These too are designed and operated as per AERB guidelines given in Annexure 4.1. The details of the waste management practices followed in India (Refs. 3, 4) are given in Annexure 4.2. Glossary of nuclear terms appearing in the manual are given in Ref. **5.**

1.8 Brief Description of Project

Introduction to EIA document (Chapter 1) of the document should include the following:

Profile of the project proponent, name and contact address with-mail, implementing organization, and organizational chart and project consultant are to be detailed.

Brief description of the project, nature, size, phasing (if any), cost and location are to be given. Its importance to the country and the region are to be included. Project site description- survey/ khasra nos, village, tehsil, district, state, extent of the land, latitude and longitude of the boundaries are to be furnished. Criteria used for its selection san be given in the form of summary of site selection committee report.

Description of existing national environmental laws/regulations on the proposed activity is to be brought out clearly. If there are any notified restrictions/limitations from the environmental angle, issued by the District administration, State or Central government, the same should be furnished.

Details of litigation(s) pending against the project/ proposed site and or any direction passed by the court of law against the project / proposed site, if any, should be stated.

In case of expansion of the project, the environmental compliance status for the existing project should be explained for the following:

Validity of the water consent, air consent, for existing projects conforming to regulatory standards, conditions stipulated while giving clearance and their compliance standards;

Notices/directions issued by the regulatory agencies under section 33(A) of the water act 1974 as amended, under section 31(A) of the air act 1981 as amended, under the provisions of the E (P) Act 1986 during the last one year.

Terms of reference provided at the scoping stage by MoEF should also be included.

PROJECT DESCRIPTION

2

2.0 Preamble

Nuclear Power Plants and other nuclear fuel plants all over the world are designed, built and operated as per the guidelines of International Atomic Energy Agency, Vienna (Ref. 6). These guidelines are adopted by regulatory body of the country, which, in the case of India, is Atomic Energy Regulatory Board (AERB), Mumbai. AERB has produced a large number of codes, standards, manuals and guides. Codes and Standards are mandatory as per Atomic Energy Act 1962. Annexure 3 gives a list of AERB publications which cover all stages of design, construction, commissioning, quality control, radiation control, QA/QC, reauthorization, emergency preparedness etc., of nuclear plants. AERB issues authorized dose limits for air and water discharge of effluents from the plant (Ref. 7). The basis for fixing such limits is briefly given in Annexure 5 and is discussed in detail in the relevant AERB documents.

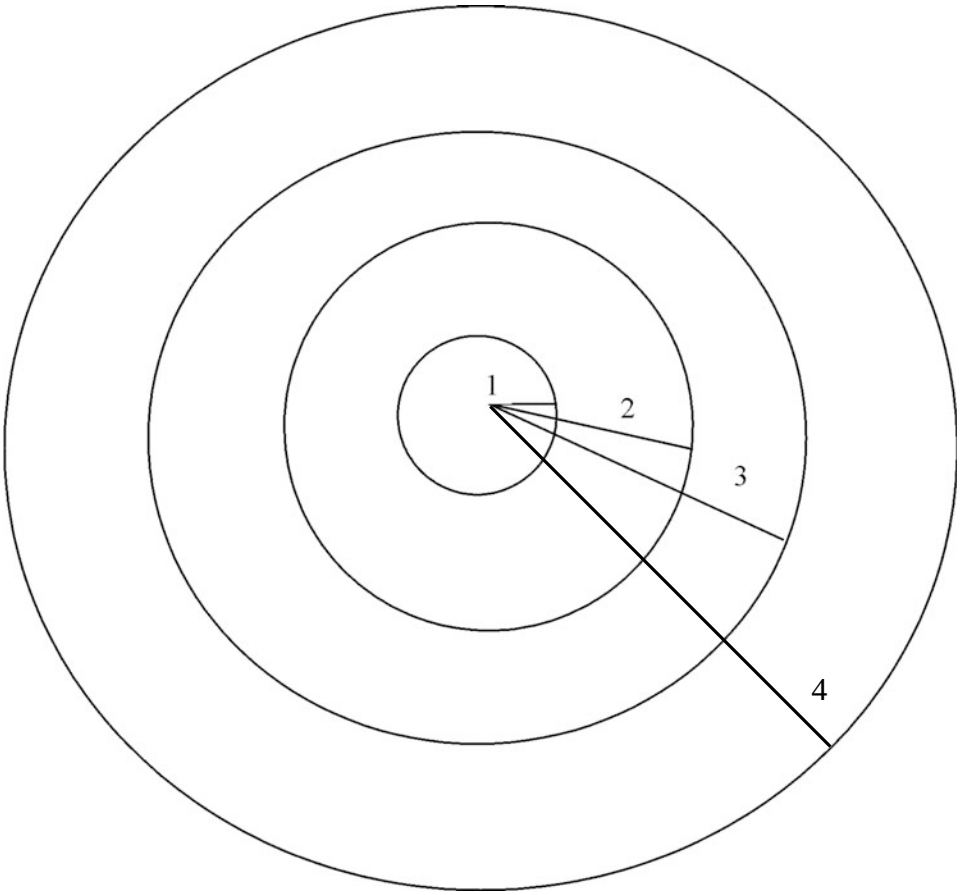
Indian nuclear power program has 2 added features to deal with such unlikely events.

a) Zoning,

b) Environmental Monitoring Laboratory at every NPP site.

a) Zoning :

- 1.5 km around the plant is a fenced area called Exclusion Zone and is under total control of the plant. No member of public is allowed to enter without permission.
- 5.0 km around the plant is a restricted area called Sterilized Zone. No new activity is permitted in this area. Existing activities, people, structures continue to remain and any change need specific approval from local authority designated.
- 16 km Emergency Planning Zone; Usually Township, Environmental Monitoring Laboratory, Schools, Hospitals are located in this Zone.
- 30 km radius zone called Impact Assessment zone is normally monitored by Environmental Monitoring Laboratory



1. Exclusion zone (1.5 km from project site)
2. Sterilized zone (5.0 km from project site)
3. Emergency Planning zone (16 km from the project site)
4. Impact Assessment zone for EML (30 km from the project site)

Fig. 2.1 Study Area

This ensures that in the event of radioactivity releases from the plant, general public and environment are not adversely affected. Detailed disaster management plans are prepared and periodic emergency drills are conducted when the plant goes operational.

b) Environmental Monitoring Laboratory : This laboratory should go into operation at least 2 to 3 years before the plant starts and collect monitoring data on air, water, soil, food and biological samples for background radioactivity, conventional pollutants etc., and on site meteorological data . This laboratory is expected to continue measurements for a stipulated period, even after de-commissioning of the plant.

The laboratory is usually in sterilized zone or beyond and serves as control room for emergency drills.

Site selection for NPP is a very elaborate and complex exercise. Annexure 2 briefly describes the methodology. The criteria (defined and elaborated by AERB) are very elaborate, based on international experience and data. Enormous amount of field data is studied before the committee takes a decision. The site is cleared by AERB.

2.1 General

Nuclear Power Plants (NPP's) are built all over the country to meet electricity demand of the region, in particular, and of the country, as a whole. Such plants are of large power generation capacity and serve as base load stations and are engines of growth and development of the region. India has adopted a three-stage nuclear power program. Under this, Pressurized Heavy Water Reactors (PHWR's) of Indian design in 3 capacities (220 MWe, 540 MWe and 700 MWe) with a total installed capacity of 10,000 MWe are proposed to be built at different places in India. These power plants use natural uranium as fuel, heavy water as moderator and primary coolant and light water as secondary coolant. The light water gets heated and produces steam, which in turn rotates turbines, and produce electricity. However, while uranium-235 is spent in the generation of electricity, the major component of natural uranium viz. uranium-238 produces plutonium inside the fuel elements, by activation process. Second stage of India's nuclear power program proposes to build fast breeder reactors using the plutonium available from spent fuel of first stage. The fast breeder reactors are expected to produce more fuel, as uranium-233 through breeding of thorium than the plutonium spent. At present, only one fast breeder reactor of 500 MWe power is under construction at Kalpakkam, near Chennai. Thorium, processed from beach sands and converted to uranium-233 in breeder reactors is planned to be used as fuel for third stage NPP's.

In view of the 3 stage program, it is necessary to take out plutonium from spent fuel of PHWR's. Hence Nuclear Fuel Reprocessing Plants (NFRP's) are built at some of the NPP sites. We have such plants at Tarapur and Kalpakkam. One plant can reprocess spent fuel from 2-3 NPP's of PHWR type. FRP's generate radioactive waste which needs to be treated and fixed properly so as not to cause any damage to human health or the environment. This requires Nuclear Waste Treatment Plant (NWTP) where liquid effluents from NFRP's are chemically treated. Depending upon the level of radioactivity, the waste is fixed in Nuclear Waste Immobilization Plant (NWIP). Such plants are also put up along with NFRP's at some of the NPP sites. At present, such plants are at Tarapur, and Kalpakkam.

The second type of Nuclear Power Plants in India (operating and under construction)are of foreign design (U.S.A., U.S.S.R) and all of them use enriched uranium (with higher % of uranium-235 than available in natural uranium) as fuel, light water as moderator and coolant. These are called Light Water Reactors (LWR's). In future, spent fuel from these may also be processed and Plutonium from such NFRP's may also be used in fast breeder reactors.

Under the EIA notification, 2006 it is now mandatory that EIA is carried out for NFRP's, NWTP's and NWIP's even if they are constructed as add-on's at NPP sites. Therefore, if it is planned to construct them along with nuclear power plant, single EIA incorporating information relevant to add-on's can be submitted. However, if such units are planned and built later, separate EIA reports in the same format should be submitted.

The TOR covering Nuclear Power Plant (NPP), Nuclear Fuel Reprocessing Plant (NFRP) and Nuclear Waste Management Plants (NWMP) are given in Annexure 1.

2.2. Project Description

This chapter on project description in the EIA study report to be prepared by the proponent should include::

- Broad details of the plant/s, location, layout and implementation schedule of the project

- Type of the project (new/expansion)
- Relevance of the project in the light of existing development plans of the region
- Project coverage, master plan, phasing and scope
- Description of the project site, geology, topography, transport and connectivity
- Summary of site selection committee report recommending the site proposed and alternative sites recommended, if any.
- Availability of ports, roads etc for transport of heavy equipments during construction and operational stages of the project
- Overall suitability of the project site and the proposed activity in the light of the existing environmental acts and serious deviations, if any.
- Special technologies involved in the design, construction and operation
- Description of various sections of the plant i.e. buildings, equipment, components and systems, utilities, spent fuel storage etc. Information on capacities and sizes to be included
- Number of such units to be built
- Details of emissions and discharges- gaseous, liquid, solid
- Cooling water intake and discharge details-flow, structure items
- Availability of power, water etc during construction and operation of the project
- Estimated water budget during construction and operation of the project
- Estimated Power requirement during construction phase
- Cost including environmental cost
- Source of financing
- Infrastructure availability such as schools, hospitals in and around the project site to meet the requirements of the staff and to be available for handling injured/radiation exposed persons in the event of disasters.
- Type of Land acquired/proposed to be acquired: agricultural, grazing-farms, irrigated, non-irrigated, forest, barren
- Mode of acquisition: government/private
- Number of trees to be cut : Permanent/to be replanted
- Number of persons to be displaced (summary of R & R plan)
- Resources such as construction material, equipment, manpower, timeframe etc., required for project implementation and whether these are available indigenously or to be outsourced

Essential Toposheets / Maps to be provided with TOR application

a. Topographical map

A topo sheet (1:50,000 scale) of the study area (exclusion and sterilized zones) delineating the major topographical features such as land use, drainage, locations of habitats, major constructions including roads, railways, pipelines, major industries if any in the area are to be mentioned.

A topo sheet covering aerial distance of 16 km from the proposed project location delineating environmental sensitive areas as specified in Form I of EIA notification dated 14th Sept 06.

- Area drainage contour map of the project area and up to 1.5 km shall be clearly indicated. In case of any proposed diversion of nallah/canal/river, same shall also be shown in the map.
- Hydrographic charts of the off-shore area giving general morphology of the coastal stretch to a scale of 1:50,000 shall be submitted covering water depth, upto 10 m beyond the maximum proposed dredging depths of the project and covering a distance of 5 km along the coast from the project limits on both sides.
- The CRZ maps indicating the High Tide Level (HTL), Low Tide Level (LTL), coastal feature maps from an authorized agency and the project lay out superimposed on the map should be submitted on 1:5000 scale map. This map should be certified by the state/Union Territory CZM authority.

b. Remote sensing imagery

Land use map of the study area to 1: 50,000 scale based on recent satellite imagery of the study area delineating the agricultural land (irrigated, un-irrigated, un-cultivable land-as per the revenue records, forest area- as per the records) grazing & waste land is to be shown.

c. Digital Elevation Model (DEM) / Contour map
Contour map of acceptable contour intervals as required by the study of core zone and site plan of the area showing the various proposed break-up of the land is to be shown.

- Description of the project site, geology, topography, transport and connectivity, demographic aspects, socio-cultural and economic aspects, villages, settlements, meteorological data.
- Environmental data relating to history of natural calamity such as cyclones, storms surges coastal areas, tornado, flood etc. should be discussed.

2.3 Description of Activities and Ancillary Operations

Details of various activities involved both during construction phase and operational phase along with flow charts duly indicating required resources should be described, supported with sufficient details in appropriate tabular forms in order to enable assessment of impacts of the activities on various facets of environment.

Requirement of housing for the workers and employees both during construction as well as operational phases should be specified in detail and how they will be catered to by the proponent. In the event the proponent proposes to develop township for housing the workers/employees involved in the project then should submit details of various types of buildings envisaged, layout plan of township, utilities and services along with methods of disposal and treatment of sewage. The proponent should comply with all statutory provisions and directions, as may be, imposed by concerned local bodies in this regard. Details of utilities such as water supply, power supply, along with sources and distribution network should be mentioned in the EIA report.

2.4 Use of Public Infrastructure

The proponent should furnish the connectivity of the project site to national road and rail network to the proposed site. In case the existing road and rail facilities are utilized, the proponent should furnish details of extra capacities required to augment the existing connectivity so that the infrastructure is not subject to congestion. The layout of such road and rail facilities should be incorporated in the project layout. Approval of appropriate authorities for the proposed layout of the connectivity should be pursued by the proponent and implemented as part of the project such that the public hitherto availing these utilities are not deprived of these road and rail facilities as a consequence of the project implementation.

2.5 Manpower Requirement

The proponent should indicate the requirement of various categories of manpower such as skilled, semi-skilled, unskilled workers, technicians, engineers, managers and other professionals for both construction phase and operational phase. The proposed training methods for imparting and up-gradation of specialized skills, where required, should be mentioned in the EIA Report.

2.6 Project Implementation Schedule

The proponent should also submit the detailed project implementation schedule bar chart, CPM/ PERT chart etc., duly bringing out interrelationship of major activities.

ANALYSIS OF ALTERNATIVES (TECHNOLOGIES AND SITE)

3.0 General

In case, the scoping exercise results in need for consideration of alternative sites or technologies on account of predicted environmental impacts, the details of such alternatives considered should be included in this chapter.

These details should comprise:

- Description of various alternatives like locations or layouts or modern technologies studied
- Comparison among different types of nuclear plants
- Comparison of cost with coal, oil or gas fired power plants
- Summary of adverse / positive environmental impacts of each alternative
- Selection of alternative

There are only two alternatives at present so far as nuclear power plants are concerned. If the NPP's are to be built with foreign collaboration / assistance, they are of LWR type except for Canada where they could be of PHWR type. Since NPP's are always built as twin units/site or in multiples of 2, generation capacity of each unit is determined by the power requirements of the region and the highest capacity reactors which can be supplied by the vendor and the capacity of the power grid.. If they are of Indian design, they have to be of PHWR Type of 540 or 700 MWe generating capacity as new units of 220 MWe will no longer be built.

DESCRIPTION OF ENVIRONMENT

4.0 Introduction

Environmental data to be considered in relation to nuclear power plant and nuclear fuel projects include (a) land, (b) air, (c) noise, (d) water, (e) marine, (f) biological (g) socio economic and health and (h) background radioactivity.

Nuclear power plants do not produce any significant conventional air/water pollutants. The radioactivity discharged by them to the air and water is regulated by Atomic Energy Regulatory Board (AERB) directives and a stack is provided for release of gaseous radioactivity. There are no solid radioactive wastes discharged to the environment. However, they do require large quantities of water for steam generation and for cooling purpose. Hence the plants have to be located either along the sea coast or along a large perennial river or a large dam / lake. The concerns at all these sites are

- The water temperature should not rise more than 5 degrees C above the ambient temperature for inland plants and more than 7 degrees C for coastal plants
- Outlet to inlet temperature difference for condenser cooling water should not be more than 10 degrees C
- Water should not contain more than permitted level of radioactivity
- Biodiversity should not be adversely affected

Attempts have been made to model temperature distribution around the discharge point to estimate the spread of the hot water and its temperature distribution (Ref. 8). Later, Department of Atomic Energy (Board of Research in Nuclear Sciences) initiated a 4 years

Multi-institutional experimental study to validate different model studies at Kalpakkam, Kaiga and Kudankulam to measure the temperature distribution around the discharge point in different seasons. The coordination committee had members from DAE, MoEF, NIO. Kochi, NIOT, Chennai, OPMES-CECRI, Tuticorin and NPCIL. Environmental Monitoring Laboratories at all the three sites actively participated (Ref. 9). Studies Confirmed that at none of the places the rise in temperature was more than permitted, though temperature distribution varied with site and season.

The permitted concentrations for water bodies and permitted rise in temperature at the discharge point should also be given as annexure to the report. It is necessary to collect the relevant baseline data from the following main sections so that when the plant goes into operation, its impact on the environment can be assessed. All the standard water (surface, ground and marine) and air quality parameters should be monitored and standard protocols should be utilized. Permitted levels of air and water radioactivity are prescribed by the AERB, in line with International Standards and for conventional chemical pollutants and temperature, national standards stipulated by MoEF / CPCB, are to be met (Ref. 10)

Every Environmental monitoring Laboratory is provided with a Manual of Standard methods for sampling, sample analysis, measurement procedure, instrument/technique to be used and data analysis and presentation (Ref. 11). This has been done to ensure that all Environmental Monitoring Laboratories in the country follow identical methodolody and their data is intercomparable.

Study Area:

As a primary requirement of the EIA process, the proponent should collect primary baseline data in the project area as well as in the area falling within exclusion and sterilized zone from the proposed project site and secondary data should be collected within 30 km distance from the project site. Baseline information as stated earlier is required to be collected by field survey, monitoring etc. Secondary data with its source should be clearly mentioned.

4.1 Land Environment

Land use / Land Cover

In the event land acquisition from either public or private sources is involved, justification for the extent of the area proposed is to be necessarily given. Availability of land for earmarking for the project activity without causing any hardship to local community and their socio-cultural and economic aspects is very important. Availability of required land for acquisition is to be ascertained from local authorities, revenue records etc. A location map to 1:50,000 scale presenting recent features with the help of satellite imagery of project area (Annexure 6) and surrounding area covering 30 km from project site delineating environmental sensitive places like protected areas notified under the wild-life (Protection) Act, 1972, critically polluted areas as identified (Annexure 7) by the CPCB from time to time, notified eco-sensitive areas, inter-state and international boundaries is to be prepared and submitted by the proponent.

Many a time, acquisitions of large stretches of land and areas being used by the local habitat may be necessitated requiring rehabilitation and resettlement (R&R) measures. It may also become necessary, in some cases, that some of the existing communities and villages may require to be shifted to other areas to earmark the required area for development. The proponent has to undertake required rehabilitation measures in such cases as a part of the project. These aspects should be sufficiently detailed. The communities likely to be affected should be informed well in advance, in consultation with concerned authorities, such that they may express their concerns during the public consultation process.

Topography

Landforms, terrain, coastal and inland topography etc., may get affected due to construction of the plant.

Baseline data is to be given on description of existing situation of the land at the proposed project area including description of terrain viz., hill slopes coastal and inland topography, coastal features (lowland, beaches, littoral areas), terrain features, slope and elevation.

Geology

Geology of the area is very important to ascertain seismic sensitivity. Baseline data is to be provided on rock types, rock texture and structure, geologic conditions, fractures, fissures, geophysical and morphological details, hydrology, history of volcanic activity, seismicity and associated hazards.

Soil Quality

Soil data including type, classification, characteristics, soil properties etc., are important from engineering considerations for design of structures, loading capacities, stockpiles etc. Changes in parameters of soil also may affect plantation and vegetative growth, which in turn may endanger the health of local community.

Baseline data of the soil ascertained by soil investigations carried out is to be provided along with the monitoring stations as shown in Table 4.1 and Table 4.2. This should include collection and measurement of natural and man-made radioactivity concentrations. The elements to be monitored in soil include U–238, Th–232 and their progenies, K-40, H-3, Cs-137, Cs-134, Sr-90, Zr-95, Nb-95, Mn-54, Ni-63, Ru-106, Co-60, Zn-65, Ce-144, Pu-239, Pu240, Am-241. Field surveys including nuclear radiation dose measurements. Soil surveys should include physical and chemical properties and radioactivity levels, in addition to the engineering properties of the soil. Annexure 8 gives the methodology, frequency, parameters to be analyzed for soil quality. Soil data in the proposed green belt area is required to ascertain the plantation suitable for development of greenbelt and for rain water harvesting.

4.2 Water Environment

Water environment includes ground, surface and marine. Baseline data with regard to these three environment should be generated (Annexure 9). In addition to the routine physico-chemical parameters for the ground, surface and marine waters the total and isotopic radioactivity contents of specific radio-nuclides must be measured. These include U–238, Th–232 and their progenies, K-40, H-3, Cs-137, Cs-134, Sr-90, Zr-95, Nb-95, Mn-54, Ni-63, Ru-106, Co-60, Zn-65, Ce-144, Pu-239, Pu-240, Am-241 in both surface and ground water samples. In case EIA is for expansion projects where NPP's are operating, data on activity due to fission and activation products including Tritium must be collected. Besides water, other aquatic components such as algae, sediment, fish etc., should also be analysed for their radioactivity contents.

Groundwater

Groundwater quality is an important parameter, as change in its chemical parameters will affect the water quality. Baseline data of groundwater quality for one season are to be collected. The monitoring stations and the quality of the ground water should be presented as shown in Table 4.3 and 4.4. In case it is proposed to tap the groundwater during construction and/or operation stage(s), the same should be quantified, and source of water supply should be identified. Ground water table and its fluctuations with time should be assessed.

Surface Water

Baseline data on location of sources of surface water like surface streams, lakes, rivers, etc., along with their description, present water quality are to be furnished. The description of the water sampling locations should be given. Surface water monitoring locations and quality is to be presented as shown in Table 4.5 and Table 4.6. In case it is proposed to tap the surface water during construction and / or operation stage(s), the same should be quantified, and source of water supply identified.

The study should cover the following ;

- Locations of monitoring stations with direction and distance from the site
- Details of springs, rivers, streams, nallahs, lakes, reservoirs in the study area
- Physico-chemical characteristics including heavy metals, biological, bacteriological characterization of surface water resources for assessment of water quality.
- Water quality monitoring at upstream and downstream side of the project should be carried out
- Delineation of watersheds and water drainage pattern in the study area.
- Surface water balance

4.3 Marine Environment

Coastal Hydrology/Geomorphology

In the case of coastal plants, marine environment study for natural and artificial radioactivity data is to be collected as part of baseline study, along with oceanographic data covering the following parameters:

- Tides
- Waves (wind waves and swells)
- Storm surges
- Currents
- Salinity
- Sea water temperature
- Suspended load and their profile upto the proposed water
- Seabed bathymetry discharge point

Baseline oceanographic data should extend at least to depths more than 10m. Details of mangroves, marshes and other coastal vegetation, coastal stability, seismic characteristics, history of any endangered species, coastal erosion and shoreline changes should be furnished

For coastal plants, baseline data should be collected on sea water temperature and on chemical parameters in the open sea and near the proposed site to determine characteristics in the marine environment such as BOD, DO, pH, TSS etc. and presented as given in Table 4.5 and Table 4.6. The elements to be monitored in marine environment include U–238, Th–232 and their progenies, K-40, H-3, Cs-137, Cs-134, Sr-90, Zr-95, Nb-95, Mn-54, Ni-63, Ru-106, Co-60, Zn-65, Ce-144, Pu-239, Pu-240, Am-241. Construction of jetty if any should be clearly stated and studies relevant to assess their environmental impacts should be provided.

4.4 Air Environment

Major pollutants generated during construction phase are dust and gases. Road traffic, crushing, grinding, screening, blasting, vehicular traffic and DG set also produce gaseous pollutants. Environmental Monitoring Laboratory (EML) should provide data on conventional pollutants (PM10, PM2.5, SO_2, NOx) and background radiation levels. Long lived gross alpha and gross

beta Levels, natural radioactivity (U, Th and their progenies and Potassium-40) and other radio nuclides like H-3, Be-7, Cs-137, Cs-134, I-131, Sr-90, Zr-95, Nb-95, Mn-54, Ni-63, Ru-106, Co-60, Zn-65, Ce-144, Pu-239, Pu240, Am-241 should be analyzed from pooled air filters samples. The monitoring locations and the data is to be presented as shown in Table 4.7 and Table 4.8.

Meteorological Data

Meteorological data covering the following should be incorporated in the EIA report to be submitted by the proponent. The data for at least a 10-year period should be presented from the nearest meteorological station, except for the history of cyclones and floods for which 50-year data is required.

- Wind speed and direction,
- Rainfall,
- Relative humidity,
- Temperature,
- Barometric pressures and
- History of cyclones / floods
- Mixing height using SODAR

Wind Speed and Direction

For preliminary studies, information may be obtained from the available meteorological records of the area. Recording of velocity and direction of wind at the proposed site should be obtained by installing continuous and self-recording anemometers. The data collected should also be correlated with the data available at places nearest to site.

Rainfall, Humidity, Temperature

Historical data on other parameters like rainfall, temperature, humidity of the proposed site area should be collected. Seasonal changes of climate are associated with the changing monsoons. The data on annual average, minimum and maximum temperature, rainfall, relative humidity should be provided in the report. The records on such data for the past may be available with the Indian Meteorological Department (IMD), Pune or at the station nearby. Current data at site should be collected by EML.

4.5 Noise Environment

Baseline data of noise levels in the project area and the neighborhood habitat is to be ascertained and monitored as per CPCB guidelines. Noise levels should be recorded using integrated noise level meter. Noise standards have been designated for different types of land use, i.e. residential, commercial, industry areas and silence zones as per annexure 11. The details of noise levels are to be given as indicated in Table 4.9.

4.6 Biological Environment

The baseline status for biological environment should be established by studying distribution pattern, community structure, population dynamics and species composition of flora and fauna. Biological environment like water encompasses both land, coastal and marine habitat and as

such field surveys differ widely in the three cases. Information of flora and fauna within the study area should be given separately. Background natural radioactivity levels should be determined in samples of flora and fauna along with bioaccumulation of any specific radio isotopes.

Flora

- Assessment of plant species with respect to dominance, density, frequency, abundance, density index, similarity index, importance value index, mangrove in wet-land coastal areas
- Quantitative estimation of forest and non-forest flora
- Information on the dependence of local people on minor forest products
- Photographs showing the vegetation in the area and important places

Fauna

- Assessment of fauna, indicating endangered and endemic species with respect to Schedule of the Wild Life Protection Act
- Location of National Parks, Sanctuary, Biosphere Reserve, Tiger Reserve, Elephant Reserve, wild life migratory routes within 30 km from the project site.
- Biodiversity, terrestrial and aquatic

In addition to the flora and fauna food samples also need to be analyzed and monitored for the following elements U–238, Th–232 and their progenies, K-40, H-3, Be-7, Cs-137, Cs-134, I-131, Sr-90, Zr-95, Nb-95, Mn-54, Ni-63, Ru-106, Co-60, Zn-65, Ce-144, Pu-239, Pu-240, Am-241.

4.7 Socio-Economic and Occupational Health and Safety Environment

Socio-cultural impacts include all kinds of influences on the local community and people's life style such as relocation of villages, industrialization, population growth nearby, and the formation of slums. The data required for R&R of the effected population as per the state norms should be collected and made available.

Baseline data of parameters at the project area and the demography, particularly on human settlements including indigenous people, health status of the communities, existing infrastructure facilities in the proposed area and distance/area of impact due to the proposed activity should be collected.

Present employment and livelihood of these populations, awareness of the population about the proposed activity should be collected. Occupational pattern of people in the area should be presented (Table 4.10 and 4.11).

Data collected for population distribution in the emergency planning zone on critical population clusters and sensitive flora and fauna groups, if any, are to be used for risk assessment in the emergency situation.

There are a number of methods available for impact and risk assessment (ref.12, 13 and 14. Consultants must mention the merits of the method used and give their findings.

4.8 Public Utilities

Vehicular traffic during the construction and operational phases may result in excessive use of existing public infrastructure like roads, railways and in-land waterways etc., resulting in congestion and early ageing etc. Similarly public utilities such as water supply, power supply, drainage, etc may also get undue demand.

Baseline data of existing public utility infrastructure should be ascertained and reported to assess the impacts of the project on these public utilities in order to incorporate desired methods in the EMP and monitor the same during the construction as well as operational phases of the project.

5

ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGRATION MEASURES

5.0 General

In the construction phase of the project the environmental pollution is due to the conventional sources and noise. The data on both is collected as part of the baseline measurements. The environmental impact and mitigation measures due to these conventional pollutants (soil, water, air and noise) should be detailed out.

There are two types of environmental impacts considered for nuclear plants. The first ones are those which occur under normal operation of the plants and the second ones are those which can occur under accident conditions. First ones do not have any observable adverse impact on the environment, flora or fauna as none of the nuclear plants produce conventional pollutants in high concentration (both during construction and operation phase) that are likely to have any adverse impact on environment. Radioactivity levels discharged through air or water route are also such that the nuclear radiation dose at exclusion zone boundary also called fence post (1.5 km radius around the plant) is only a small fraction of the radiation dose permitted for general population. The most important radioisotopes released through stack in PHWR type reactors are Tritium, Argon -41 and gaseous fission products of noble gases Krypton and Xenon and for Light water reactors are Iodine 131 and gaseous fission products of Krypton and Xenon. Most of these are short-lived.

Similarly, for water discharge of liquid effluents, radioactivity is mainly due to activation of impurities in moderator and coolant are in low concentration except H-3. Further, adequate dilution is assured so that both radioactivity and temperature at the outfalls are within permissible limits. No solid wastes are discharged to the environment and spent fuel is stored in underwater, underground ponds and cooled continuously. However, radioactive solid wastes produced at different stages of nuclear fuel cycle cover a wider range of materials, sizes, shapes, and degrees of contamination. These wastes are categorized depending on the radiation field, concentration, and type of radioactivity. They are segregated as compressible or non-compressible and combustible and non-combustible. Major portion of the total solid waste has low activity and is either combustible or compressible. Specially designed incinerators are employed for burning the combustible low level wastes for volume reduction before their safe disposal. It is usually kept in this manner for several months to a few years and latter taken up for reprocessing on batch to batch basis.

Permitted radiation dose, by definition, is that at which no damage will be observed either on man or on flora and fauna. It is seen that even at a site having multiple nuclear power plants(4 or 6) as well as those having NPP's along with nuclear fuel reprocessing plant and nuclear waste management plant (like Tarapur) do not contribute at exclusion zone boundary more than a few per cent of the permitted dose of 1 mSv/year for the population.

The impacts to be considered in the case of nuclear plants are due to the possibility of accidents in which radioactivity in significant amounts may be released to the environment through air or

water route and may cause adverse impact on people, flora and fauna and the attempt in the design and operation of nuclear plants is :

a) to minimize possibility of such accidents through design of multiple safety and control systems and laying down of operating procedures to minimize human errors and

b) to lay down emergency management procedures and test their working through mock exercises, periodically.

Emergencies that can occur in nuclear plants under worst conditions of failures of control and safety systems are called Design Basis Accidents (DBA). In such accidents, it is assumed that all critical control and safety systems fail simultaneously. The consequences of such accidents are then analyzed and it is then seen if the environment and public at large will still be safe. If not additional control/safety systems are added to ensure that even in such DBA, the environment and population around are safe. Ensuring that the design of the plant will assure this is done by AERB.

Details of control and safety features of each type of nuclear plant are given below. They are practiced internationally and are the minimum requirements of such plants.

It can happen that the accident is even worse than DBA postulated above and is even more catastrophic. Such accidents are called Beyond DBA (Worse than those assumed under DBA). Examples of such accidents are very major earthquakes, tornadoes and cyclones in coastal areas, terrorist strike etc. Such accidents can never be anticipated and / or fully programmed. Hence for Beyond DBA situations, Emergency Preparedness Plan is prepared and its efficacy is checked through periodic exercises and mock drills. Guidelines for preparing this plan are provided in AERB documents and the Executive Summary of this plan must be submitted to MoEF along with EIA report.

5.1 Nuclear Power Plants

Important features of Nuclear Power Plants are given in Chapter 2. The control and safety features of NPP's are as follows:

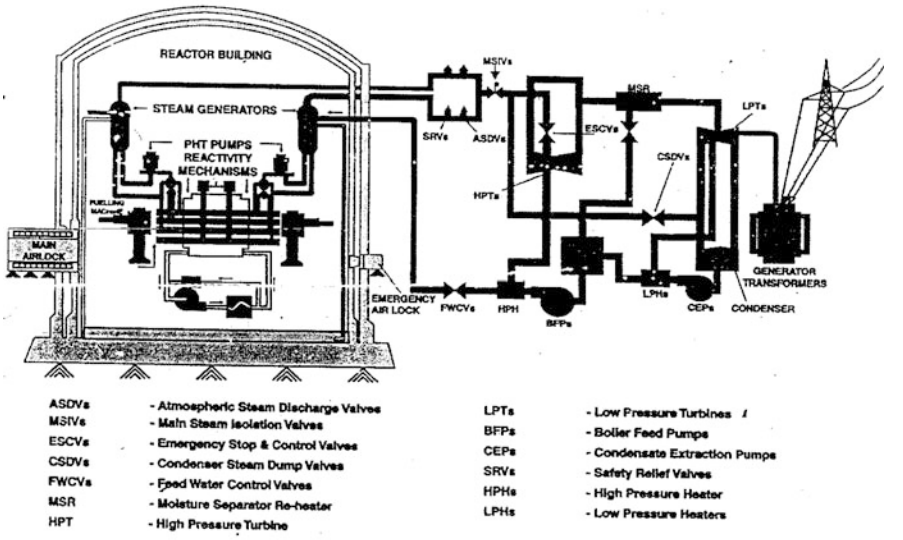


Fig.5.1 Pressurized Heavy Water Reactor (PHWR)

1. For control of the electrical power output of the plant there are 2 independent control systems. a) Control rods and b) moderator level. Control rods are made of neutron absorbing substances like boron or Cadmium. Inserting these rods into the core brings down the power level and raising them increases the power.

   Similarly, raising the moderator level increases the power and lowering the level decreases the power output. In PHWR type power plants, heavy water is the moderator and in light water reactors, ordinary water is the moderator. Moderator level control is slow control whereas control rods are faster in controlling the power output.

2. Increasing or decreasing the number of fuel elements in PHWR also increases or decreases the power level. Every day a few fuel elements are changed in PHWR. This is done by automatic fuelling machine through remote control. This provision does not exist in Light Water Reactors (LWR's) and fuel once loaded lasts for years without replacing.

There are two additional safety features in NPP's

(i) Fuel cladding: the fuel is clad in a double walled Zircaloy or stainless steel tube. Coolant flows through annular portion to cool and/or moderate the neutrons. This ensures that radioactive fission/activation products do not come into reactor environment.

(ii) Nuclear reactor is housed in a double walled pre-stressed concrete building with a gap between the walls. This is to ensure that even if there is a beyond DBA accident, radioactivity is contained in the building and id not released to the environment.

There are a number of safety equipments too which include neutron flux monitors, moderator flow monitors, moderator temperature monitors etc. All critical systems are triplicated and unless at least 2 out of 3 sensors give the same reading, the system is supposed to be not working properly. All the systems are operated in fail-safe manner i.e. if any system is not working as intended, the reactor will come to safe mode. It is to ensure safety of the environment and the population.

The EIA report should contain a brief description of control and safety features with their response times.

Environmental impact during construction phase is similar to any other industrial plant and air, water, noise levels have to be within CPCB/MoEF standards.

Light Water Reactors: From environmental considerations, there are no big differences. Instead of Trtium being the radioisotope of concern, Iodine-131 is the radioisotope of concern. The reactor system is much simpler as seen in the schematic diagram below. We have only 2 such units in operation at Tarapur and 2 units of 1000 MWe capacity each are nearing completion at Kudankulam in Tamil Nadu. More such units will be built in near future. A Fast Breeder Reactor of 500 MWe is being built at Kalpakkam which is expected to make second stage of # stage programme. Once built and satisfactorily operated, many more such NPP's will be built. They too will be of Indian design.

5.2 Nuclear Fuel Reprocessing Plants (NFRP's):

The main objective of fuel reprocessing are (i) recovery and reuse of uranium and plutonium produced in the reactor and (ii) transformation of radioactive waste into a suitable form for permanent safe waste disposal. The PUREX process is the basic process used in India and this is

based on dissolving spent fuel in nitric acid and separating uranium and plutonium from fission and activation products by extraction with tri-butyl-phosphate (TBP) in three or more successive cycles. The waste contains about 99% of the non-gaseous fission products, un-recovered uranium, plutonium and other minor actinides and activation and corrosion products. The low and intermediate level liquid wastes typically consist of solution from the second and third cycle of uranium and plutonium purification streams, condensates from concentrators and vessel off-gas systems, and waste from the solvents used in recycle of plutonium in the conversion process.

Gaseous effluent arises when the spent fuel is chopped and dissolved in nitric acid and comprises of fission product gases, Kr and Xe and some of the volatile species like iodine and ruthenium. Iodine, $CO_{x,}$ NO_x are removed by caustic scrubbing and the rare gases are discharged. Radioactive particulates and aerosols in the gaseous effluents are removed by HEPA filters and treated gases are discharged through stack.

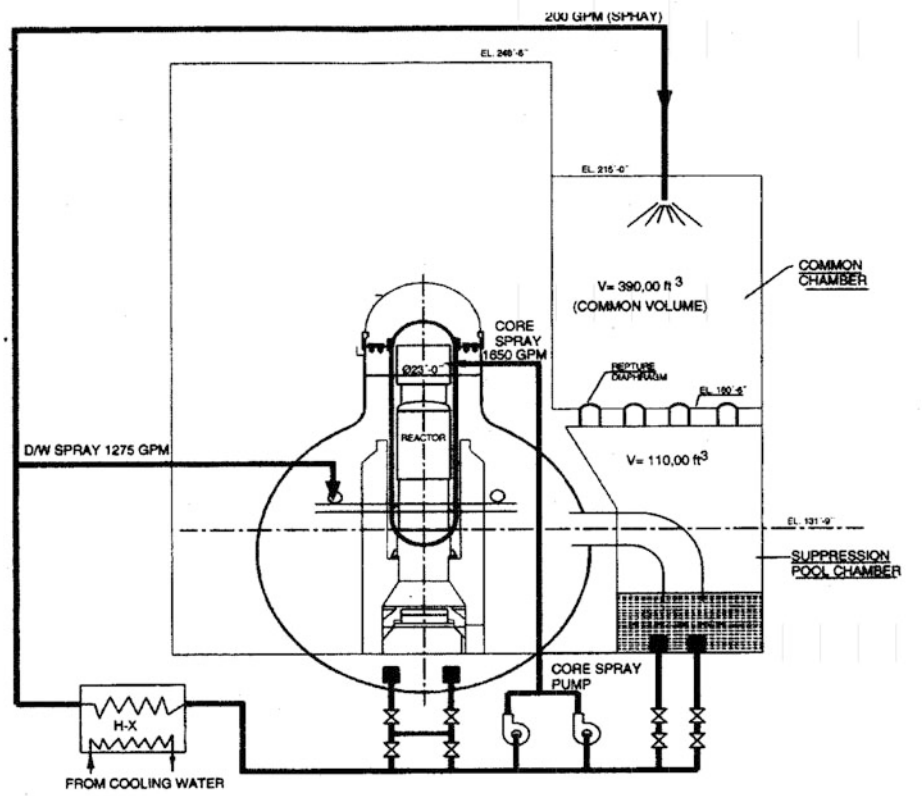


Fig.5.2 Light Water Reactor (LWR)

5.3 Nuclear Waste Treatment Plants (NWTP's):

Treatment of liquid waste from reprocessing plant is a multi-stage process.

Specific management schemes and techniques have been developed for the confinement of intermediate and high level wastes over the last 3 decades. The experience acquired to-date in the management of these wastes has resulted not only in satisfying regulatory standards but restricting the discharges to the environment far below allowed discharge limits. The major radionuclides of interest in these streams are Cs-137, Sr-90 and I-131 as fission products, Co, Fe, Ni and Cr as activation and corrosion products and small amounts of unrecovered plutonium and transuranics. Segregation of these waste streams according to their nature and contamination levels constitutes the basic step in the effluent treatment to follow. Low level waste is generally diluted and discharged to the receiving waters.

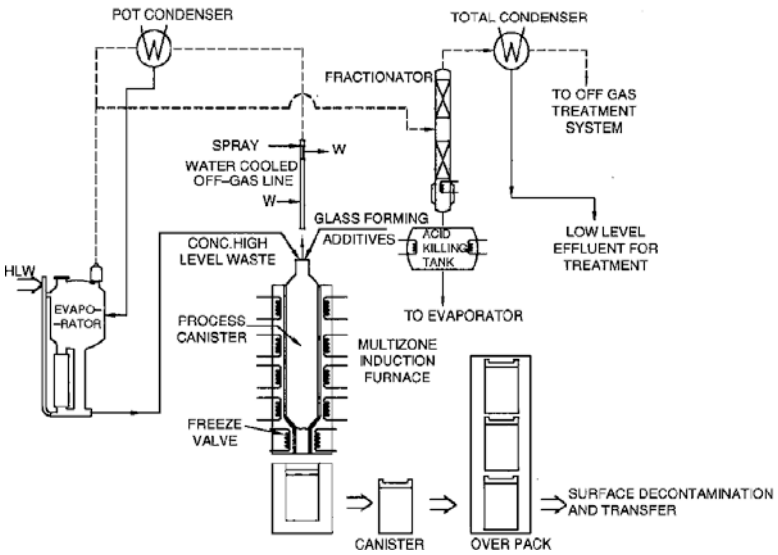
The treatment techniques involve chemical flocculation, sedimentation, ion-exchange and evaporation prior to their discharge in an environmentally acceptable manner. Decontamination by chemical treatment involves co-precipitation using phosphates, ferro-cyanides and hydroxides in association with scavengers used for effective removal of Cs-137, Sr-90 and Co-60. An overall decontamination factor upto 200 can be achieved. With the intention to restrict discharges of radioactivity to the environment to as low as possible, a very high volume reduction with practically zero-release has been attained by non-boiling solar evaporation at one of the NPP sites (Kota, Rajasthan). This site offers most favourable climatological conditions (high temperature, low humidity, high wind velocities).

Volume reduction techniques alone are not enough for the management of these wastes. The waste concentrates are required to be appropriately solidified or conditioned because solidification can immobilize the waste thereby diminishing its potential for migration of radioactivity.

One of the methods followed for intermediate level waste is to fix it in concrete and store. However, commercially available cement was unsuitable from leaching considerations. Hence special cement with additives and polymer impregnation was developed, having long-term durability and desirable holding properties. The solid waste is fixed using this cement into concrete blocks and stored underground

5.4 Nuclear Waste Immobilization Plant (NWIP's):

High level waste concentrates are required to be appropriately solidified or conditioned. Solidification immobilizes the waste thereby reduces its potential for migration and hence migration of embedded radioactivity. Fig.5.3 shows the flow chart for the Waste immobilization plant.



5. 3 Waste Immobilization Plant

Highly radioactive waste liquid from fuel reprocessing is first stored in high integrity stainless steel tanks. These tanks are located in stainless steel lined underground vaults which provide necessary containment as well as biological shielding. Immobilization plant utilizes a borosilicate glass process involving calcination followed by melting in the processing vessel, heated by an independently controlled multi-zone induction furnace.

After homogenization, the freeze valve indicator of the processing vessel is energized and the molten glass is cast into a separate high integrity stainless steel container. The canister filled with Vitrified Waste Product (VWP) is allowed to cool slowly in an insulated assembly.

The above VWP is stored in a specially engineered storage vault with constant surveillance and air cooling. The air is discharged into the atmosphere through stack. A single storage facility at Tarapur is good enough for the entire nuclear program of the country for the next decade or so. After about 30 years of interim storage, these canisters will be transferred to permanent burial place for which a number of sites are under study.

Thus, no solid waste is discharged into the environment. All the operations in WIP are remotely done and hence no personal radiation exposures occur. More details are available elsewhere (2,3) and regulatory documents of AERB are given in Annexure 4.

EIA report should give the actual plant details and monitoring points and possible environmental pathways other than stack, if any, to demonstrate that safety features are adequately built-in . General plan of treatment of all types of radioactive wastes is depicted in the fig.5.4 below..

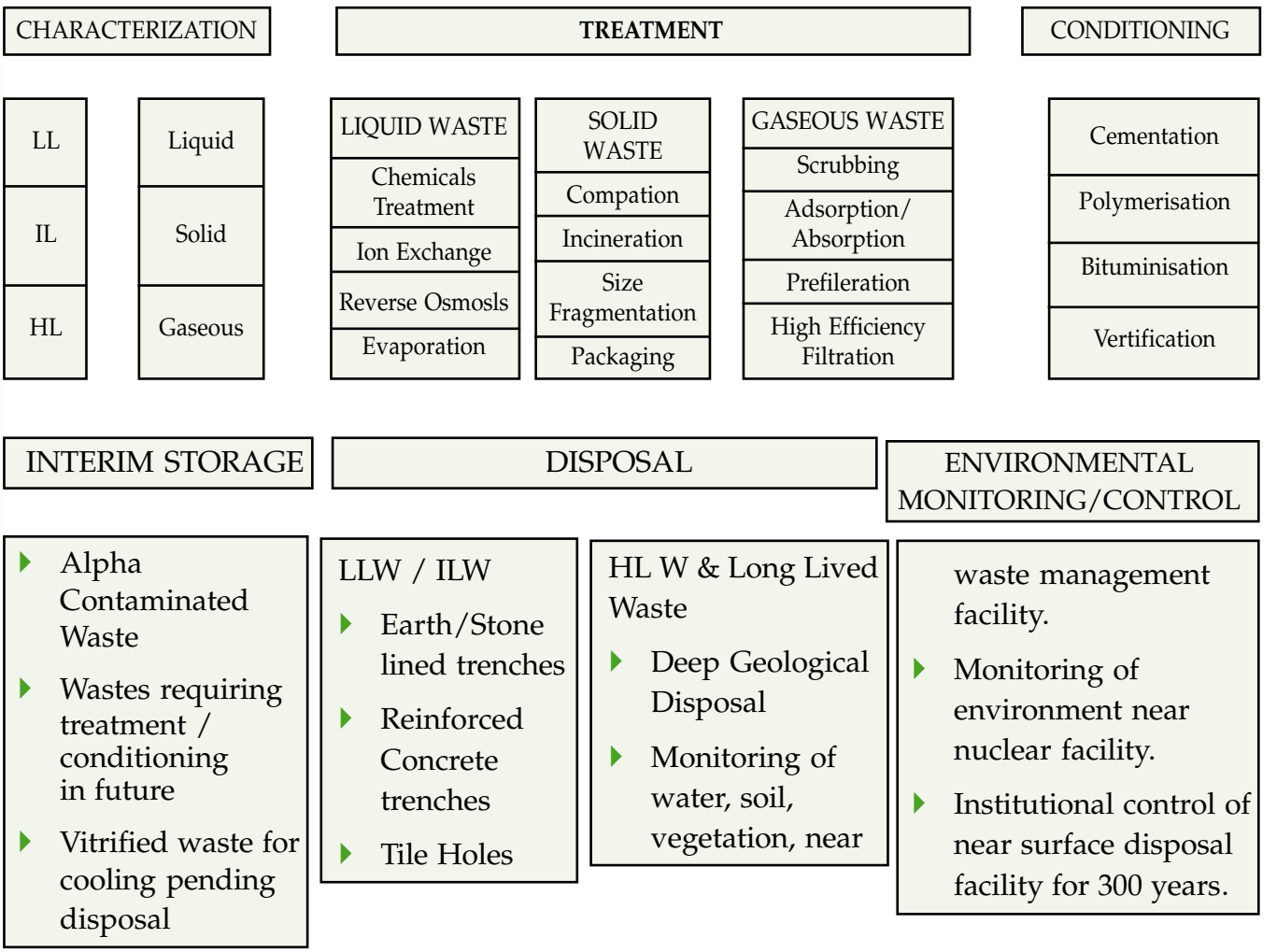


Fig. 5.4 Management Methodology of Different Types of Radioactive Waste

ENVIRONMENTAL MONITORING PROGRAMME

Environmental Monitoring Laboratory is established at the proposed plant site much before the plant to establish background air, water, soil and sediment pollution levels and noise levels for conventional pollutants. Meteorological parameters are also monitored on a continuous basis. This is done to ensure that during construction phase, pollutants and noise levels are within standards of CPCB/MoEF. Standard methods recommended by CPCB are to be followed.

Equally important aim of setting up this laboratory is to demonstrate compliance with radiation exposure limits set for members of public by regulatory body (AERB) based on international guidelines. This requires detailed measurements on a number of environmental matrices for radioactivity content that might have been transferred to them from the release of radioactive effluents during normal operations of NPP's. The samples are selected on the basis of potential pathway of exposure (Fig.6.1 and Fig.6.2). Associated data on utilization of environment and demography are used for the estimation of intake of radioactivity and the resulting radiation exposure based on International Commission for Radiation Protection (ICRP) principles. The number and type of samples and sample frequency are based on site specific considerations related to the utilization of local environment and existing population clusters. In general, more samples are collected close to plant premises or wherever population clusters exist and sampling frequency is reduced with increase in radial distance from the plant. Samples collected fall under 3 categories

(a) samples that are collected and analysed for the estimation of the dose to a member of the public and are directly related to this purpose. They include water and different food material.

(b) samples that serve as trend indicators like sediments and air particulates and (c) sensitive indicator organisms that accumulate specific radionuclide to a greater extent to serve as marker e.g. goat's thyroid for iodine and aplysia (stark fish) specific for cobalt. A quality assurance study is carried out using International Reference Centre (IRC, France) to ensure quality of measurements and data.

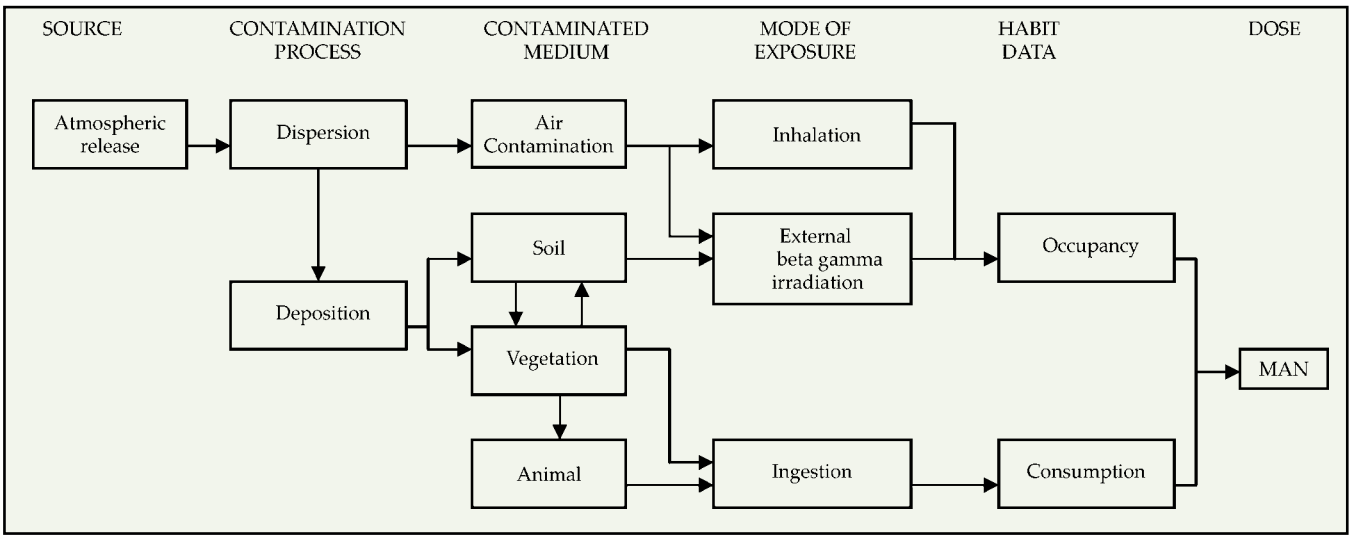


Fig. 6.1 Possible paths of human exposure in the environment for gaseous effluents

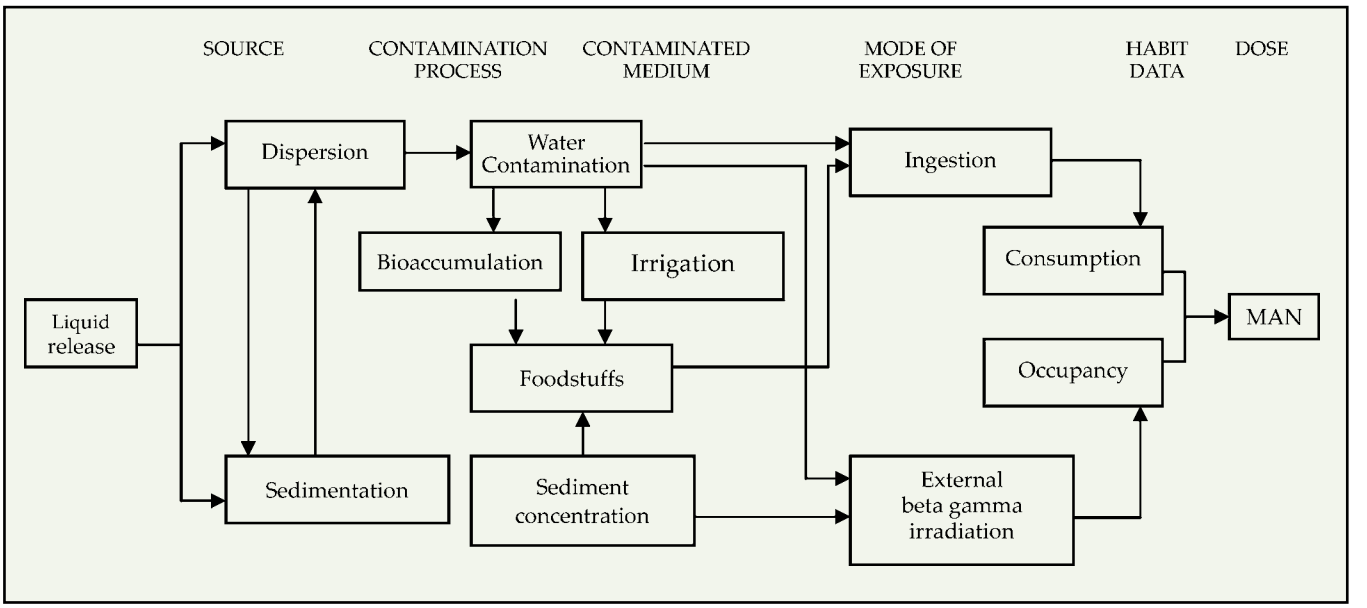


Fig. 6.2 Possible paths of human exposure in the environment for liquid effluents

A three tier system of regulatory control and compliance is employed for radiological surveillance of effluents and resulting exposure in the public domain arising from nuclear plant operations viz., (i) discharge criteria are specified for each plant in the form of technical specifications for individual radionuclides and release routes, (ii) effluents prior to discharge are monitored at the source level to ensure that the discharge criteria is met, and (iii) monitoring program is established for detailed survey of different environmental compartments within a radius of 30 km. These measurements are carried out by Environmental Monitoring Laboratory, mostly located in the township of each NPP. So far, discharge data as a function of the TECSPECS limit for the gaseous and liquid effluents from every NPP has shown strict compliance with prescribed limits.

To meet all the above objectives, Environmental Monitoring Laboratory (EML) is a very essential feature of Indian nuclear power program. The minimum requirements for EML are as follows.

6.1 Environmental Monitoring Laboratory

Location : Beyond sterilized zone, preferably in township

Transport : At least one vehicle for sampling and survey within 30 km radius.

Laboratories : At least 2 chemistry Laboratories, one for sample preparation and the other for chemical analysis.

Instrument Room/s: Air conditioned: To house ambient air quality monitoring systems, soil sampling augers, gross alpha and gross beta counters and alpha spectrometers for all environmental samples, Liquid scintillation Counters for trtium measrements Gamma spectrometer with HPGe detector for fission and activation product measurements, Personal Computers (PC's) for data management and atmospheric modelling, Thermo-Luminescent Dosimeter (TLD)readers, spectrophotometer, Atomic Absorption Spectro-photometer, micro-balance, low background beta counters, gross alpha and gross beta counters, low-level beta counter, beta gamma survey meter, scintillometer for background radiation dose mapping etc. Conventional water pollution monitoring requires pH meter, DO meter, turbidity meter, conductivity meter, BOD incubator, microscopes etc. Usually, there are many more systems for augmenting the basic system.

Similarly, for air sampling, Total SPM, PM-10, PM-2,5 samplers and automatic ambient air monitoring systems for gaseous pollutants are used at EML. At other sampling stations, bubblers are used for air sampling and measurements are done at EML using CPCB methods.

Meteorological Tower with anemometer, wind-vane, temperature and solar radiation measuring device mounted on the tower, SODAR for atmospheric stability study, Rain gauge and other requirements like baloons for high altitude measurements are required.

To serve as Emergency Control Room, it should stock Potassium Iodate (thyroid blocker) and Prussian Blue tablets (Cesium blocker), Communication equipments like walkie-talkie, mobile phones, Fax, etc.

Every EML is provided with a Manual of Standard Methods to be followed so that all EM laboratories in the country follow the same sampling, chemical analysis, measurement procedures, data reporting and report submission method. For example, water quality parameters reported are pH, temperature, turbidity, total suspended solids, total dissolved solids and conductivity. Inorganic parameters of water quality are total alkalinity, total hardness, calcium hardness, chlorides, sulphates, sodium and potassium. Heavy metals Cd, Cr, Cu, Co, Ni, Fe, Mn, Zn and lead are also to be reported. Most of the laboratories have ISO certification and / or accredition by NABL.

In the first survey within 30 km radius, background natural radiation dose is measured using either a GM survey meter or scintillometer, sampling sites are fixed as per population distribution criteria, soil, flora and fauna samples are collected and analysed. Samples of water, sediments

and organisms are collected from water body/ies from where water is supposed to be drawn for plant's requirements. Based on the results, sampling sites, sampling components and frequency is finalized. At all the selected sampling sites, environmental TLD's are placed for 3 months to measure natural radiation dose. TLD's are $CaSO_4$ doped with Dysprosium (Dy) and are used for radiation monitoring. For both types of monitoring, the same readers can be used. Reading a TLD also anneals it which resets it to zero value and the same TLD is ready for use again.

When the plant goes operational, personal radiation exposures of all the radiation workers in the plant is monitored using TLD badges. This service is provided from EML at most of the places. During pre-operational surveys, critical pathways (like goat's thyroid for Iodine- 131 from LWR or atmospheric weapon tests) are established by extensive sampling of flora and fauna over the land and under water. Critical pathways are also looked for toxic metals and inactive nuclides which are chemically similar to important radionuclides.

This chapter of the EIA report should include technical aspects of monitoring including measurement methodologies, data analysis, reporting schedules, emergency procedures. Even though details are given above, the report should contain details of the equipment and facilities actually built/proposed to be built/being used.

It should also include

- Matrix of environmental monitoring sites during construction and operation stage
- Monitoring facilities and their on-site Installation
- Frequency, location, parameters to be monitored
- Compilation and analysis of data, comparison with base line data and compliance to accepted norms and reporting system

Detailed budget & procurement schedules should be given.

It may be noted that if the proposed site is not virgin and has operating nuclear power plants and EIA report is being prepared for additional NPP's at the same site or for building NFRP and/or NWMP's or both, background air/water/soil/sediment and other background environmental data will show the presence of build-up of radioactivity due to operation of the existing plants. For example if PHWR type NPPs are operating at the site, tritium activity will be observed in all environmental samples. This background data is useful for the regulatory body if the environmental impact of the existing plants is within the stipulations. This data is also useful to AERB for apportionment of additional radiation dose at exclusion zone from the proposed new units.

7

ADDITIONAL STUDIES

7.0 General

Additional studies arising out of public consultation and comments of the appraisal committee and probabilistic risk evaluation must be included in this section.

7.1 Public Consultation

Public hearing with the issues raised by the public and the response of the project proponent in tabular form should be presented and discussed. The issues identified by appraisal committee on the TOR should also be addressed.

7.2 Items identified by the proponent

The proponent may be able to identify issues beyond those included in the common TOR as may be specifically considered by him important from environmental point of view. In such cases the proponent should include such issues as additional studies under TOR and pursue them in the EIA study after the regulatory authority approves TOR.

7.3 Items identified by the regulatory authority

During the scoping process, the regulatory authority may direct studies on specific issues, beyond those included in the TOR proposed by the proponent, as may be specifically considered important from environmental point of view. In such cases the proponent should pursue those issues as additional studies in the EIA study after the regulatory authority approves TOR.

7.4 Items identified by the public and other stakeholders

After completion of the public consultation, the applicant shall address all the material environmental concerns expressed during the process, and make appropriate changes in the draft EIA and EMP. The final EIA report, so prepared, shall be submitted by the applicant to the concerned regulatory authority for appraisal. The applicant may alternatively submit a supplementary report to draft EIA and EMP addressing all the concerns expressed during the public consultation. A statement of the issues raised by the public and the comments of the applicant shall also be prepared in the local language and in English and annexed to the proceedings.

7.5 Risk Assessment and Disaster Management Plan

Risk assessment report as per the guidelines of AERB should be prepared by specialists in the field as per international practice in nuclear industry. Disaster Management Plan must include emergency planning, emergency procedures, details of infrastructure facilities available / planned and details on safety measures adopted. DMP is also to be prepared as per AERB guidelines. However, an executive summary of offsite emergency plan should be furnished.

Risk assessment requires data on population distribution, critical population groups, critical marine organisms, critical flora besides pollution levels radioactivity levels in all environmental compartments. All these data need to be collected. The programmes for risk and impact evaluation used (Ref. 12-14) need to be mentioned and risk / imacts evaluated.

Emergency Plans / Preparedness:

Accident at NPP in which radioactivity is released to the environment in public domain is postulated as a very low probability but high consequence event.

Emergency Preparedness measures include emergency preparedness exercises. A detailed Emergency Preparedness manual for such exercises which details procedures for conducting Emergency drills at plant, site and general emergency condition is to be prepared. EIA report should detail all the above features and whether the manual has been prepared.

7.6 Natural Resource Conservation and Optimization

Plan of action for conservation of natural resources such as water through the use of cooling towers, energy efficiency and green house gas reduction potential of the activity if any should also be highlighted in this chapter.

7.7Rehabilitation and Resettlement(R&R) Action Plans

Detailed R&R plan with data on the existing socio-economic status of the population in the study area and broad plan for resettlement of the displaced population, site for the resettlement colony, alternative livelihood concerns / employment and rehabilitation of the displaced people, civil and housing amenities being offered, etc and the schedule of the implementation of the project specific R&R Plan. The Corporate Social Responsibility / Community development need to be also prepared. It is to be arrived at after conducting the socio-economic survey of the surrounding population. Adequate budget should be provided in the project cost estimates to cater to the proponent's responsibility.

7.8Epidemiological and Health Status Survey

Since harmful effects of radioactivity and nuclear radiation exposures are both genetic and somatic, for a new site, it is advisable to carry out epidemiological and health status survey of the population living within 30 km radius around the proposed site. This job may be entrusted to the state health department or any reputed medical college and hospital in the area so that the data obtained has credibility with the local people. The survey should include a questionnaire for all members inhabiting the area followed by medical examination of unusual cases suffering from genetic disorders / abnormalities / con-genital disorders or diseases. The data will be useful in subsequently ascertaining whether NPP and / other plants at the proposed site could have caused such diseases. This study can be repeated every 10 years and the results will go a long way in allaying public apprehensions regarding ill-effects of plant operation. In case the proposal is for additional NPP's / nuclear fuel plants at the existing site where no epidemiological / health study has been conducted, the EIA should be submitted with the results of such an epidemiological / health survey. This data provides baseline of disease pattern, particularly any genetic diseases.

8

PROJECT BENEFITS

8.0 General

This chapter should cover the benefits accruing to the locality, neighbourhood, region and nation as a whole. It should bring out details of benefits by way of:

- Meeting demand of electricity
- Reduction of Green House Gas emissions
- Improvements in the physical infrastructure by way of addition of project infrastructure, ancillary industries that may come up on account of the project
- Improvements in the social infrastructure like roads, railways, townships, housing, water supply, electrical power, drainage, educational institutions, hospitals, effluent treatment plants, improved waste disposal systems, improved environmental conditions, etc.
- Employment potential : skilled, semi-skilled and unskilled labour both during construction and operational phases of the project with specific attention to employment potential of local population, necessity of imparting any specialized skills to them to be eligible for such employment in the project on a long term basis i.e., during operational and maintenance stages of the project.

9

ENVIRONMENTAL COST BENEFIT ANALYSIS

9.0 General

If recommended by the Expert Appraisal Committee at the Scoping stage i.e., at the time of deciding upon the TOR, this chapter should include the Environmental Cost Benefit Analysis of the project.

9

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

10.0 General

In practice, mitigation is emphasized in the EIA process following impact identification and prediction, and recommended measures will be an important part of the EIA report. These measures will be incorporated into the terms and conditions of project approval and implemented during the impact management stage of the EIA process. The objectives of environmental management are to:

- Ensure the mitigation measures are implemented
- Establish systems and procedures for this purpose
- Monitor the effectiveness of mitigation measures and
- Take any necessary action when unforeseen impact occur

10.1 Components of EMP

The EMP should contain the following:

- Summary of potential impact & proposed mitigation measures. Allocation of resources and responsibilities for implementation
- Administrative and technical setup for management of environment
- Institutional arrangements proposed with other organizations/Govt. authorities for effective implementation of environmental measures proposed in the EIA
- Safe guards/mechanism to continue the assumptions/field conditions made in the EIA
- Environmental specifications for contractors should cover the required safeguards during the design and construction stage
- Approach towards voluntary compliance (ISO 14001 & ISO 18001) should be explained

a) Construction Phase

- R & R of Displaced Persons
- Environmental Management during construction phase
- Site preparation
- Sanitation
- Air Environment
- Noise Environment

- Water Environment
- Land Environment
- Background radioactivity in air, water and soil

b) Operational Phase

- Air, Noise, Water, Land, Solid Waste and socio-economic Environment
- Community and green-belt Development
- Post project Radioactivity Monitoring and surveillance program
- Biological Environment Management

c) Emergency Preparedness- Documentation and Exercises- Plant, Site and General emergency.

d) Any other aspects that are required to be covered / included as per AERB guidelines / regulations.

e) Decommissioning of the project and subsequent plans.

After an expected operating life time, nuclear reactors will be shut down and dismantled after removing the fuel core and residual radioactivity. This procedure is called decommissioning and decontamination. The world-wide experience has been limited to the decommissioning of a few small research reactors. Dismantling requires removal of materials including soil having radioactivity above the regulatory limits from the site to facilitate unrestricted use of the site.

10.2 Environmental Management Cell

Proposal to set up a separate environmental cell to oversee implementation of the EMP and evaluate the results of monitoring should be furnished. Survey and analysis to be carried out periodically. Establishing a multidisciplinary internal environmental audit team for compliance review should be planned.

11

SUMMARY AND CONCLUSIONS

11.0 General

Summary EIA should be a summary of the full EIA report condensed to ten A-4 size pages at the maximum. It should necessarily cover in brief the following chapters of the full EIA report.

- Introduction
- Project description
- Analysis of Alternatives
- Description of the environment
- Anticipated environmental impacts & mitigation measures
- Additional studies
- Project benefits and costs evaluation
- Important Aspects of the Environmental Monitoring Program
- Important Aspects of the Environmental Management Plan
- Disclosure of consultants

12

DISCLOSURE OF CONSULTANTS ENGAGED

12.0 General

The EIA consultants shall have accreditation with Quality Control of India (QCI)/ National Accreditation Board of Education and Training (NABET) as per office memorandum dated 2nd December 2009 of MoEF. This chapter shall include the names of the consultants engaged with their brief resume and nature of consultancy rendered. The consultants shall include the copy of the accreditation certificate and data provided by the other organizations/ laboratories including their status of approvals etc.

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Glossary of Nuclear Terms

Absorbed Dose

The fundamental dosimetric quantity D is defined as:
D = dE /dm

where, 'dE' is the mean energy imparted by ionising radiation to the matter in a volume element and 'dm' is the mass of matter in the volume element. The SI unit of absorbed dose is joule/kg (J.kg-1), termed the gray (Gy).

Acceptable Limits

Limits acceptable to the regulatory body for accident condition or potential exposure

Acceptance Criteria

The standard or acceptable value against which the value of a functional or condition indicator is used to assess the ability of a system, structure or component to perform its design function or compliance with stipulated requirements.

Activity

The quantity 'A' for an amount of radionuclide in a given energy state at a given time is defined as:

A = dN/dt Where 'dN' is the expectation value of the number of spontaneous nuclear transformations from the given energy state in a time interval 'dt'. The SI unit of activity is the reciprocal of second (s-1), termed the Becquerel (Bq)

ALARA

An acronym for 'As Low As Reasonably Achievable'. A concept meaning that the design and use of sources, and the practices associated therewith, should be such as to ensure that exposures are kept as low as reasonably practicable, with economic and social factors taken into account

Annual Limit on Intake (ALI)

The intake by inhalation, ingestion or through the skin of a given radionuclide in a year by the reference man, which would result in a committed dose equal to the relevant dose limit. The ALI is expressed in units of activity.

Atomic Energy Regulatory Board (AERB)

A national authority designated by the Government of India having the legal authority for issuing regulatory consent for various activities related to the nuclear and radiation facility and to perform safety and regulatory functions, including their enforcement for the protection of site personnel, the public and the environment against undue radiation hazards

Becquerel

(See "Activity").

Beyond Design Basis Accidents (BDBA)

Accidents of very low probability of occurrence, more severe than the design basis accidents, those may cause unacceptable radiological consequences; they include severe accidents also.

Cladding
An external sheath of material over nuclear fuel or other material that provides protection from a chemically reactive environment and containment of radioactive products produced during the irradiation of the composite. It may provide a structural support.

Collective Dose
An expression for the total radiation dose incurred by a population and defined as the product of the number of individuals exposed to a source and their average radiation dose.

Competent Authority
Any official or authority appointed, approved or recognised by the Government of India for the purpose of the Rules promulgated under the Atomic Energy Act, 1962.

Conditioning of Waste
The processes that transform waste into a form suitable for transport and/or storage and/or disposal. These may include converting the waste to another form, enclosing the waste in containers and providing additional packaging.

Criticality
The 'stage' or 'state' of a fissile material system where a self-sustained nuclear chain reaction is just maintained.

Criticality Analysis (PSA)
Analysis for evaluating the likelihood and severity of the failure.

Decay Heat
The heat produced by the decay of radioactive nuclides.

Decommissioning
The process by which a nuclear or radiation facility is finally taken out of operation in a manner that provides adequate protection to the health and safety of the workers, the public and the environment.

Decontamination
The removal or reduction of contamination by physical or chemical means.

Defence-in-Depth
Provision of multiple levels of protection for ensuring safety of workers, the public or the environment.

Defence-in-Depth (Security)
A concept used to design physical protection systems that requires an adversary to overcome or circumvent multiple obstacles, either similar to or diverse, in order to achieve his objective.

Design Basis Accidents (DBAs)
A set of postulated accidents which are analysed to arrive at conservative limits on pressure, temperature and other parameters which are then used to set specifications to be met by plant structures, systems and components, and fission product barriers

Discharge (Radioactive)
Planned and controlled release of (gaseous or liquid) radioactive material into the environment.

Discharge Limits
The limits prescribed by the regulatory body for effluent discharges into atmosphere/ aquatic environment from nuclear/radiation facilities.

Disposal (Radioactive Waste)
The emplacement of waste in a repository without the intention of retrieval or the approved direct discharge of waste into the environment with subsequent dispersion.

Dose Limit
The value of the effective dose or the equivalent dose to individuals from controlled practices that shall not be exceeded.

Emergency
A situation which endangers or is likely to endanger safety of the site personnel, the nuclear/ radiation facility or the public and the environment.

Emergency Exercise
A test of an emergency plan with particular emphasis on coordination of the many interphasing components of the emergency response, procedures and emergency personnel/ agencies. An exercise starts with a simulated/postulated event or series of events in the plant in which an unplanned release of radioactive material is postulated.

Emergency Plan
A set of procedures to be implemented in the event of an accident.

Emergency Planning Zone (EPZ)
The zone defined around the plant upto 16 km radius providing a basic geographic framework for decision making on implementing measures as part of a graded response in the event of an off-site emergency.

Engineered Safety Features (ESFs)
The system or features specifically engineered, installed and commissioned in a nuclear power plant to mitigate the consequences of accident condition and help to restore normalcy, e.g. containment atmosphere clean-up system, containment depressurization system, etc

Evacuation

The temporary removal of persons from locations where dose rates or projected doses arising in an emergency situation are unacceptably high, or where the avertable dose exceeds the relevant intervention level.

Exclusion Zone
An area extending upto a specified distance around the plant, where no public habitation is permitted. This zone is physically isolated from outside areas by plant fencing and is under the control of the plant management.

Exposure Pathway
A route by which radiation or radionuclides can reach humans and cause exposure.

Fail Safe Design

A concept in which, if a system or a component fails, then the plant/component/ system will pass into a safe state without the requirement to initiate any operator action.

Fuel Element
A component of fuel assembly that consists primarily of the nuclear fuel and its encapsulating materials.

Gray (Gy)
The special name of the unit of absorbed dose. One 'gray' is equal to one joule per kilogramme

1 Gy = 1 J kg-1.

High Level Waste (HLW)
A type of waste, which contains any of the following: l The radioactive liquid containing most of the fission products and actinides present in spent fuel, which forms the residue from the first solvent extraction cycle in reprocessing, and some of the associated waste streams;

Solidified high level waste from above and spent reactor fuel (if it is declared a waste); Any other waste with similar radiological characteristics.

Intermediate Level Waste (ILW)
Radioactive waste, in which the concentration or quantity of radionuclides is above that of low level waste but below that of high level waste (HLW), with the thermal power below that of HLW. It requires shielding during handling and transportation. Thermal power of ILW is below 2 kW/m3. This is also termed as 'Medium Level Waste'.

Long-lived Wastes
Radioactive wastes containing long-lived radionuclides having sufficient radiotoxicity and/or concentrations requiring long time isolation from the biosphere. The term longlived radionuclides refers to half lives usually greater than 30 years.

Loss of Coolant Accident (LOCA)
An accident resulting from the loss of coolant to the fuel in a reactor due to a break in pressure retaining boundary of the primary coolant system.

Low and Intermediate Level Waste (LILW)
Radioactive wastes in which the concentration or quantity of radionuclides is above clearance levels established by the regulatory body, but with radionuclide content and thermal power below those of high level waste. Low and intermediate level waste is often separated into short lived and long lived wastes.

Low Level Waste (LLW)
Radioactive waste in which the concentration or quantity of radionuclides is above clearance levels established by the regulatory body but with the radionuclide content below those of intermediate and high level wastes. It does not require shielding during handling and transportation.

Member of the Public

Any individual in the population except for one who is subject to occupational or medical exposure. For the purpose of verifying compliance with the annual dose limit for public exposure, the member of the public is the representative individual in the relevant critical group.

Near Surface Disposal
Disposal of waste with/without engineered barriers, or below the ground surface with adequate final protection covering to bring the surface dose rate within prescribed limits.

Normal Exposure
An exposure which is expected to be received under normal operating conditions of an installation or a source, including possible minor mishaps that can be kept under control.

Nuclear Power Plant (NPP)
A nuclear reactor or a group of reactors together with all the associated structures, systems, equipment and components necessary for safe generation of electricity.

Nuclear Safety
The achievement of proper operating conditions, prevention of accidents or mitigation of accident consequences, resulting in protection of site personnel, the public and the environment from undue radiation hazards.

Occupational Exposure
All exposures of personnel incurred in the course of their work.

Occupational Worker
Any person, working full time or part time in a nuclear or radiation facility, who may be employed directly by the "consentee" or through a contractor.

Off-site Emergency
Accident condition/emergency situation involving excessive release of radioactive materials/ hazardous chemicals from the plant to the public domain calling for intervention.

Off-site Emergency Director (OED)
A specifically designated officer (for instance, the Collector/District Magistrate) with adequate legal authority to control and coordinate all off-site emergency measures in the public domain

Plant Emergency
Declared emergency conditions in which the radiological/other consequences, confined to the plant or a section of the plant, requiring immediate operator action\

Poison (Neutron Poison)
A substance used to reduce reactivity in a reactor core, by virtue of its high neutron absorption cross-section

Probabilistic Risk Assessment (PRA)/Probabilistic Safety Assessment (PSA)
A comprehensive structured approach to identifying failure scenarios constituting a conceptual and mathematical tool for deriving numerical estimates of risk. The term PRA and PSA are interchangeably used.

Prophylaxis
The intake of specific stable chemical compounds which have a reducing or blocking effect on the uptake of certain radionuclides, e.g. the use of stable KI (Potassium Iodide) or KIO3 (Potassium Iodate) to reduce the uptake of radioiodines (particularly I-131) in thyroid gland

Public Exposure
Exposure incurred by members of the public from radiation sources, excluding any occupational or medical exposure and the normal local natural background radiation, but, including exposure from authorised sources and practices and from intervention situations.

Quality Assurance (QA)
Planned and systematic actions necessary to provide the confidence that an item or service will satisfy given requirements for quality.

Quality Control (QC)
Quality assurance actions, which provide means to control and measure the characteristics of an item, process or facility in accordance with the established requirements.

Radiation Surveillance
Measures that may be specified by the competent authority to provide adequate protection either generally or in any individual case

Radiation Worker
Any person who is occupationally exposed to radiation and who in the opinion of the regulatory body should be subjected to radiation surveillance

Radioactive Waste
Material, whatever its physical form, left over from practices or interventions for which no further use is foreseen: (a) that contains or is contaminated with radioactive substances and has an activity or activity concentration higher than the level for clearance from regulatory requirements, and (b) exposure to which is not excluded from regulatory control.

Radioactive Waste Management Facility
Facility specifically designed to handle, treat, condition, temporarily store or permanently dispose of radioactive waste.

Repository
A facility where radioactive waste is emplaced for disposal. Future retrieval of waste from the repository is not intended.

Repository, geological
A facility for radioactive waste disposal located underground (usually more than several hundred meters below the surface) in a stable geological formation to provide long term isolation of radionuclides from the biosphere. Usually such a repository would be used for long-lived and/ or high level waste.

Repository, near surface
A facility for radioactive waste disposal located at or within a few tens of meters from the Earth's surface. Such repository is suitable for the disposal of short-lived low and intermediate level waste.

Safety Guide
A document containing detailed guidelines and various procedures/ methodologies to implement the specific parts of a safety code, that are acceptable to the regulatory body, for regulatory review. This is issued under the authority of regulatory body and is of non-mandatory nature.

Secondary Containment
The structure surrounding the primary containment that acts as a further barrier to limit the release of radioactive materials and also protects the primary containment from external effects. It includes secondary containment structure and its access openings, penetrations and those systems or portions thereof, which are connected to the containment structure.

Severe Accident
Nuclear facility conditions beyond those of the design basis accidents causing significant core degradation.

Short-lived Waste
Radioactive waste in quantities and/or concentrations, which will decay to activity levels considered acceptably low from the radiological point of view within the time period during which administrative controls are expected to last. Radionuclides in shortlived wastes will generally have half-lives shorter than 30 years.

Site Emergency
Accidental condition/emergency situation in the plant involving radioactivity transgressing the plant boundary but confined to the site, or involving release of hazardous chemicals or explosion, whose effects are confined to the site, with off-site consequences being negligible.

Site Emergency Director
A specifically designated officer with adequate authority to control and coordinate all site emergency actions.

Site Evaluation Report (SER)
A document indicating the impact of a nuclear/radiation facility on the environment and the impact of the environment on the same so as to establish the suitability of the site for safe operation of the facility.

Site Selection Stage
The stage at which identification of one or more preferred candidate sites for a facility are carried out to determine/demonstrate their suitability from various aspects, and in particular, from the safety point of view.

Siting
The process of selecting a suitable site for a facility including appropriate assessment and definition of the related design bases.

Solidification (Radioactive Waste)
Immobilisation of gaseous, liquid-like materials by conversion into solid waste form, usually with the intent of producing a physically stable material that is easier to handle and less dispersible. Calcination, drying, cementation, bituminisation and vitrification are some of the typical ways of solidifying liquid radioactive waste

Spent Fuel
Irradiated fuel not intended for further use in reactors in its present form.

Sterilised Zone

The annulus of specified radius around the plant, beyond the exclusion zone, where only natural growth is permitted and developmental activities which lead to growth of population are restricted by administrative control.

Stochastic Effects (Radiation)

Radiation effects generally occurring without a threshold level of dose whose probability is proportional to the dose and whose severity is independent of the dose

Storage (Radioactive Waste)

The placement of radioactive waste in an appropriate facility with the intention of retrieving it at some future time. Hence, waste storage is by definition an interim measure and the term interim storage should not be used.

Suppression Pool

A pool of water located at the lowermost elevation of the reactor building, into which steam resulting from LOCA/MSLB is directly led and condensed to reduce the pressure in the primary containment.

Technical Specifications for Operation

A document approved by the regulatory body, covering the operational limits and conditions, surveillance and administrative control requirements for safe operation of the nuclear or radiation facility. It is also called as 'operational limits and conditions'

Waste Immobilisation

The conversion of radioactive waste into solid form (by solidification, or by embedding, or encapsulating in a matrix material) to reduce the potential for migration or dispersion of radionuclides during transport, storage and disposal.

Waste Management

All administrative and operational activities involved in the handling, pre-treatment, treatment, conditioning, transportation, storage and disposal of radioactive waste.

Waste Treatment

Operations intended to benefit safety and/or economy by changing the characteristics of the wastes by employing methods such as

(a) volume reduction;

(b) removal of radionuclides;

(c) change of composition.

After treatment, the waste may or may not be immobilised to achieve an appropriate waste form.

TABLES

Table No. 4.1 Description of Soil Sampling Locations

Station No.	Location	Distance & Direction from project area	Project area/ study area	Environmental setting

Table No. 4.3 Analysis of Soil samples

Station No	Parameters	Unit	Result			Standards
			SS1	SS2	SS3	

Table No. 4.3 Description of Ground Water Sampling Locations

Station No.	Location	Distance & Direction from project area	Project area/ study area	Environmental setting

Table No. 4.4 Analysis of Ground Water

Station No	Parameters	Unit	Result			Standards

Table No. 4.5 Description of Surface Water Sampling Locations

Station No.	Location	Distance & Direction from project area	Project area/ study area	Environmental setting

Table No. 4.6 Analysis of Surface Water

Station No	Parameters	Unit	Result			Standards

Table No. 4.7 Description of Ambient Air Monitoring Stations

Station No.	Location	Distance & Direction from project area	Project area/ study area	Environmental setting

Table No. 4.8 Analysis of Ambient Air Quality

Parameter	PM_{10}				$PM_{2.5}$				NO_x				SO_2				Radioactive elements*			
Monitoring Station & Category*	No. of samples	Maximum	Minimum	Mean	No. of samples	Maximum	Minimum	Mean	No. of samples	Maximum	Minimum	Mean	No. of samples	Maximum	Minimum	Mean	No. of samples	Maximum	Minimum	Mean

*** Add as many sets of columns as the number of radio-isotopes.**

Table No. 4.9 Description of Noise Monitoring Stations

S. No	Locations	Environmental Setting*	Average Day noise level (dBA)	Average Night noise level (dBA)	Day time (6.00 A.M. to 10.00 P.M)	Day time (10.00 P.M. to to 6.00 A.M)	
					Standard (L_{eq} in dBA)	Standard (L_{eq} in dBA)	

*Industrial area/ Commercial area /Residential area /Silence zone

Table No. 4.10 Demographic Profiles of the Villages in the Study Area

Sl. No.	Demographic Feature	Study Area	Share in total Population (%)
1.0	Total Population		
2.0	Households		
3.0	Occupation		

Table No. 4.11 Other Infrastructural Facilities Available in the Study Area

Sr. No.	Name of the village	DWF	Tp	W	T	TW	HP	R	C	L	S	O	PO	TO	PT	P	B	RS	NW	CB	CoB

Note:

DWF : Drinking Water Facility
Tp ; Tap
W : Well
T : Tank
TW : Tube Well
HP : Hand Pump
R : River
C : Canal
L : Lake
S : Spring
O : Others
PO : Post Office
TO : Telegraph Office
PT : Post & Telegraph Offices
P : Phone
B : Bus
RS : Railway Service
NW : Navigable Waterways
CB : Commercial Bank
CoB : Co-operative Bank

ANNEXURES

Annexure 1

TOR For Environmental Impact Assessment (EIA) of Nuclear Power Plant, Nuclear Fuel Reprocessing Plant and Nuclear Waste Management Plants

Objectives

Terms of Reference (TOR) for the preparation of Environmental Impact Assessment (EIA) have been redefined and elaborated in the EIA notification of MOEF, dated September 14, 2006 and its amendment of Dec, 2009. They have been devised to improve the quality of reports, facilitating decision making and the process of decision making more transparent. Under this notification, Nuclear Power Project and processing of nuclear fuel have been put under category A which will require EIA clearance from Ministry of Environment and Forests. Therefore, in addition to nuclear power plant, nuclear fuel reprocessing plant and nuclear waste management plants will also require EIA clearance. Documents prepared using this TOR will help the project proponents and consultants to prepare reports with relevant project specific data, which are informative, relevant and easy to comprehend. This TOR covers Nuclear Power Plant (NPP), Nuclear Fuel Reprocessing Plant (NFRP) and Nuclear Waste Management Plants (NWMP) and is expected to cover all environmental related factors and concerns of the experts who will be granting approval.

Information to be provided

i) Type of Nuclear Plant/s proposed to be built with brief description of each plant

ii) How many plants of each type are operating or are being built in the country?

iii) What are the advantages of each type of plant proposed to be built at the proposed site.

iv) What alternatives are available for each plant and what determined the choice made?

v) How these plants will help the country and the region?

vi) How good is the experience in terms of safety and environmental quality from similar plants built elsewhere in the country?

vii) How many similar plants are planned at present at other places in the country?

Under the EIA notification, 2006 and its amendment of Dec.2009, it is now mandatory that EIA is carried out for NFRP's, NWTP's and NWIP's even if they are constructed as add-on's at NPP sites. Therefore, if it is planned to construct them along with nuclear power plant, single EIA incorporating information relevant to add-on's can be submitted. However, if such units are planned and built later, separate EIA reports in the same format should be submitted and Environmental Clearance sought. It may be noted that NFRP, NWIP, NWIP, NETP's are exempted from public consultations

Preamble

Nuclear Power Plants and other nuclear plants given above are similar to any industrial plant during construction phase and give rise to similar air, water, land and noise pollution problems. However, once they go operational, the environmental impact is mainly due to radioactivity released to the environment through air and water routes under normal as well as accidental condition. To deal with radioactivity in air and water and to assess its impact on people and environment, every nuclear plant site in India has an Environmental Monitoring Laboratories which goes operational at least one year before the plants goes operational (usually it goes operational 2-3 years before the plant) and collects radioactivity and conventional pollution data from 30 km environmental impact zone. It enables estimation of radiation does at fence post (1.5 km). This dose must be below 1 mSv/y to meet AERB requirements

1.0 Introduction

This chapter should cover the following, in addition to

(i) a brief description of the Indian nuclear program, number and location of similar plants

(ii) purpose of the proposed plant, plant site and brief description of the plant i.e. name, nature, size, location, its importance to the country and the region

(iii) Profile of the project proponents, name and address with e.mail i.d., phone/fax etc of the implementing organization, organizational chart, project consultants etc.,

(iv) Any litigation pending against the proposed project and/or any direction/order passed by any court of law against the project should be clearly mentioned with full details thereof

(v) In case of expansion/modernization project, the environmental compliance status for the existing project should be given.

(vi) Environmental Impact assessment methodology followed, its advantages over other methods and its salient features.

2.0 Project Description

Project Site

This chapter should cover the broad details of the plant/s, location, layout and implementation schedule of the project.

- Type of the project (new/expansion)
- Relevance of the project in the light of existing development plans of the region
- Project coverage, master plan, phasing and scope
- Description of the project site, geology, topography, transport and connectivity, phasing
- Summary of site selection committee report recommending the site proposed and alternative sites recommended, if any.

- Availability of ports, roads etc for transport of heavy equipments during construction and operational stages of the project
- Does the proposed site fall under CRZ or sensitive area
- Availability of power, water etc during construction and operation of the project
- Estimated water budget during construction and operation of the project
- Estimated Power requirement during construction phase
- Infrastructure availability such as schools, hospitals in and around the project site to meet the requirements of the staff and to be available for handling injured/radiation exposed persons in the event of disasters.
- Type of Land acquired/proposed to be acquired: agricultural, farm, grazing, irrigated, non-irrigated, forest, barren
- Mode of acquisition: government/private
- Number of trees to be cut : Permanent/to be replanted
- Number of persons to be displaced (summary of R & R plan)
- Special technologies involved in the design, construction and operation
- Cost of each project stage including environmental cost, if any
- Source of financing
- Man-power requirements and time frame for implementation

Essential Maps to be provided with the application:

- Map indicating the project site in the state, district, tehsil/taluka etc.
- Map of the project area including exclusion zone, sterilized zone and emergency planning zones from the boundary of the proposed/existing project area, delineating protected areas notified under the wild life (Protection) Act, 1972/critically polluted areas as notified by CPCB from time to time/ notified eco sensitive areas/ inter-state boundaries and international boundaries.
- A map covering aerial distance of 16 km on the landward side from the proposed project boundary delineating environmental sensitive areas as specified in column no 9(iii), Form 1 of EIA notification dated September 14, 2006.
- Land use map of the study area to 1:25,000 scale based on recent satellite imagery of the proposed area and 10 kms from the proposed project boundary delineating the cropping pattern, wastelands, forest area and built-up areas, water bodies indicating source of water supply for the plant/s, human habitation and other surface features such as railway tracks, ports, airports, roads, NH, major industries etc.

Site lay-out plan of the proposed development shall be submitted to a scale of 1:5000 clearly marking the lay-out of breakwaters, navigation channels, administrative and operational

buildings, utilities, town-ships, green-belts etc. Boundaries of the proposed plants shall be shown therein with latitude and longitude.

- Area drainage contour map of the project area and up to 1.6 km from the peripheral limits of the proposed project area shall be clearly indicated. In case of any proposed diversion of nallah/canal/river, same shall also be shown in the map.
- Hydrographic charts of the off-shore area giving general morphology of the coastal stretch to a scale of 1:50,000 shall be submitted covering water depth, upto 10 m beyond the maximum proposed dredging depths of the project and covering a distance of 5 km along the coast from the project limits on both sides.
- The CRZ maps indicating the High Tide Level (HTL), Low Tide Level (LTL), coastal feature maps from an authorized agency and the project lay out superimposed on the map should be submitted on 1:5000 scale map. This map should be certified by the state/Union Territory CZM authority.

Plant Details

- Process description
- Plant facilities including utilities
- Main components of the plant and their functions
- Control and safety systems
- Gaseous emissions, liquid and solid discharges
- Spent fuel storage/disposal arrangements

3.0 Analysis of Alternatives

The types of NPP's considered and the reasons for selecting the proposed plant.

4.0 Description of Environment

During construction phase, nuclear plants are similar to any other industrial plants and hence produce similar conventional air pollutants and noise levels. However, after they go operational, the only pollution is due to radioactivity release through stack and water discharges. Hence, environmental impact in relation to the nuclear power plants and other nuclear fuel plant that needs to be considered are air, water, marine, biological and human health due to nuclear radiations. Periodically, there could be additional negative impact due to operation of DG sets during construction phase.

Nuclear power plants do not produce any significant conventional air/water pollutants like SO_2, NOx. The radioactivity discharged by them to the air and water is regulated by Atomic Energy Regulatory Board (AERB) directives. The NPP stack has provisions of holding the pollutants till short-lived radioactivity has decayed. In addition, it can be treated through filtration and chemical absorption also. There are no solid wastes discharged into the environment. However, they do require large quantities of water for steam generation and for cooling purpose. Hence the plants have to be located either along the sea coast, along a large perennial river or a large dam / lake.

The water temperature should not rise more than 5 degrees C above the ambient temperature for inland sites and more than 7 degrees C above the ambient temperature for coastal sites.

- Water should not get contaminated beyond permitted level
- Marine bio-diversity should not to affected

The permitted concentrations for water bodies and permitted rise in temperature at the discharge point should also be given in the report. Permitted levels of air and water radioactivity are prescribed by the AERB, in line with International Standards and for conventional chemical pollutants, national standards stipulated by MoEF / CPCB are to be met.

It is necessary to collect the relevant baseline data from the following relevant main sections so that when the plant goes into operation, its impact on the environment can be assessed

Study Area:

As a primary requirement of the EIA process, the proponent should collect primary baseline data in the project area as well as in the area falling within the sterilized zone of the proposed project site and secondary data should be collected within 30 km distance from the project site. The study areas mentioned in this document shall be considered for guidance purpose but the exact study area for different environmental attributes (water, air, noise, soil etc.) is to be submitted considering the proposed activities and location along with proper reasoning, for review and approval by the expert appraisal committee.

4.1 Land Environment

Topography

Baseline data should be given on the existing situation of the land at the proposed project Site including description of terrain slopes, coastal and inland topography, coastal features (low-land, beaches etc). Study of land use pattern, habitation, cropping pattern, forest cover, environmentally sensitive places etc. by employing remote sensing techniques (if available) and through secondary data sources.

Soil

Soil data including type, classification, characteristics and properties are important for the design of structures at the proposed site and hence must be given due consideration. Changes in the parameters of soil may affect plantation and vegetative growth, which in turn may endanger the health of local habitat. Hence baseline data of the soil characteristics for the project area must be given.

The elements to be monitored from different sampling points in the study area in soil include U–238, Th–232 and their progenies, K-40, H-3, Cs-137, Cs-134, Sr-90, Zr-95, Nb-95, Mn-54, Ni-63, Ru-106, Co-60, Zn-65, Ce-144, Pu-239, Pu-240, Am-241. Natural radiation dose should also be measured as well as estimated. In case of existing site where additional plants are to be built, artificial radioactivity due tritium from operating units (PHWR type reactors) also must be measured to assess the health of the existing plants.

4.2 Water Environment

Radio active elements of U–238, Th–232 and their progenies, K-40, H-3, Cs-137, Cs-134, Sr-90, Zr-95, Nb-95, Mn-54, Ni-63, Ru-106, Co-60, Zn-65, Ce-144, Pu-239, Pu-240, Am-241 in both surface and ground water samples are to be analyzed.

Ground Water

In addition to the radioactive elements, baseline data of ground water including data of pH, dissolved solids, suspended solids, BOD, etc, is to be collected at least for one season. Usage of ground water in the plant is to be indicated. Depth of ground water table and fluctuations are to be monitored and reported.

Surface Water

Baseline data on location of surface waters like lagoons, lakes, tidal inlets, streams, rivers, their details, present quality and their usage, if any, is to be indicated. Details of the water bodies in the project area should be described separately. Water quality is to be monitored at least for one season. Both ground water and surface waters should be monitored for natural radioactivity and tritium

4.3 Marine Environment

Coastal Hydrology/Geomorphology

Coastal hydrology requires collection of oceanographic data during the study period, covering the following parameters:

Tides
Waves (wind waves and swells)
Storm surges
Currents
Salinity
Sea water temperature
Suspended load and } their profile upto the proposed water
Seabed bathymetry } discharge point

Baseline oceanographic data should extend at least to depths more than 10m. Details of mangroves, marshes and other coastal vegetation, sand dunes, coastal stability, seismic characteristics, history of any endangered species, coastal erosion and shoreline changes should be furnished The elements to be monitored in marine environment include U–238, Th–232 and their progenies, K-40, H-3, Cs-137, Cs-134, Sr-90, Zr-95, Nb-95, Mn-54, Ni-63, Ru-106, Co-60, Zn-65, Ce-144, Pu-239, Pu240, Am-241.

Bed Sediment Contamination

Baseline data on bottom sediments and the associated bottom biota and other physical habitat, at the proposed project area and in the neighborhood areas has to be collected and analyzed. Natural

radioactivity and tritium levels are to measured in all the above samples and reported. Sediments do get contaminated with radinuclides during operation of nuclear plants. Hence near coast sediment samples are routinely collected and analysed for same radioisotopes as for marine environment, given above viz.

U–238, Th–232 and their progenies, K-40, H-3, Cs-137, Cs-134, Sr-90, Zr-95, Nb-95, Mn-54, Ni-63, Ru-106, Co-60, Zn-65, Ce-144, Pu-239, Pu240, Am-241.

Sea/Harbor Water Quality

Baseline data shall be collected on chemical parameters in the open sea and near the proposed site to determine chemical characteristics in the marine environment such as sea water temp, BOD, DO, pH, TSS etc.

Construction of jetty, if any, should be clearly stated and studies relevant to assess their environmental impacts should be provided. If the water is taken and discharged into sea, the environmental impact of structures to be built for this purpose should be evaluated.

4.4 Air Environment

Baseline data of ambient air parameters such as $PM_{10,}$ $PM_{2.5}$, NOx, SOx,, should be provided. Long lived gross alpha and gross beta Levels, natural radioactivity (U, Th and their progenies and Potassium-40) and other radio nuclides like H-3, Be-7, Cs-137, Cs-134, I-131, Sr-90, Zr-95, Nb-95, Mn-54, Ni-63, Ru-106, Co-60, Zn-65, Ce-144, Pu-239, Pu240, Am-241 should be analyzed from pooled air filters samples. In case of existing site, tritium, argon 41 and iodine 131 levels should also be measured. This data is to be collected from a number of sampling stations in the impact zone area of 30 km around the plant site.

Meteorological data for at least 10 years covering the following should be included in the EIA report. This data should be from the project site or the nearest meteorological station. The current data should be from the proposed site:

- Wind speed and direction
- Rainfall
- Temperature
- Relative Humidity
- Barometric Pressure
- Data on history of cyclones and tidal surges should be collected for 100 years
- SODAR data on mixing height

4.5 Noise Environment

Baseline data on noise pollution at the project area and the neighborhood up to 1.6km or nearest residential areas is to be monitored as per the CPCB norms.

4.6 Biological Environment

Marine / Coastal Ecology / Fisheries

Baseline data of aquatic flora/fauna at the project area including the coastal area is to be ascertained by proper surveys including mangroves and marshes and other coastal vegetation. Data on coastal stability, seismic characteristics, history of any endangered species, coastal erosion, shoreline changes, if any and marine environmental features should be indicated.

Flora and Fauna in the neighborhood

Details on secondary data on the existing flora and fauna in the study area as well as 15km from its boundary, carried out by an university/ institution under the relevant discipline (such as BSI, ZSI, WII etc.) shall be included in the list of flora and fauna along with classification as per Schedule given in the Wild Life Protection Act, 1972 and in the Red Book Data and a statement clearly specifying whether the study area forms a part of an ecologically sensitive area or migratory corridor of any endangered fauna.

Natural radioactivity must be measured in all the above samples to assess environmental impact over long periods.

Data on the radioactivity in food needs to be provided by analyzing the following parameters U–238, Th–232 and their progenies, K-40, H-3, Cs-137, Cs-134, Sr-90, Zr-95, Nb-95, Mn-54, Ni-63, Ru-106, Co-60, Zn-65, Ce-144, Pu-239, Pu240, Am-241.

4.7 Socio Economic and Health Environment

Baseline data at the project area should include the demography, telecommunications, archaeological sites, particularly on settlements, health status of the communities, existing infrastructure facilities of the proposed area and area of impact due to the proposed activity. Present employment and livelihood of these populations, awareness of the population about the proposed activity should also be included.

Risk assessment requires data on population distribution, critical population groups, critical marine organisms, critical flora besides pollution levels radioactivity levels in all environmental compartments. All these data need to be collected. The programme for risk evaluation need to be mentioned as there are many programmes available (Ref. 12-14) and risk evaluated. The merits of the programme used also need to be given.

5.0 Anticipated Impact and Mitigation Measures

In the construction phase of the project the environmental pollution is due to the conventional sources and noise. The data on both is collected as part of the baseline measurements. The environmental impact and mitigation measures due to these conventional pollutants (soil, water, air and noise) should be detailed out.

Nuclear Power Plants (NPP's):

Environmental Impacts of NPP's are primarily due to radioactivity released to the environment through their stacks and radioactivity in the form of effluents and hot water discharged to the

water body. The height of stacks is so calculated that at full power, under all meteorological conditions by the time the air from stack reaches ground at fence post, its radioactivity is below the permitted limit. For any emergency in the plant, hold-up and treatment facility is provided whereby air is held inside till its radioactivity decays to permissible level for discharge. Most of the radioactivity released through stacks of all types of reactors is short-lived with half lives in hours to seconds. Hence hold-up times are not very long. The only long-lived isotope is tritium. In addition, traces of another long lived isotope carbon-14 are also released, its concentration is too small to be of any significance. The total stack emission of radioactivity and the dose there-from at the fence post (1.5 km) is estimated to assess if it is within AERB stipulated limit.

Similarly, in water discharge of liquid effluents, radioactivity due to tritium is measured and radiation dose at fence post is within permitted limit. There are no solid wastes as spent fuel is stored in underground trenches and cooled continuously for removing decay heat. It is usually kept in this manner for several months to a few years and then taken up for reprocessing, which is a batch process. Suitable underground pools are built at site for storage of spent fuel and its impact, if any, also needs to be taken into account.

Nuclear Fuel Reprocessing Plants (NFRP's):

The spent fuel is dissolved and the liquid is chemically treated to take out plutonium and Uranium predominantly and the liquid effluents are stored in underground tanks at site and later sent to Waste Treatment Plant. There are no direct discharges of liquids and solids to the environment. Most of the operations in such plants are automatic and remote controlled so that no worker is exposed to higher dose of radiation. The most serious concern in such plants is possibility of excessive radiation dose to the operating staff.

Nuclear Waste Treatment Plants (NWTP's):

All the liquid radioactive waste from NFRP's is classified according to its radioactivity content into 3 categories:

- Low-level Liquid Waste: This is diluted and discharged to the water body ensuring that it does not cause any adverse impact on environment. Low-level solid waste from decontamination, glove-box waste etc., is fixed in concrete and stored in Near Surface Disposal Facility .
- Intermediate-level Liquid Waste: This is either stored to allow decay or chemically treated (usually both) to convert into high level and low level components.
- Classification of radioactive waste and its treatment is given in the Annexure 4.1 and 4.2.

Nuclear Waste Immobilization Plant (NWIP's):

High-level solid waste is immobilized by fixing it in glass and is sealed in a stainless steel canisters. The canisters are over packed in another comtainer and termed as Vitrified Waste Product (VWP) and further stored in a specially engineered vault (Solid Storage & Surveillance Facility) (SSSF) at plant site, with constant surveillance and air cooling for a period of about 30 years, prior to their disposal in deep geological repository. This interim storage ensures decay heat removal from the Vitrified Waste Product and their safe transportation to the deep geological repository..

6.0 Environmental Monitoring Program

The chapter shall include details of the environmental monitoring programs. It should include technical aspects of monitoring the effectiveness of mitigation measures (including measurement methodologies, data analysis, reporting schedules, emergency procedures, detailed budget and procurement schedules)

Summary matrix of environmental monitoring during construction and operation stage
Monitoring facilities
Frequency, location, parameter s to be monitored

Compilation and analysis of data, comparison with baseline data and compliance to stipulated norms and reporting system. Every Environmental Monitoring Laboratory is provided with a manual which gives detailed measurement, data analysis and reporting method and the equipment required.

7.0 Additional Studies

Additional studies arising out of public consultation and comments of the appraisal committee and probabilistic risk evaluation must be included in this section.

Public Consultation

Public hearing with the issues raised by the public and the response of the project proponent in tabular form should be presented and discussed. The issues identified by appraisal committee on the TOR should also be addressed.

Risk Assessment and Disaster Management Plan

Risk assessment report prepared by specialists in the field as per international practice in nuclear industry and conclusions mentioned in the report. Disaster Management Plan must include emergency planning, emergency procedures, details of infrastructure facilities available / planned and details on safety measures adopted.

Once critical groups have been identified from the data and proper computer programme has been identified by the consultant, risk is estimated for different sensitive groups and to the population in emergency planning zone. If it is protected, impact zone will automatically be taken care as the levels of both conventional and radioactive pollutants will be much smaller in the impact zone.

There are a number of methods available for impact and risk assessment. Consultants must mention the merits of the method used and give their findings.

Emergency Plans / Preparedness:

Accident at NPP in which radioactivity is released to the environment in public domain is postulated as a very low probability but high consequence event.

Emergency Preparedness measures include zoning and emergency preparedness exercises. A detailed Emergency Preparedness manual for such exercises which details procedures for conducting Emergency drills at plant, site and Emergency planning zone level. EIA report should detail all the above features and whether the manual has been prepared.

Natural Resource Conservation and Optimization

Water conservation measures should be addressed. Energy efficiency measures in the activity are to be drawn up.

R & R Action Plan

Detailed R & R plan with data on the existing socio-economic status of the population in the study area and broad plans for resettlement of the displaced population, site for the resettlement, alternative livelihood concerns/employment and rehabilitation of the displaced persons, civil and housing amenities being offered and implementation schedule.

Epidemiological/Health Survey:

For every new site, an epidemiological survey through questionnaire followed by health check up by medical doctor must be carried out in 25-30 km radius area to map any genetic/somatic abnormalities, prevailing diseases or any diseases which can be caused due to nuclear radiation exposures. This will enable detection of any diseases due to nuclear plant/s operations. Such studies should be repeated once every 10 years. For existing site where expansion or additional plants are proposed to be built, such studies, if not carried out earlier, should be undertaken and results included in EIA Report. These studies may be entrusted to State Health Department/ Local Medical College/ Hospital of repute.

8.0 Project Benefits

This chapter shall list the benefits accruing to the locality, neighborhood, region and nation as a whole. It should bring out details of benefits by way of:

- Improvement in the physical infrastructure by way of addition of project infrastructure, ancillary industries that may come on account of the project due to additional availability of electricity
- Improvements in the social infrastructure like roads, railways, townships, housing, water supply, drainage, educational institutions, hospitals, effluent treatment plants, improved water disposal systems, improved environmental condition, improved ecology etc.
- Employment potential for skilled, semi-skilled and unskilled labor both during construction and operational phases of the project with specific attention to employment potential of local population as well as necessity for imparting any specialized skills to them to be eligible for such employment in the project on a long term basis i.e., during operation and maintenance stages of the project and
- Other tangible benefits like improved standard of living, health, education etc.

9.0Environmental Cost Benefit Analysis

This chapter should include the environmental cost benefit analysis of the project if identified in the scoping stage

10.0 Environment Management Plan

This chapter should contain the following aspects:

- Summary of potential adverse impacts and recommended mitigation measures
- Allocation of resources and responsibilities for implementation
- Administrative and Technical setup for the Management of Environment
- Environmental specifications for the contractors should contain adequate safeguards to ensure that management measures will not be compromised under adverse field conditions or time constraints
- Emergency preparedness manual shall be prepared for each NPP site which should also include plant emergency, site emergency and general emergency exercises and their periodicity

Construction Phase

R & R of Displaced Persons
Environmental Management during construction phase
Site preparation
Sanitation
Air Environment
Noise Environment
Water Environment
Land Environment

Post Construction Phase

Air, Noise, Water, Land, Solid Waste and socio-economic environment
Green-belt Development
Post project Radioactivity Monitoring and surveillance program
Biological Environmental Management

Emergency Preparedness- Documentation and Exercises- Plant, Site and General emergency.

11.0 Summary and Conclusions

It shall be the summary of the full EIA Report condensed to ten A-4 size pages at the maximum. It should necessarily cover in brief the following chapters of the full EIA report. Introduction/ Project Description/ Analysis of Alternatives/ Description of the Environment/ Anticipated Impacts and Mitigation measures/ Environmental Monitoring Program/Additional Studies/ Project Benefits/ Environmental Cost Benefit Analysis/Environmental Management Plan/ Summary and Conclusions / Disclosure of Consultants engaged

12.0 Disclosure of Consultants

This chapter should include the names of the consultants engaged and should include their brief resume and nature of consultancy being provided by each of them.

Enclosures

Feasibility report / executive summary of site selection committee report/ executive summary of off-site emergency planning/ EIA report/Form 1/Photographs of the project site, impact areas/ epidemiological and health status survey report.

Annexure 2
Siting of Nuclear Power Plants

Site selection process for a nuclear power plant is a very comprehensive and involved process. A senior committee is appointed by the project proponents to recommend suitable sites for nuclear power plants. This committee examines all the potential sites, based on power requirements, willingness of the state government to extend all cooperation and availability of infra-structure e.g. land, water, roads, etc. The site selection criteria are defined in the AERB code, given as the first reference below and is to be strictly followed by the committee. The other references are required for evaluation of the site and are also helpful in the preparation of EIA report.

1. Code of Practice on Safety in Nuclear Power Plant Siting AERB/SC/S/1990
2. Atmospheric Dispersion and Modelling AERB/SG/S-1/
3. Hydrological dispersion of Radioactive Materials in relation to Nuclear Power Plant Siting AERB/SG/S-2/1998
4. Extreme Values of Meteorological Parameters AERB/SG/S-3
5. Hydrological Aspects of Siting of Nuclear Power Plants AERB/SG/S-4/2000
6. Methodologies for environmental Radiation dose assessment AERB/NF/SG/S-5/2005
7. Design basis flood for Nuclear Power Plants on Inland Sites AERB/SG/S-6A/1998
8. Design Basis Flood for Nuclear Power Plants at Costal Sites AERB/SG/S-6B/2002
9. Man-induced Events and Establishment of Design Basis Events AERB/SG/S-7
10. Site Consideration of Nuclear Power Plants for Off-site Emergency Preparedness AERB/NPP/SG/S-8/2005
11. Population Distribution and Analysis in Relation to Siting of Nuclear Power Plants. AERB/SG/S-9/1998
12. Quality Assurance in Siting of Nuclear Power Plants AERB/NPP/SG/S-10/2005
13. Safety Guide for Seismic Studies and Design Basis Ground Motion for Nuclear Power Plant SitesAERB/SG/S-11/1990

All suitable sites are listed in the order of merit. Merit criteria are defined in the terms of reference of the committee. Some of the important factors are distance from populated areas, airports, seismic zone of the site etc. Sites which are suitable for Nuclear Power Plants (NPP) are considered suitable for Nuclear Fuel Reprocessing Plant as well as Nuclear Waste Management plants as these are add-ons to NPP and do not have any special adverse environmental impact. Some of the rejection criteria are as follows.

Rejection Criteria (1)

S.No.	Hazard	Rejection criteria and Screening Distance Value (SDV)
1.	Earthquake	Site falling in seismic zone V as per BIS 1893
2.	Earthquake	Distance from capable fault < 5 km
3.	Earthquake	Potential for soil liquefaction
4.	Earthquake/ Geological	Potential for slope instability which cannot be mitigated by Engineering measures
5.	Earthquake/	Potential for ground collapse/subsidence/uplift
6.	Geological	Possibility of formation of sand dunes
7.	Aircraft Impact	Distance from small air fields < 5 km
8.	Aircraft Impact	Distance from major airports < 8 km
9.	Aircraft Impact	Distance from military airfields < 15 km
10.	Explosion	Distance from military installations storing Ammunition < 10 km

1. Environmentally sensitive locations like national parks, sensitive marine environment/biota may impose rejection of the candidate site.
2. Existance of places like architectural/historical monuments, pilgrimage or tourist interest within 5 km of the site imposes rejection of candidate site

Population Considerations:

1) Population Centres of more than 10,000 should not be within 10 km of the site
2) Population density within a radius of 10 km of the plant should be less than 2/3 of the state average
3) No population centres of more than 100,000 within 30 km from the plant
4) Total population in the sterilized area should be small (< 20,000)

Availability of water, particularly for in-land plants is a major consideration. Adequate quantity of water to the extent of a minimum of 30 days shutdown cooling requirements shall be ensured at the site to serve as Ultimate Heat Sink. Method to calculate the quantity required is given in the AERB code. There are many other considerations like, extreme meteorological conditions, suitability of the site for emergency preparedness etc. are given in AERB documents listed above. All the documents can be viewed and downloaded from AERB web site www.aerb.gov.in

Annexure 3

AERB Documents Relevant for Nuclear Power Plants

The following documents of AERB cover all stages of NPP from design to decommissioning and are to be referred by Project proponents for preparation of EIA report..

a) General

1. Code of Regulation of Nuclear and Radiation Facilities AERB/SC/G/2000
2. Consenting Process for Nuclear Power Plants and Research Reactors AERB/NPP&RR/SG/G-1/2007
3. Consenting Process for Nuclear Fuel Cycle Facilities and Related Industrial Facilities Other than NPP's and Research Reactors,AERB/NF/SG/G-2/2996
4. Regulatory Consents for Nuclear and Radiation Facilities : Contents and Formats AERB/SG/G-7/2001
5. Criteria for regulation of Health and safety of Nuclear Power Plant Personnel, the public and the environment AERB/SG/G-8/2001
6. Staffing Recruitment, Training, Qualification & Certification of Operating Personnel of NPPs AERB/SG/O-1/1999

b) Site Selection

Please see Annexure 2

c) Design

7. Code of Practice on Design for Safety in Pressurised Heavy Water Based Nuclear Power Plants AERB/SC/D/1989
8. Safety Classification and Seismic Categorisation for Structures, Systems and Components of Pressurised Heavy Water Reactors AERB/NPP-PHWR/ SG/D-1/2003
9. Hydrogen Release and Mitigation Measures under Accident Conditions in PHWR's AERB/NPP-PHWR/SM/D-2/2004.
10. Fire Protection in Pressurised Heavy Water Reactor Based NPPs AERB/SG/D-4/1999
11. Design Basis Events for Pressurised Heavy Water Reactor AERB/SG/D-5/2000
12. Fuel Design for Pressurised Heavy Water Reactors AERB/NPP-PHWR/ SG/D-6/2003
13. Core Reactivity Control in Pressurised Heavy Water Reactor AERB/SG/D-7/1998
14. Primary Heat Transport System for Pressurised Heavy Water Reactors AERB/NPP-PHWR/SG/D-8/2003
15. Safety system for Pressurized Heavy Water Reactors AERB/NPP-PHWR/SG/D-10/2005
16. Emergency Electric Power Supply System for Pressurized Heavy Water Reactor, AERB/SG/D-11/2001

17 Radiation Protection Aspects in Design for Pressurized Heavy Water Reactor Based Nuclear Power Plants AERB/NPP-PHWR/SG/D-12/2005.

18. Liquid & Solid Radwaste Management in PHWR Based Nuclear Power Plants, AERB/NPP-PHWR/SG/D-13/2003

19. Control of Airborne Radioactive Materials in Pressurised Heavy Water Reactors AERB/SG/D-14/2001

20. Ultimate Heat Sink & Associated Systems in Pressurized Heavy Water Reactor AERB/SG/D-15/2001

21. Loss of Coolant Accident Analysis for Pressurised Heavy Water Reactor AERB/SG/D-18/2001

22. Safety Related Instrumentation and Control for Pressurised Heavy Water Reactor Based Nuclear Power Plants AERB/NPP-PHWR/SG/D-20/2003

23. Containment system Design for Pressurised Heavy Water Reactors AERB/NPP-PHWR/SG/D-21; 2007

24. Vapour Suppression System (Pool Type) for Pressurised Heavy Water Reactor AERB/SG/D-22/2000

25. Design of Fuel Handling and Storage Systems for Pressurised Heavy Water Reactors AERB/SG/D-24/2003

d) Radiation Protection

26. Methodologies for Environmental Radiation Dose Assessment AERB/NF/SG/S-5/2005

27. Radiation Protection during Operation of Nuclear Power Plants AERB/SG/O-5/1998

e) Emergency Preparedness

28. Preparation of Site Emergency Plans for Nuclear Facilities AERB/SG/EP-1/1999

29. Preparation of Off-site Emergency Plans for Nuclear Facilities AERB/SG/EP-2/1999

30. Role of the Regulatory Body with respect to Emergency Response & Preparedness at Nuclear & Radiation Facilities AERB/SG/G-5/2000

f) Operation

31. Code of Practice on Safety in Nuclear Power Plant Operation, AERB/SC/O/1989

32. In-Service Inspection of Nuclear Power Plants AERB/NPP/SG/O-2/2004

33. Operation Limits and conditions for Nuclear Power Plants AERB/SG/O-3/1999

34. Commissioning Procedures for Pressurised Heavy Water Based Nuclear Power Plants AERB/SG/O-4/1998

35. Preparedness of the Operating Organisation for Handling Emergencies at Nuclear Power Plants AERB/SG/O-6/2000

36. Maintenance of Nuclear Power Plants AERB/SG/O-7/1998
37. Surveillance of items important to safety in Nuclear Power Plants AERB/SG/O-8/1999
38. Management of Nuclear Power Plants for Safe Operation AERB/SG/O-9/1998
39. Renewal of Authorisation for Operation of Nuclear Power Plants AERB/SG/O-12/2000
40. Operational Safety Experience Feedback on Nuclear Power Plants AERB/NPP/SG/O-13/2006
41. Life Management of Nuclear Power Plants AERB/NPP/SG/O-14/2005
42. Proof and Leakage Rate Testing of Reactor Containments AERB/NPP/SG/O-15/2004

g) Radioactive Waste

Please see Annexure 4.1 for AERB Publications on this subject

h) Quality Assurance

43. Code of Practice on Quality Assurance for Safety in Nuclear Power Plants AERB/SC/QA/1988
44. Safety Guide for Quality Assurance in the Design of Nuclear Power Plants AERB/SG/QA-1/2001
45. Quality Assurance in the Procurement of Items and Services for Nuclear Power Plants AERB/SG/QA-2/1998
46. Quality Assurance in the Manufacture of Items for Nuclear Power Plants AERB/SG/QA-3/1998
47. Safety Guide for Quality Assurance during Site-Construction of Nuclear Power Plants AERB/SG/QA-4/2001
48. Quality Assurance During Commissioning and Operation of Nuclear Power Plants AERB/SG/QA-5/1993
49. Establishing and implementing of Quality Assurance Programme of Nuclear Plants AERB/NPP/SG/QA-6/2005
50. Assessment of implementation of quality assurance AERB/NPP/SG/QA-7/2005
51. Non Conformance, Control, Corrective and preventive actions for NPPs' AERB/NPP/SG/QA-8/2007
52. Document Control and Records Management for QA in NPPs' AERB/NPP/SG/QA-9/2007

i) Civil Design

53. Civil Engineering Structures Important to Safety of Nuclear Facilities AERB/SS/CSE/1998
54. Design of Concrete Structures Important to Safety of Nuclear Facilities AERB/SS/CSE-1/2002
55. Design, Fabrication and Erection of Steel Structures Important to Safety of Nuclear FacilitiesAERB/SS/CSE-2/2002

Annexure 4.1

AERB Documents Relevant to Nuclear Fuel Reprocessing and Nuclear Waste Management

Radioactive Waste Management practices in India are keeping pace with international standards (2). There are several ways of classifying radioactive waste. First attempt was to classify it by its radioactivity content into the following 3 groups viz., low, intermediate and high (3).

Low-level waste : Specific radioactivity 37 - $3.7x10^6$ Bq/L

Intermediate-level waste : Specific radioactivity $3.7x\ 10^6 – 3.7x\ 10^{11}$ Bq/L

High-level waste : Specific radioactivity > $3.7x\ 10^{11}$ Bq/l

Several other methods of classification based on properties of radioactive waste have since been used. These include origin, criticality, radiological and other physical properties, chemical and biological properties have also been used. The current approach is based on International Atomic Energy Agency 1981 classification which is based method to be used for disposal. In this classification all radioactive wastes are classified into 5 categories viz., High Level Long-Life, Intermediate Level Long-Life, Low-Level Long-Life, Intermediate Level Short-Life and Low-Level Short –Life.

Last 2 categories are discharged into the water bodies. Liquid waste from NPP also falls in this category. Intermediate level waste is mostly stored so that it decays to low-level and is then discharged to water body after dilution. Other types of wastes are chemically treated in Waste Treatment Plant to separate it into high-level waste as solid and low level waste as liquid. Low level is discharged into the water body as mentioned above. High level and/or long-lived waste is immobilized by fixing it into glass medium and then pouring it into steel canisters and is then sealed. The canisters are over packed in another container to be stored as VWP in safe air cooled Solid Storage & Surveillance Facility (SSSF). . The process of fixation of solid waste is carried out in Waste Immobilization Plant (WIP). The authorized limits for the discharge of radioactivity into water body are prescribed by Atomic Energy Regulatory Board (AERB) of India

1. Code for Management of Radioactive Waste AERB/NRF/SC/RW
2. Liquid and Solid Radwaste Management in Pressurised Heavy Water Reactor Based Nuclear Power Plants AERB/NPP-PHWR/ SG/D-13/2003
3. Core management and Fuel handling in Operation of Pressurised Heavy Water Reactors AERB/SG/O-10A/1998
4. Core Management and Fuel Handling in Boiling Water Based NPPs AERB/SG/O-10B/ 1999
5. Management of Radioactive Waste Arising from Operation of Pressurised Heavy Water Reactor Based Nuclear Power Plants AERB/NPP/SG/O-11/2004

6. Predisposal management of low and intermediate local radioactive waste AERB/NRF/SG/RW-2; 2007

7. Safety Guide for Near Surface Disposal of Radioactive Solid Waste AERB/SG/RW-4/2007

8. Consenting Process for Nuclear Fuel cycle Facilities and Related Industrial Facilities other than NPPs and Research Reactors AERB/NF/SG/G-2/2006

9. Regulatory Inspection and Enforcement in Nuclear and Radiation Facilities AERB/SG/G-4/2002

Annexure 4.2

Waste management practices followed in India

The qualitative classification described earlier originated from the practical aspects related to the processing and transportation of radioactive waste. Thus, they are not based on quantitative assessments and justification but have served the purpose in the evolution of waste management practices in the country. The current classification system based on quantitative approach is practiced in many facilities and they encompass all types of wastes viz: gaseous, liquid and solid wastes.

The gaseous radioactive wastes are grouped under 3 categories (IAEA, 1970) as shown below. The particulate radionuclide associated with gaseous effluents come under category-I which can have radioactivity concentrations in the range of 37 –3.7 x 10^6 Bq/m^3. These wastes are released into the atmosphere after filtration. Category-III gaseous wastes contain radionuclide concentration higher than 3.7 x 10^6 Bq/m^3 and they are managed with a combination of adsorption and filtration techniques.

Quantification and characterization of gaseous radioactive waste		
Category	**Activity level (A: Bq/m^3)**	**Remarks**
I	$37 < A \leq 3.7 \times 10^6$	Low Level Waste
II	$3.7 \times 10^6 < A < 3.7 \times 10^{11}$	Intermediate Level Waste

The liquid wastes are classified in 5 categories based on their concentration levels (IAEA, 1970) as shown below. The category-I comprises of liquid wastes containing β, γ radionuclides with concentrations ≤ 3.7 x 10^4 Bq/m^3. Such liquid effluents do not require treatment and are discharged directly into the nearby hydrosphere. The category-II liquid waste comprises of radionuclides with concentrations in the range of 3.7 x 10^4 and 3.7 x 107 Bq/m^3 which are sent to Effluent Treatment Plant (ETP) for chemical treatment. Category-III liquid wastes comprise of β, γ radionuclides having concentration higher than 3.7 x 10^7 Bq/m^3 and equal or lower than 3.7 x 10^9 Bq/m^3. These liquid effluents are also sent to ETP for chemical treatment under shielding conditions. Category-IV liquid wastes contain β, γ radionuclides with concentrations higher than 3.7 x 10^9 Bq/m^3 but lower than 3.7 x 10^{14} Bq/m^3. These effluents are treated under shielding conditions. The liquid effluents having radionuclide concentrations higher than 3.7 x 10^{14} Bq/m^3 are stored in underground steel tanks under cooling conditions.

Quantification and characterization of liquid radioactive waste		
Category	**Activity level (A: Bq/m^3)**	**Remarks**
I	$A \leq 3.7 \times 10^4$	Not normally treated
II	$3.7 \times 10^4 < A \leq 3.7 \times 10^7$	Without shielding
III	$3.7 \times 10^7 < A \leq 3.7 \times 10^9$	Shielding possible
IV	$3.7 \times 10^9 < A \leq 3.7 \times 10^{14}$	Shielding necessary
V	$3.7 \times 10^{14} > A$	Cooling and shielding necessary

Solid wastes are classified into 4 categories based on radiation dose on the surface of the package (IAEA, 1970) as shown below: Category- comprises of solid radioactive wastes with β, γ Emitters whose radiation level on the surface is ≤ 2mGy/hr. Such solid wastes are usually handled and transported without any special precautions and are suitable for disposal in earth trench/concrete trench in the near surface disposal facility. The decision to dispose in earth trench depends on site specific soil characteristics. Category-II comprises of solid radioactive wastes with β, γ emitters and insignificant amount of α emitters whose surface radiation level is higher than 2 mGy/hr and equal or lower than 20 mGy/hr. Such solid wastes are transported in simple containers shielded with a thin layer of concrete or lead and are generally disposed off in concrete trenches/ vaults in near surface disposal facility. Category-III comprises of radioactive wastes with β, γ emitters and insignificant amounts of á emitters whose surface radiation level is higher than 20 mGy/hr. Such solid radioactive wastes are handled with special precautions. The radioactive packages showing surface radiation level less than 0.5 Gy/hr are disposed off in concrete vaults and those showing greater than 0.5 Gy/hr are disposed off in tile holes of the near-surface disposal facility. The solid radioactive wastes with dominant α emitters and insignificant amount of β, γ emitters belong to category- IV and the activity levels of these wastes are expressed in Bq/m^3. These wastes are disposed off in concrete trenches/tile holes if α activity is very low while the wastes having higher concentrations are stored above surface or in tile holes with the intention of retrieval.

Quantification and characterization of solid radioactive waste		
Category	**Type of radiation**	**Radiation on the surface (D: mGy/hr)**
I	β, γ-emitters	$D \leq 2$
II	β, γ-emitters	$2 < D < 20$
III	β, γ-emitters	$D \geq 20$
IV	A bearing waste	A activity is expressed in Bq/m^3

Annexure 5

Dose Apportionment and Authorized Discharge Limits

The authorized dose limits through air and water route given by AERB and included in the TECHSPECs of the plant has the following basis. Maximum radiation dose per annum for members of public as per International Commission on Radiological Protection (ICRP), adopted for India also by AERB is 1 mSv. This is the maximum dose permitted at the fence-post (1.5 km) from air and water routes. If there are more than one reactor or other nuclear fuels plants proposed for the site, the dose is divided among them such that the total for all of them from both pathways (air and water) does not exceed 1 mSv/y. It is advantageous for the proponents to disclose their long term plans for the site. Otherwise if other NPP's, FRP, WMD or WIP are proposed later, the authorized limit for discharges for the first NPP is reduced to a fraction of the original number according to the number of units to be added. This may sometimes put limit on the number of units which can be accommodated at one site. It ensures that no member of public receives higher than permitted dose because there is hardly any population in the sterilized zone which is 5 km.

ICRP and AERB Dose Limits

	ICRP	AERB
Occupational Workers		
Individual Dose Limit (mSv/year)	20	30
Averaged over 5 years Cumulative Dose for 5 years (mSv)	100	100
Member of Public		
Individual Dose Limit (mSv/year)	1	1
Averaged over 5 years Maximum Dose in a year (mSv)	5	5

To estimate the actual dose received, components of both air and water pathways given in figures 6.1 and 6.2, respectively are measured routinely at EML and radiation dose from each at fence-post is estimated using standard parameters like consumption of each item and hence its total radioactivity. All doses from both air, water, soil, marine pathways are added and this should not exceed 1 mSv/year. It is known from global as well as our data that water route contributes less than 5%, marine route too is less than 5% and the rest 90% is for the air route. Though the methodology for exact calculation of apportionment is given in Ref. 26 of Annexure 3. In simple terms, one has to estimate total annual consumption of the item (food, water, air etc.,) and its radioactivity content and multiply with conversion factor for radioactivity in Bq to dose in milli or micro Sievert to get annual dose from that item. In the case of fish, if it concentrates some radioactive isotopes, one has to multiply by the weighting factor which essentially is an accumulation factor.

Annexure 6

Land use / land cover classification system

Level -I	Level -II	Level -III
1. Built – up land	1.1. Built –up land	1.1.1. Urban (towns & cities)
2. Agricultural land	2.1. Crop land (i) kharif (ii) rabi (iii) double cropped	2.1.1. Irrigated crop land
		2.1.2. Unirrigated crop land
	2.2. Fallow	2.2.1. Fallow
	2.3. Plantation	2.3.1. Types of plantation, casuarina, coconut, tea etc.
3. Forest	3.1 evergreen /semi-evergreen	3.1.1. Dense / closed 3.1.2. Open
	3.2. Deciduous	
	3.3. Degraded scrub land	
	3.4. Forest blank	3.4.1. Degraded forest
		3.4.2. Forest blank
	3.5. Forest plantation	3.5.1. Types of plantatin eg. teak, sal etc.
	3.6. Mangrove	
4. Wastelands	4.1. Salt affected land	
	4.2. Water logged land	
	4.3. Marshy/swampy land	
	4.4. Gullied/ravinous land	
	4.5. Land with or without scrub	
	4.6. Sandy area (coastal & desertic)	Minimum mappable unit IS 2.25 hectares on 1:50,000 scale
	4.7. Barren rocky / stony waste / sheet rock areas	
5. Water bodies	5.1. River / stream	
	5.2 Lake/reservoir/tank/canal	
6. Others	6.1. Shifting cultivation	6.1.1. Current
		6.1.2. Old / abandoned
	6.2.grassland / grazing land	6.2.1. Grassland / grazing land
	6.3. Snow covered/glacial area	6.3.1. Snow covered / glacial area
	6.4. Mining area	6.4.1. Mining dumps

Note: Land use / Land cover categories at different levels and corresponding scales for mapping are as follows:

Level – I – categories – 1:1000,000 scale

Level – II – categories – 1:250,000 scale

Level – III – categories – 1:50,000 scale and 1:25,000 scale

(Sources: Description and classification of land use / land cover : NRSA – TR – LU & CD – 01 –90)

Annexure 7

List of critically polluted industrial cluster/area identified by CPCB

S. No.	Critically Polluted Industrial Area and CEPI	Industrial Clusters/Potential Impact Zones
1	Ankleshwar (Gujarat) *CEPI-88.50* (*Ac_Wc_Lc*)	GIDC Ankleshwar and GIDC, Panoli
2	Vapi (Gujarat) *CEPI-88.09 (Ac_Wc_Lc)*	GIDC Vapi
3	Ghaziabad (Uttar Pardesh) *CEPI-87.37* (*Ac_Wc_Lc*)	**Sub-cluster A** • Mohan nagar Industrial area • Rajinder nagar Industrial area • Sahibabad Industrial area **Sub-cluster B** • Pandav nagar Industrial area • Kavi nagar Industrial area • Bulandshahar Road Industrial area • Amrit nagar • Aryanagar Industrial area **Sub-cluster C** • Merrut road Industrial area **Sub-cluster D** • Loni Industrial area • Loni Road Industrial area • Roop Nagar Industrial area **Sub-cluster E** • Hapur Road Industrial area • Dasna • Phikua **Sub-cluster F** (other scattered Industrial areas) • South side of GT road • Kavi Nagar • Tronica city • Anand Nagar • Jindal Nagar • Prakash Nagar • Rural Industrial estate
4	Chandrapur (Maharashtra) *CEPI-83.88* (*Ac_Wc_Lc*)	Chandrapur (MIDC Chandrapur, Tadali, Ghuggus, Ballapur)
5	Korba (Chhatisgarh) *CEPI-83.00* (*Ac_Ws_Lc*)	a) Industrial areas and their townships of NTPC, BALCO, CSEB (East) & CSEB (West) b) Korba town
6	Bhiwadi (Rajassthan) *CEPI-82.91* (*Ac_Wc_Ls*)	a) RIICO Industrial areas Phase I to IV b) Bhiwadi town c) Other surrounding industrial areas: Chopanki, Rampura Mundana, Khuskhera Phase I to III.
7	Angul Talcher (Orissa) *CEPI-82.09* (*Ac_Wc_Lc*)	a) MCL Coal Mining Area, Angul – Talcher region b) Industrial Area (60 km x 45 km) Following blocks of Angul District: - Kohina block - Talcher block - Angul block - Chhendipada block - Banarpal block And Odapada block of Dhenkamal District
8	Vellore (North Arcot) (Tamilnadu) *CEPI-81.79 (Ac_Wc_Lc)*	Ranipet, SIPCOST Industrial Complex
9	Singurauli (Uttar Pradesh) *CEPI-81.73* (*Ac_Wc_Ls*)	Sonebhadra (UP) • Dala-Tola • Obra • Renukoot • Anpara • Renusagar • Kakri • Dudhichuwa • Bina • Khadia • Shakti Nagar • Rihand Nagar • Bijpur Sigrauli (Madhya Pradesh) Vindhyachal Nagar and Jayant, Nigahi, Dudhichua, Amlohri & Jhingurdah townships

S. No.	Critically Polluted Industrial Area and CEPI	Industrial Clusters/Potential Impact Zones
10	Ludhiana (Punjab) *CEPI-81.66* (*Ac_Wc_Ls*)	Ludhiana Muncipal limits covering industrial clusters: • Focal Point Along with NH_I_Tota Eight Phase • Industrial Area-B-From Sherpur chowk to Gill road & Gill road to Miller Kotla road (left Side of Road) • Mixed Industrail Area – Right side of Gill road • Industrial area – C (near Jugiana Village) • Industrial Area A & Extension: Area between old GT Road and Ludhiana by pass road • Industrial Estate : Near Dholwal chowk • Mixes Industrial Area (MIA) Miller gunj • MIA-By pass road • Bahdur Industrial Area • Tejpur industrial Complex.
11	Nazafgarh drain basin, Delhi *CEPI-79.54* (*As_Wc_Lc*)	Industrial areas : Anand Parvat, Naraina, Okhla and Wazirpur
12	NOIDA (Uttar Pradesh) *CEPI-78.90* (*Ac_Wc_Lc*)	Territorial jurisdiction of : • Noida Phase - 1 • Noida Phase - 2 • Noida Phase – 3 • Surajpur Industrial Area • Greater Noida Industsrial Area • Village-Chhaparaula
13	Dhanbad (Jharkhand) *CEPI-78.63* (*Ac_Ws_Lc*)	Four blocks of Dhanbad district: • Sadar (Dhanbad Municipality) • Jharia (Jharia Municipality, Sindri Industrial Area) • Govindpur (Govindpur Industrial Estate) • Nirsa
14	Dombivalli (Maharashtra) *CEPI-78.41*(*Ac_Wc_Ls*)	MIDC Phase-I, Phase-II
15	Kanpur (UttarPradesh) *CEPI-78.09* (*Ac_Wc_Ls*)	• Industrial areas: • Dada Nagar • Panki • Fazalganj • Vijay Nagar • Jajmau
16	Cuddalore (Tamilnadu) *CEPI-77.45* (*As_Wc_Lc*)	SIPCOT Industrial Complex, Phase I & II
17	Aurangabad (Maharashtra) *CEPI-77.44* (*Ac_Wc_Ls*)	MIDC Chikhalthana, midc Waluj, MIDC Shendra, and Paithan Road industrial area
18	Faridabad (Haryana) *CEPI-77.07* (*Ac_Ws_Lc*)	• Sector 27 - A, B, C, D • DLF Phase – 1, Sector 31, 32 • DLF Phase – 2, Sector 35 • Sector 4, 6, 24, 25, 27, 31, 59 • Industrial area Hatin • Industrial Model town Ship
19	Agra (Uttar Pradesh) *CEPI-76.48* (*As_Wc_Ls*)	Nunihai Industraial Estate, Rambag Nagar, UPSIDC Industrial Area, and Runukata Industrial Area
20	Manali (Tamilnadu) *CEPI-76.32* (*Ac_Ws_Ls*)	Manali Industrial Area
21 22	Haldia (West Bengal) *CEPI-75.43* (*As_Wc_Ls*) Ahmedabad (Gujarat) *CEPI-75.28* (*Ac_Ws_Ls*)	5 km wide Strip (17.4 x 5.0 km) of industrial area on the southern side of the confluence point of Rivers Hugli and Rupnarayan, covering Haldia Municipa Area & Sutahata Block-I and II • GIDC Odhav • GIDC Naroda
23	Jodhpur (Rajasthan) *CEPI-75.19 (As_Wc_Ls*)	• Industrial areas including Basni Areas (Phase-I & II), Industrial Estate, Light & Heavy industrial areas, industrial areas behind new Power House, Mandore, Bornada, Sangariya and Village Tanwda & Salawas. • Jodhpur city
24	Greater Coach (Kerala) *CEPI-75.08* (*As_Wc_Ls*)	Eloor-Edayar Industrail Belt, Ambala Mogal Industrial areas
25	Mandi Gobind Garh (Punjab) *CEPI-75.08* (*Ac_Ws_Lc*)	Mandi Govindgarh municipal limit and Khanna area
26	Howrah (West Bengal) *CEPI-74.84* (*As_Ws_Lc*)	a) Liluah-Bamangachhi Region, Howrah b) Jalah Industrial Complex-1, Howrah
27	Vatva (Gujarat) *CEPI-74.77* (*Ac_Wc_Ls*)	GIDC Vatva, Narol Industrial Area (Villages Piplaj, Shahwadi, Narol)

S. No.	Critically Polluted Industrial Area and CEPI	Industrial Clusters/Potential Impact Zones
28	Ib Valley (Orissa) *CEPI-74.00* (*Ac_Ws_Ls*)	Ib Valley of Jharsuguda (Industrial and Mining area)
29	Varansi-Mirzapur (Uttar Pradesh) *CEPI-73.79* (*As_Wc_Ls*)	• Industrial Estate, Mirzapur • Chunar • Industrial Estate, Chandpur Varanasi • UPSIC, Industrial Estate, Phoolpur • Industrial Area, Ramnagar, Chandaull
30	Navi Mumbai (Maharashtra) *CEPI-73.77* (*Ac_Ws_Ls*)	TTC Industrial Area, MIDC, Navi Mumbai (including Blocks-D, C, EL, A, R, General, Kalva)
31	Pali (Rajasthan) *CEPI-73.73* (*As_Wc_Ls*)	a) Existing industrial areas: Mandia Road, Puniyata Road, Sumerpur b) Pali town
32	Mangalore (Karnataka) *CEPI-73.68* (*Ac_Ws_Ls*)	Baikampady Industrial Area
33	Jharsuguda (Orissa) *CEPI-73.34* (*Ac_Ws_Ls*)	Ib Valley of Jharsuguda (Industrial and Mining area)
34	Coimbatore (Tamil Nadu) *CEPI-72.38* (*Ac_Ws_Ln*)	SIDCO, Kurichi Industrial Clusters
35	Bhadravati (Karnataka) *CEPI-72.33* (*Ac_Ws_Ln*)	KSSIDC Industrial Area Mysore Paper Mill & VISL Township Complex
36	Tarapur (Maharashtra) *CEPI-72.01* (*Ac_Ws_Ls*)	MIDC Tarapur
37	Panipat (Haryana) *CEPI-71.91* (*As_Ws_sc*)	Panipat Municipal limit and its industrial clusters
38	Indore (Madhya Pradesh) *CEPI-71.26* (*As_Ws_Ls*)	Following 09 industrial areas: • Sanwer Road • Shivaji Nagar • Pologround • Laxmibai Nagar • Scheme No. 71 • Naviakha, • Pipliya • Palda • Rau • Indore city • Other surrounding industrial areas : Manglia, Rajoda, Barlal, Asrawad, Tejpur Gadwadi
39	Bhavnagar (Gujarat) *CEPI-70.99* (*As_Ws_Ls*)	GIDC Chitra, Bhavnagar
40	Vishakhapatnam (Andhra Pradesh) *CEPI-70.82* (*As_Ws_Ls*)	Bowl area (the area between Yarada hill range in the south to Simhachalam hill range in the north and sea on the east and the present NH-5 in the West direcdtion)
41	Junagarh (Gujarat) *CEPI-70.82* (*As_Ws_Ls*)	Industrial Areas: • Sabalpur • Jay Bhavani • Jay Bhuvneshwari • GIDC Junagarh (I&II)
42	Asansole (West Bengal) *CEPI-70.20* (*As_Ws_Ls*)	Burnpur area surrounding IISCO
43	Patancheru- -Bollaram (Andhra Pradesh) *CEPI-70.07* (*As_Ws_Ls*)	Industrial Area: • Patancheru • Bollaram

Note: Names of identified industrial clusters/ potential impact zones are approximate location based on rapid survey and assessment and may alter partially subject to the detailed field study and monitoring. Detailed mapping will be made available showing spatial boundaries of the identified industrial clusters including zone of influence/buffer zone, after in depth field study.

Aggregated Comprehensive Environmental Pollution Index (CEPI) scores of 70 and above are considered as critically polluted industrial clusters/ areas.

Source: Ecological Impact Assessment Series: EIAS/5/2009-10
Details of Critically Polluted Industrial Areas and Clusters/ Potential Impact Zone in terms of the Office Memorandum no. J-11013/5/2010-IA.II(I) dated 13.1.2010

Annexure 8
Sampling, Frequency & Method of Baseline Environment Monitoring

Attributes	Sampling		Measurement Method	Remarks
A. Air Environment	**Network**	**Frequency**		
Meteorological ▸ Wind speed ▸ Wind direction ▸ Maximum temperature ▸ Minimum temperature ▸ Relative humidity ▸ Rainfall ▸ Solar radiation ▸ Cloud cover ▸ Environmental Lapse Rate	1 site in the project area	1 hourly continuous	Mechanical/automatic weather station Max/Min Thermometer Hygrometer Rain gauge As per IMD specifications As per IMD specifications Mini Sonde/SODAR	IS 5182 Part 1-20 Site specific primary data is essential Secondary data from IMD CPCB guidelines
Pollutants ▸ SPM ▸ RSPM ▸ SO_2 ▸ NO_x	**Nos. of sampling location to be decided**	24 hourly twice a week @4 hourly. Twice a week, One non monsoon season 8 hourly, twice a week	As per CPCB guidelines .	Monitoring Network ▸ Minimum one locations in upwind side, two sites in downwind side / mpact zone ▸ All the sensitive eceptors need to be covered for core zone and buffer zone
B. Noise	**Network**	**Frequency**		
▸ Hourly equivalent noise levels	Identified study area	Once in season	Noise level meter	IS:4954-1968 as adopted by CPCB

Attributes	Sampling		Measurement Method	Remarks
C. Water ▸ Parameters for water quality ▸ pH, temperature, turbidity, magnesium hardness, total alkalinity, chloride, sulphate, nitrate, fluoride, sodium, potassium, salinity ▸ Total nitrogen, total phosphorus, DO, BOD, COD ▸ Heavy metals ▸ Total coliforms, faecal coliforms ▸ Phyto plankton	▸ Set of grab samples for ground and surface water		Samples for water quality should be collected and analysed 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.	
D. Land environment				
Soil ▸ Organic Matter ▸ Texture ▸ pH ▸ Electrical conductivity ▸ Permeability ▸ Water holding capacity ▸ Porosity ▸ Cation Exchange Capacity	Sample from villages (soil samples be collected as per BIS specifications)	One season	Collected and analysed as per soil analysis reference	Analysis be done as per BIS specifications

Adopted from: EIA manual 2001, Ministry of Environment and forests, New Delhi

Annexure 9

Criteria for raw water used for organized community water supplies (surface and ground water) primary parameters

Parameters	Range/Limiting Value		Note
	Use with only disinfection	Use after conventional treatment	
1. pH	6.5 to 8.5	6.0 to 9.0	To ensure prevention of corrosion in treatment plant and distribution system and interference in coagulation and chlorinating.
2. Colour Pt. scale Hz Units	< 10	< 50	Color may not get totally removed during treatment
3. Suspended Solids mg/l	< 10	< 50	High SS may increase the cost of treatment.
4. Odour, dilution factor	< 3	< 10	May not be tackled during treatment.
5. DO, (%saturation)	90-100	80-120	May imply higher chlorine demand.
6. BOD, mg/l	< 3	< 5	Same as above.
7. TKN, mg/l	< 1	< 3	Same as above.
8. Ammonia, mg/l	< 0.05	< 1	Same as above.
9. Faecal coliform MPN/100 ml	< 200	< 2000	Not more than 20% samples show greater than limit.
10. EC, µm/ hos/cm	< 2000	< 2000	High conductivity implies dissolved high solids making water unpalatable.
11. Chloride, mg/l	< 300	< 300	May cause physiological impact and unpalatable taste.
12. Sulphates,mg/l	< 250	<250	May cause digestive problems
13. Phosphates, mg/l	< 0.7	< 1.0	May interfere with coagulation
14. Nitrate, mg/l	< 50	< 50	May cause methamoplobinemea
15. Fluoride, mg/l	< 1.0	< 1.5	Higher value shall cause fluorosis and lower value shall carries.
16. Surfactants, mg/l	< 0.2	< 0.2	May impair treatability and cause foaming.

Additional Parameters for Periodic Monitoring (Seasonal – Only to be done when there are known natural or anthropogenic sources in the upstream catchment region likely or apprehended to contribute or other well founded apprehensions)

Parameters	Desirable	Acceptable	Note
Dissolved Iron mg/l	< 0.3	< 0.5	Affect taste and cause stains
Copper, mg/l	—	< 1.0	May cause live damage
Zinc, mg/l	—	< 5.0	Cause bitter stringent taste
Arsenic, mg/l	< 0.01	< 0.05	Cause hyperkeratosis & skin cancer
Cadmium, mg/l	< 0.001	< 0.005	Toxic
Total Chromium, mg/l	< 0.05	< 0.05	Toxic
Lead, mg/l	< 0.05	< 0.05	Physiological abnormality
Selenium, mg/l	< 0.01	< 0.01	Toxic symptoms similar to arsenic
Mercury, mg/l	< 0.005	<0.0005	Carcinogenic and poisonous
Phenols, mg/l	< 0.001	< 0.001	Toxic and cause taste and odour problem
Cyanides, mg/l	< 0.05	< 0.05	Physiological abnormality
PAH, mg/l	< 0.0002	< 0.0002	Carcinogenic
Total Pesticides, mg/l	< 0.001	< 0.0025	Trend to bioaccumulates & carcinogenic

(Source: Ecological Impact Assessment Series: EIAS/03/2002-03 Published by CPCB)

Use based classification of surface waters in India

Designated-Best-Use	Class of water	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	1. Total Coliforms OrganismMPN/100ml shall be 50 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 6mg/l or more 4. Biochemical Oxygen Demand 5 days 20oC 2mg/l or less
Outdoor bathing (Organized)	B	1. Total Coliforms Organism MPN/100ml shall be 500 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 5mg/l or more 4. Biochemical Oxygen Demand 5 days 20oC 3mg/l or less
Drinking water source after conventional treatment and n disinfectio	C	1. Total Coliforms Organism MPN/100ml shall be 5000 or less 2. pH between 6 to 9 3. Dissolved Oxygen 4mg/l or more 4. Biochemical Oxygen Demand 5 days 20oC 3mg/l or less
Propagation of Wild life and Fisheries	D	1. pH between 6.5 to 8.5 2. Dissolved Oxygen 4mg/l or more 3. Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	1. pH between 6.0 to 8.5 2. Electrical Conductivity at 25°C micro mhos/cm Max.2250 3. Sodium absorption Ratio Max. 26 4. Boron Max. 2mg/l

(Source: Guidelines for Water Quality Management –CPCB 2008)

Annexure 10
National Ambient Air Quality Standards (NAAQS)

S. No	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and other areas	Ecologically Sensitive area (notified by central government)	Methods of measurement
(1)	(2)	(3)	(4)	(5)	(6)
1	Sulphur dioxide (SO_2), $\mu g/m^3$	Annual* 24 hours**	50 80	20 80	- Improved West & Gaeke -Ultraviolet fluorescence
2.	Nitrogen Dioxide (NO_2), g/m^3	Annual* 24 hours**	40 80	30 80	-Modified Jacob & Hochheiser (Na-Arsenite) -Chemiluminescence
3.	Particulate Matter (Size less than 10m) or PM_{10} g/m^3	Annual* 24 hours**	60 100	60 100	- Gravimetric - TOEM - Beta attenuation
4.	Particulate Matter (Size less than 2.5m) or $PM_{2.5}$ g/m^3	Annual* 24 hours**	40 60 μ	40 60	- Gravimetric - TOEM - Beta attenuation
5	Ozone (O_3) g/m^3	8 hours** 1 hour**	100 180	100 180	- UV photometric - Chemiluminescence - Chemical method
6	Lead (Pb) g/m^3	Annual* 24 hours**	0.50 1.0	0.50 1.0 filter	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon
7	Carbon Monoxide (CO) g/ m^3	8 hours** 1 hour**	02 04	02 04	-Non Dispersive Infra Red (NDIR) spectroscopy
8	Ammonia (NH_3) g/m^3 24 hours**	Annual*	100 400	100 400	- Chemiluminescence - Indophenol blue method
9	Benzene (C_6H_6) g/m^3	Annual*	05	05	-Gas chromatography based continuous analyzer -Adsorption and Desorption followed by

10	Benzo(a)Pyrene (BaP) – particulate phase only, ng/m^3	Annual*	01	01	GC analysis -Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As) ng/m^3	Annual*	06	06	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni) ng/m^3	Annual*	20	20	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals

** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Note:

Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation

(Source: National Ambient Air Quality Standards, CPCB Notification dated 18th November 2009)

Annexure 11

Noise Ambient Air Quality Standards

Area code	Category of area	Limits in db (A) Leq	
		Day time	Night time
A	Industrial area	75	70
B	Commercial area	65	55
C	Residential area	55	45
D	Silence zone	50	40

Note:

1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is an area comprising not less than 100 meters around hospitals, educational institutions, courts, religious places or any other area, which is declared as such by the competent authority.
4. Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.

   * dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

   A "decibel" is a unit in which noise is measured.

   "A", in dB(A) L_{eq}, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.

   L_{eq}: It is an energy mean of the noise level over a specified period.

   (Source: Noise pollution (Regulation and control) Rules, 2000)

QUESTIONNAIRE

QUESTIONNAIRE FOR ENVIRONMENTAL APPRAISAL OF NUCLEAR POWER PLANT, NUCLEAR FUEL REPROCESSING PLANT AND/OR NUCLEAR WASTE MANAGEMENT PLANTS

Note 1: All information to be given in the form of Annex/s should be properly numbered and form part of reply to this proforma.

Note 2: Please enter v in appropriate box where answer is Yes / No

Note 3: No abbreviation to be used - Not available or Not applicable should be clearly mentioned.

Note 4 : Zones (Exclusion, Sterilized, Emergency Planning, Impact) should be clearly marked

Note 5 : Please indicate source of data.

1. General Information

1.1 Name of the Project :

a. Name of the authorized signatory :

b. Mailing Address :
E-mail :
Telephone :
Fax Number :

c. Does the project related to new project/ expansion project/ modernization project :

d. If existing/expansion/ modernization project :

e. Capacity (TPA) for existing and after expansion :

1.2 Location

S.No & Village	Tehsil	District	State

1.3 Site Information

(a) (i) Geographical Location

- Latitude
- Longitude
- Survey of India Topo sheet number
- Elevation above Mean Sea Level

(ii) Distance from river, lake, sea, airport, town, sanctuary
Whether any part falls within the coastal regulation zone (CRZ)

(iii) Land acquired/being acquired (in ha)
a. Government Land (in ha)
b. Private Land (in ha)
c. Is it agricultural/forest

(b) Land requirement for the proposed project/s (in ha)
Plant/s
Expansion
Green Belt
Roads/infrastructure
Township (outside exclusion zone)
Others (specify)
Total

(c) Existing usage of land for (in ha)

(i) Agriculture
(ii) Forest
(iii) Waste-land
(iv) Grazing
(v) Surface water Bodies
(vi) Others

1.4 Current land use of the proposed project site (in ha.)

a. Built-up land
b. Agricultural land
c. Forest
d. Mangroves
e. Wastelands
f. Water bodies
g. Others
h. Total

(As per land use/land cover classification system mentioned as Annexure of this manual)

1.5 Environmental sensitivity details within 10 km from the boundary of the project for applicability of "General Condition (GC)" as per EIA notification dated 14.9.2006.

S.No	Item	Name	Aerial Disance (in Km)
1.	Protected areas notified under the wild life (Protection) Act, 1972		
2	Critically polluted areas as notified by the Central Pollution Control Board from time to time		
3	Notified Eco-sensitive areas		
4	Inter-state boundaries and international boundaries		

1.6 Environmental sensitivity areas as mentioned at column 9(III) of EIA Notification 2006

Areas	Name/ Identity	Aerial distance (within 15 km) Proposed project location boundary
Areas protected under international conventions, national or local legislation for their ecological, landscape, cultural or other related value		
Areas which are important or sensitive for ecological reasons – Wetlands, watercourses or other water bodies, coastal zone, biospheres, mountains, forests		
Areas used by protected, important or sensitive species of flora or fauna for breeding, nesting, foraging, resting, over wintering, migration		
Inland, coastal *, marine or underground waters		
State, National boundaries		
Routes or facilities used by the public for access to recreation or other tourist, pilgrim areas		
Defense installations		
Densely populated for built-up area		
Areas occupied by sensitive man-made land uses *(hospitals, schools, places of worship, community facilities)*		
Areas containing important, high quality or scarce resources *(ground water resources, surface resources, forestry, agriculture, fisheries, tourism, minerals)*		
Areas already subjected to pollution or environmental damage *(those where existing legal environmental standards are exceeded)*		
Areas susceptible to natural hazard which could cause the project to present environmental problems *(earthquakes, subsidence, land slides, erosion, flooding or extreme or adverse climatic conditions)*		

*** wherever it is covered in the CRZ implications should be incorporated**

2.0 Baseline data for Radioactivity in the project area

	Natural radioactivity (in Bq / Kg)			
	Potassium	Uranium	Thorium	Radium -226 Ra-228
Soil				
Water				
Air	Radioactivity	in Bq/m3		
	Gross Beta	Gross Alpha	Tritium	

In case of expansion projects, also include

Environment	Artificial radioactivity (in Bq / Kg)			
	Tritium	Type different radio-isotopes		
Air				
Water				
Soil/sediment				

Meteorological data

Ambient air quality data

Water quality data

Marine data

Biological data

Description of the flora/vegetation in the project area and within 11 km radius

Description of fauna (non-domesticated) in the project area and within 11 km radius

3. Plant Details

(i) Process description in brief (attach additional sheets)

(ii) Safety Systems and controls

(iii) Spent fuel storage

(iv) Water Requirement

Process	
Cooling	
Township	

(v) Source of water for the plant : Sea Water/Others. If Others, complete the following*

S. No.	Source	m^3/day
	River/Dam/Lake (name)	

[*Annex a copy of sanction letter / permission from the concerned authority (Central Ground Water Authority in case of ground water abstraction is from notified area / State Ground Water Board in case of non-notified area / State Irrigation Department for surface water pumping) for drawing water.]

(vi) Waste water/cooling water discharge

S. No.	Source	Remarks
	Quantity	
	Characteristics	

(vii) Power requirement during

S. No.	Source	Remarks
	Construction	
	Operation	
	Stand by power	

4. Radioactivity discharges to

S. No.	Source	Remarks
	Air	
	Water	
	Solid Waste	

5. Chemical Pollutant Discharges (in case of NFRP & NWMP's)

S. No.	Source	Remarks

6. Environmental Impact during construction phase

(Briefly describe arrangements for construction workers health and safety, temporary housing and other welfare measures)

7. Human Settlement

	Exclusion Zone	Other Areas
Population*		
No. of villages		
Number of households village-wise		

[* As per 2001 census record or actual survey]

8. Rehabilitation & Resettlement (R&R) Plan*

[*Provide a comprehensive rehabilitation plan, if more than 1000 people are likely to be displaced, otherwise a summary plan]

(a) Villages falling within the study area

	Villages	
	Number	Name
Project site		
Township site		

(b) Details of village(s) in the Exclusion zone

S. No.	Village name	Population		Average Annual
		Tribal	Others	Income

(c) Population to be displaced and / or Land oustees

Name of village(s) falling within	Number of oustees		
	Land (only)	Homestead (only)	Land and Homestead (both)
Plant/s Site			
Township Site 1. 2.			

(d) Whether R&R package has been finalised?
If yes, salient features of R&R plan for oustees.

(i) Site details where the people are proposed to be resettled & facilities existing / to be created.

(ii) Funds earmarked for compensation package.

(iii) Agency /Authority responsible for their resettlement.

(iv) Time of commencement of resettlement of Project Affected People (PAP).

(v) Period by which resettlement of PAP will be over.

9. Emergency Management Plan

Briefly describe the plan and system proposed for its management.

10. Environmental health and safety

(a) What major health and safety hazards are anticipated?

(b) What provisions have been made/proposed to be made to conform to health and safety requirements?

(c) Has epidemiological and health survey of population within 30 km radius done

Yes No

Attach findings summary

11. Environmental Management Plan

11.1 Capital cost of the project (as proposed to approved by the funding agency)

Rs. Lakhs

11.2 Cost of environmental protection measures

S.No		Capital cost		Annual recurring cost	
		Existing	Proposed	Existing	Proposed
1	Pollution control (provide break-up separately)				
2	Pollution monitoring (provide break-up separately)				
3	Fire fighting & emergency handling				
4	Green Belt				
5	Training in the area of environment & safety				
6	Others (specify)				

12. Compliance with environmental safeguards (For existing units)

a. Status of the compliance of conditions of Environmental clearance issued by MoEF, If any, enclosed — Yes ☐ No ☐

b. Status of the compliance of 'Consent to Operate' issued by SPCB, if any, enclosed — Yes ☐ No ☐

c. Latest 'environmental statement' enclosed — Yes ☐ No ☐

13. Clearances Obtained (Y)/to be obtained (N)

Clearances	Y / N
Regulatory consent for siting (AERB)	
Regulatory consents for construction (AERB) - Excavation - First pour of concrete - Erection of major equipment	
Regulatory consents for commissioning (AERB)	
Regulatory consents for operation (AERB)	
Regulatory consents for authorization of power generation (AERB)	
Authorization for storage and import of hazardous chemicals (AERB)	
Authorization for safe disposal of radioactive wastes (AERB)	
Authorization for transfer / safe disposal of radioactive waste (AERB)	

Consent to establish plant (SPCB)
Authorization for storage and disposal of hazardous waste (SPCB)
Consent to discharge air (SPCB)
Consent to discharge water (SPCB)
Forestry clearance if forest land is involved
Wild life clearance if with 10km of National park / Sanctuary
CRZ clearance

14. Public Hearing

a. Date of Advertisement

b. Newspapers in which the advertisement appeared

c. Date of Hearing

d. Panel present

e. List of public present

f. Summary of public hearing details

S.No	Summary/issues raised by the public	Response of project Proponents

g. Observations made by the public hearing panel

Date .....

Name and Signature of the Competent Officer/authority

E-mail:
Phone and Fax nos:

Given under the seal of organization on behalf of whom the applicant is signing

Note:

The project authorities are earnestly advised in their own interest to provide complete information