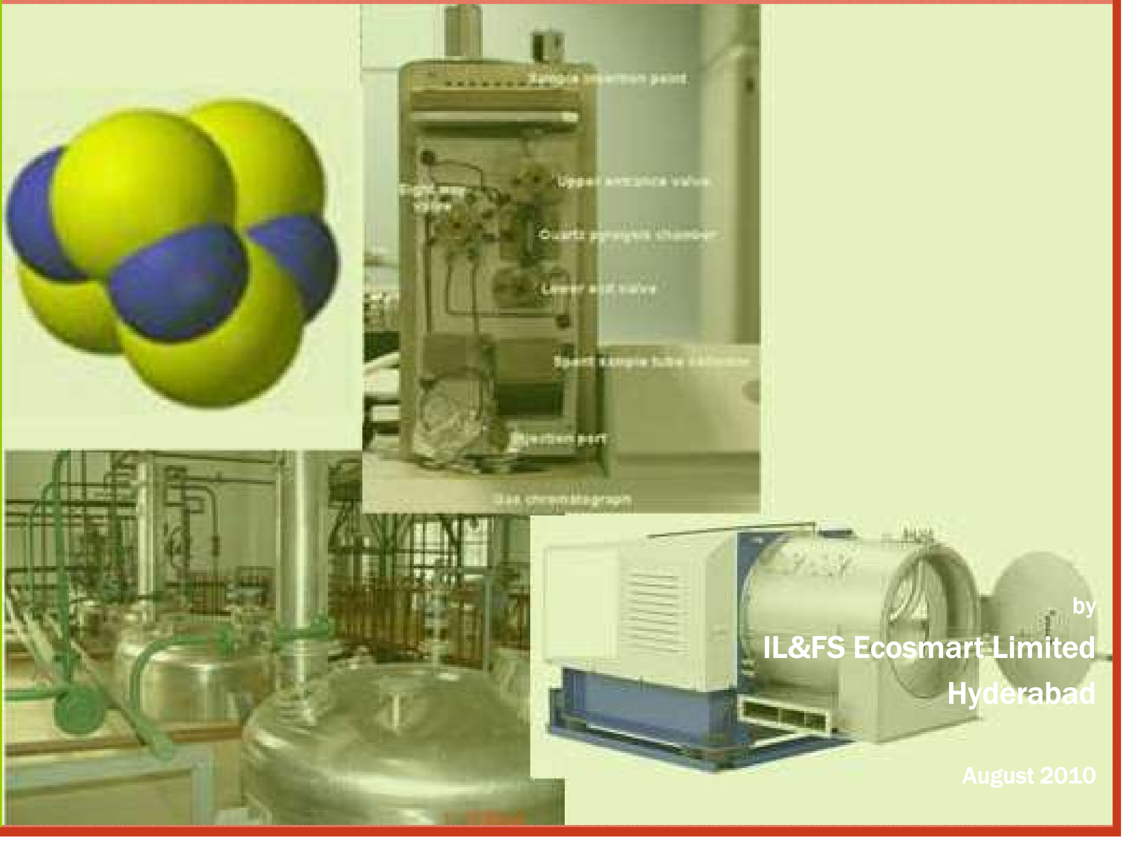
TECHNICAL EIA GUIDANCE MANUAL

FOR

SYNTHETIC ORGANIC CHEMICALS INDUSTRY

Prepared for

The Ministry of Environment and Forests
Government of India



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ACRONYMS

AAQ	Ambient Air Quality
ANDA	Abbreviated New Drug Applications
B/C	Benefits Cost Ratio
BAT	Best Available Technology
BOC	Basic Organic Chemicals
BOD	Biochemical Oxygen Demand
BOQ	Bill of Quantities
BOT	Build Operate Transfer
CCA	Conventional Cost Accounting
CER	Corporate Environmental Reports
CETP	Common Effluent Treatment Plan
CEAA	Canadian Environmental Assessment Agency
CFE	Consent for Establishment
CNS	Central Nervous System
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CREP	Corporate Responsibility for Environmental Protection
CRZ	Coastal Regulatory Zone
DfE	Design for Environment
DMP	Disaster Management Plan
EAC	Expert Appraisal Committee
ECI	Environmental Condition Indicators
EcE	Economic-cum-Environmental
EIA	Environmental Impact Assessment
EIS	Environmental Information System
EMA	Environmental Management Accounting
EMP	Environmental Management Plan
EMS	Environmental Management System
EPI	Environmental Performance indicators
ES	Environmental Statements
ETP	Effluent Treatment Plan
FCA	Full Cost Assessment
HAZOP	Hazard and Operability Studies

HAL	Hindustan Antibiotics Limited
HAPs	Hazardous Air Pollutants
HTL	High Tide Level
IL&FS	Infrastructure Leasing & Financial Services Limited
IVI	Importance Value Index
ISO	International Standard Organization
LCA	Life Cycle Assessment
LDAR	Leak Detection and Repair
LTL	Low Tide Level
MCA	Maximum Credible Accident
MEK	Methyl Ethyl Ketone
MoEF	Ministry of Environment & Forests
NAQM	National Air Quality Monitoring
NGO	Non-Government Organizations
O&M	Operation and Maintenance
OECD	Organization for Economic Co-operation and Development
PM	Particulate Matter
PPA	Participatory Poverty Assessment
PRA	Participatory Rural Appraisal
PSU	Public Sector Unit
QA/QC	Quality Assurance/Quality Control
QRA	Quantitative Risk Assessment
RBC	Rotating Biological Contactors
SBR	Styrene-Butadiene
SEA	Strategic Environmental Assessment
SEAC	State Level Expert Appraisal Committee
SEIAA	State Level Environment Impact Assessment Authority
SEZ	Special Economic Zone
SOCs	Synthetic Organic Chemicals
SIA	Social Impact Assessment
SPCB	State Pollution Control Board
SPCC	Spill Prevention Containment and Cleanup
SPM	Suspended Particulate Matter
TA	Technology Assessment
TCA	Total Cost Assessment
TDI	Toluene Diisocyanate
TDS	Total Dissolved Solids
TEQM	Total Environmental Quality Movement
TGM	Technical EIA Guidance Manual

ToR	Terms of Reference
TSS	Total Suspended Solids
TPP	Triphenylphosphine
TPPO	Triphenylphosphine Oxide
UT	Union Territory
UTEIAA	Union Territory Level Environment Impact Assessment Authority
UTPCC	Union Territory Pollution Control Committee
VOCs	Volatile Organic Compounds

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Acknowledgement

The Notification issued on the prior environmental clearance process by the Ministry of Environment and Forests (MoEF) on September 14, 2006 delegated substantial powers to the State Level Environment Impact Assessment Authorities (SEIAA) to grant environmental clearance for certain categories of developmental activities/projects. It was felt that proper guidance to the stakeholders would enhance appreciation of environmental impacts of proposed projects and possible mitigation measures. Further, such a guidance would also help ensure that decision making authorities across different States and Union Territories could adopt similar considerations and norms with due weightage for site-specific considerations.

We feel privileged to be part of the interventions being spearheaded by Sh. Jairam Ramesh, Hon'ble Minister, MoEF, Government of India, to mainstream environmental considerations in the decision making process. IL&FS Ecosmart as part of this important initiative, prepared Technical EIA Guidance Manuals for 27 identified development activities. In view of the diversity of 27 developmental activities entrusted to IL&FS Ecosmart Ltd., in consultation with the MoEF, an expert Peer and Core Committee was constituted to review and finalize each of the draft Manuals. The Manuals prepared by IL&FS were technically reviewed and up-dated by the respective sector-specific expert resource persons.

The Manuals designed by the Expert Committee have benefitted from the advise and feedback received from MoEF. The Manuals are designed to provide readers with an in-depth understanding of the environmental clearance mechanism, developmental activity specific environmental impacts with possible mitigation measures, environmentally compliant manufacturing/ production processes and pollution control technologies, etc.

IL&FS Ecosmart hopes that these Manuals are a step forward to realize the MoEF's desired objective of enhancing functional efficiency and effectiveness in the environmental clearance process. We hope the stakeholders will find the Manuals useful.

We take this opportunity to convey our appreciation to the MoEF team under the leadership of Mr. J.M. Mauskar, Additional Secretary, for the technical inputs, guidance and support extended throughout the project period for successful completion of the project. The technical guidance and support extended by the Expert Peer and Core Committee under the Chairmanship of Dr. V. Rajagopalan, former Chairman, Central Pollution Control Board and inputs of the sector-specific resource persons are gratefully acknowledged.

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FOREWORD

The Ministry of Environment & Forests (MOEF) introduced the Environmental Impact Assessment (EIA) Notification 2006 on 14th September 2006, which not only reengineered the entire environment clearance (EC) process specified under the EIA Notification 1994, but also introduced a number of new developmental sectors which would require prior environmental clearance. The EIA Notification 2006 has notified a list of 39 developmental sectors which have been further categorised as A or B based on their capacity and likely environmental impacts. Category B projects have been further categorised as B1 and B2. The EIA Notification 2006 has further introduced a system of screening, scoping and appraisal and for the setting up of Environment Impact Assessment Authority (EIAA) at the Central level and State Level Environment Impact Assessment Authorities (SEIAAs) to grant environmental clearances at the Central and State level respectively. The Ministry of Environment & Forests is the Environment Impact Assessment Authority at the Central level and 25 State Level Environment Impact Assessment Authorities (SEIAAS) have been set up in the various States/UTs. The EIA Notification 2006 also stipulates the constitution of a multi-disciplinary Expert Appraisal Committee (EAC) at the Centre and State level Expert Appraisal Committees (SEACs) at State/UT Level for appraisal of Category A or B projects respectively and to recommend grant/rejection of environmental clearance to each project/activities falling under the various sectors to the EIAA/SEIAAs respectively.

Although the process of obtaining environmental clearance consisting of Screening, Scoping and Appraisal and for undertaking public consultation including the process of conduct of Public Hearing has been elaborated under the EIA Notification 2006, the Notification itself provides for bringing out guidelines from time to time on the EIA Notification 2006 and the EC process with a view to bringing clarity on the EC process for expediting environmental clearance. This need was further reinforced after the constitution of SEIAAs and SEACs in various States, who were assigned the task for the first time and for addressing the concerns of standardization of the quality of appraisal and in reducing inconsistencies between SEACs/SEIAAs in granting ECs for similar projects in different States.

The Technical Guidance Manual of **"Synthetic Organic Chemicals Industry"** sector mainly involving organic compounds, dye and dye intermediates, bulk drugs & intermediates, synthetic rubbers etc describes types of processes and pollution control technologies, operational aspects of EIA with model TOR of that Sector, technological options with cleaner production and waste minimization techniques, monitoring of environmental quality, post clearance monitoring protocol, related regulations, and procedure of obtaining EC if linked to other clearances for e.g., CRZ, etc.

Initiatives regarding hazardous emissions generated during organic chemical production and use are important dynamics that shape the industry. The chemical business is by far the largest polluting industry generating at least three times more pollution than the second greatest offending industry. Cleaner technologies of production involves reducing material inputs, re-engineering processes to recover/reuse by-products, improving management practices, substituting benign chemicals for toxic ones and by adopting good house keeping practices. Proper implementation of measures for safety, occupational health and risk assessment is also important. Some smaller facilities have been able to conform to environmental thresholds merely by reducing pollution by adopting pollution prevention policies.

India's industrial competitiveness and environmental future depends on Industries such as Synthetic Organic Chemicals Industry adopting energy and resource efficient technologies. Recycling and reuse of materials is critical. To keep pace with changing technologies and needs of sustainable development, the manual would require regular updating in the future. The manual will be available on the MoEF website and we would appreciate receiving responses from stakeholders for further improvements.

I congratulate the entire team of IL&FS Ecosmart Ltd., experts from the sector who were involved in the preparation of the Manuals, Chairman and members of the Core and Peer Committees of various sectors and various Resource Persons whose inputs were indeed valuable in the preparation and finalization of the Manuals.

Jairam Ramesh

(Jairam Ramesh)

1.
INTRODUCTION TO THE TECHNICAL EIA GUIDANCE MANUALS PROJECT

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

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

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

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

Devolution of the power to grant clearances at the state level for certain category of the developmental activities / projects is a step forward to fulfill the basic tenets of the re-engineering *i.e.*, quicker, transparent and effective process but many issues impede/hinder its functional efficiency. These issues could be in technical and operational as listed below:

Technical issues

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

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

Operational issues

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

1.1 Purpose

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

Chapter 1 (Introduction): This chapter provides a brief introduction on the EIA, basic tenets of EIA Notification, technical & operational issues in the process of clearance, purpose of the TGMs, project implementation process and additional information.

Chapter 2 (Conceptual facets of an EIA): Provides an overall understanding to the conceptual aspects of control of pollution and EIA for the developmental projects. This basic understanding would set the readers at same level of understanding for proper interpretations and boundaries for identifying the environmental interactions of the developmental projects and their significance for taking measures of mitigation. This chapter covers the discussion on environment in EIA context *i.e* sustainable development, pollution control strategies, preventive environmental management tools, Objectives of EIA, types and basic principles of EIA, project cycle for synthetic organic chemicals industry, understanding on type of environmental impacts and the criteria for the significance analysis.

Chapter 3 (The Synthetic Organic Chemical Industry): The purpose of this chapter is to provide the reader precise information on all the relevant aspects of the industry, which is essential to realize the likely interaction of such developmental activities on the receiving environment. Besides, this Chapter gives a holistic understanding on the sources of pollution and the opportunities of the source control.

The specific coverage which provides precise information on the industry include (i) introduction - Common unit processes and operations, Chemical synthesis, (ii) Basic Organic Chemicals, (iii) Dyes and Dye Intermediates, (iv) Bulk Drugs and Intermediates, (v) Synthetic rubbers, (vi) the summary of applicable national regulation for this developmental activity.

Chapter 4 (Operational aspects): The purpose of this chapter is to facilitate the stakeholders to extend clear guidance on coverage of legislative requirements, sequence of procedures for obtaining the EIA clearance and each step-wise provisions and considerations.

The coverage of the Chapter include provisions in the EIA Notification regarding synthetic organic chemicals industry, screening (criteria for categorization of B1 and B2, siting guidelines, *etc.*), scoping (pre-feasibility report, guidance for filling form 1, identification of valued environmental components, identification of impacts, *etc.*), arriving at terms of reference for EIA studies, impact assessment studies (EIA team, assessment of baseline quality of environment, impact prediction tools, significance of impacts), social impact assessment, risk assessment considerations, typical mitigation measures, designing considerations for environmental management plan, structure of EIA report for incorporation of study findings, process of public consultation, project appraisal, decision making process and post-clearance monitoring protocol.

Chapter 5 (Roles and responsibilities of various organizations involved in the process of prior environmental clearance): The purpose of this Chapter is to brief the stakeholders on the institutional mechanism and roles & responsibilities of the stakeholders involved in the process of prior environmental clearance. The Coverage of the Chapter include (i) roles and responsibilities of the stakeholders, (ii) organization specific functions, (iii) constitution, composition and decision making process of SEIAA and (iv) EAC & SEAC and (v) other conditions which may be considered.

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

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

- Project proponents will be fully aware of the procedures, common ToR for EIA studies, timelines, monitoring needs, *etc.*, in order to plan the projects/studies appropriately.
- Consultants across India will gain similar understanding about a given sector, and also the procedure for EIA studies, so that the quality of the EIA reports gets improved and streamlined
- Reviewers across the States/UTs will have the same understanding about an industrial sector and would able to draw a benchmark in establishing the significant impacts for the purpose of prescribing the ToR for EIA studies and also in the process of review and appraisal.
- Public who are concerned about a new or expansion projects, can use this manual to get a basic idea about the manufacturing/production details, rejects/wastes from the operations, choice of cleaner/control technologies, regulatory requirements, likely environmental and social concerns, mitigation measures, *etc.*, in order to seek clarifications appropriately in the process of public consultation. The procedural clarity in the document will further strengthen them to understand the stages involved in clearance and roles and responsibilities of various organizations.
- In addition, these manuals would substantially ease the pressure on reviewers at the scoping stage and would bring in functional efficiency at the central and state levels.

1.2 Project Implementation

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

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

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

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

1.3 Additional Information

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

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

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

This manual is prepared considering the Notification issued on 14th September, 2006 and latest amendment as on 1st December 2009. For recent updates, if any, may please refer the website of the MoEF, Government of India *i.e.,* http://moef.nic.in/index.php.

2.
CONCEPTUAL FACETS OF EIA

It is an imperative requirement to understand the basic concepts concerned to the pollution control and the environmental impact assessment in an overall objective of the sustainable development. This Chapter highlights the pollution control strategies and their tools besides the objectives, types & principles of EIA, type of impacts their significance analysis, in order to provide consistent understanding to the reader before assessing the development of activity-specific environmental concerns in Chapter 3 and identification & prediction of significant impacts in order to design mitigation measures as detailed in Chapter 4.

2.1 Environment in EIA Context

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

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

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

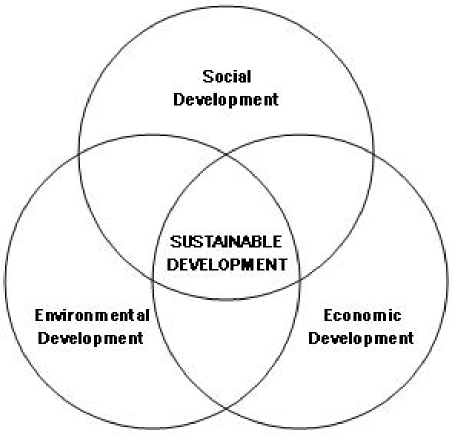


Figure 2-1: Inclusive Components of Sustainable Development

2.2 Pollution Control Strategies

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

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

Therefore, there is a need to shift the emphasis from the reactive to preventive strategy *i.e.,* to promote preventive environmental management. Preventive environmental management tools may be grouped into management based tools, process based tools and product based tools, which are given below:

Management Based Tools	**Process Based Tools**	**Product Based Tools**
Environmental Management System (EMS) Environmental Performance Evaluation Environmental Audits Environmental Reporting and Communication Total Cost Accounting Law and Policy Trade and Environment Environmental Economics	Environmental Technology Assessment Toxic Use Reduction Best Operating Practices Environmentally Best Practice Best Available Technology (BAT) Waste Minimisation Pollution Prevention Cleaner Production 4-R Concept Cleaner Technology Eco-efficiency	Industrial Ecology Extended Producers Responsibility Eco-labeling Design for Environment Life Cycle Assessment (LCA)

2.3 Tools for Preventive Environmental Management

The tools for preventive environmental management can be broadly classified into following three groups.

- Tools for assessment and analysis - risk assessment, life cycle assessment, total cost assessment, environmental audit/statement, environmental benchmarking, environmental indicators
- Tools for action - environmental policy, market based economic instruments, innovative funding mechanism, EMS and ISO certification, total environmental quality movement, eco-labeling, cleaner production, eco-efficiency, industrial ecosystem or metabolism, voluntary agreements
- Tools for communication - state of environment, corporate environmental reporting

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

2.3.1 Tools for assessment and analysis

2.3.1.1 Risk assessment

Risk is associated with the frequency of failure and consequence effect. Predicting such situations and evaluation of risk is essential to take appropriate preventive measures. The major concern of the assessment is to identify the activities falling in a matrix of high & low frequencies at which the failures occur and the degree of its impact. The high frequency, low impact activities can be managed by regular maintenance *i.e*, LDAR (Leak detection and repair) programmes. Whereas, the low frequency, high impact activities are of major concern (accidents) in terms of risk assessment. As the frequency is low, often the required precautions are not realized or maintained. However, the risk assessment identifies the areas of major concerns, which require additional preventive measures; likely consequence distances considering domino effects, which will give the possible casualties and ecological loss in case of accidents. These magnitudes demand the attention for preventive and disaster management plans (DMP). Thus is an essential tool to ensure safety of operations.

2.3.1.2 Life cycle assessment

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

Industries/firms may apply this to minimise costs incurred on the environmental conservation throughout the project life cycle.

2.3.1.3 Total cost assessment

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

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

A comparison of cost assessments is given below:

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

2.3.1.4 Environmental audit/statement

Key objectives of an environmental audit includes compliance verification, problem identification, environmental impact measurement, environmental performance measurement, conforming effectiveness of EMS, providing a database for corrective actions and future actions, developing company's environmental strategy, communication and formulating environmental policy.

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

2.3.1.5 Environmental benchmarking

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

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

2.3.1.6 Environmental indicators

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

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

Management performance indicators are related to the management efforts to influence the environmental performance of the organisational operations.

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

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

2.3.2 Tools for action

2.3.2.1 Environmental policy

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

2.3.2.2 Market-based economic instruments

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

- **Pollution charge:** Charge system will assess a fee or tax on the amount of pollution a firm or source generates. It is worthwhile for the firm to reduce emissions to the point, where its marginal abatement costs is equal to the tax rate. Thus firms control pollution to different degrees *i.e.* High cost controllers – less; low-cost controllers-more. The charge system encourages the industries to further reduce the pollutants. The collected charges can form a fund for restoration of the environment. Another form of pollution charge is a deposit refund system, where, consumers pay a surcharge when purchasing a potentially polluting product, and receive a refund on return of the product after useful life span at appropriate centers. The concept of extended producers' responsibility brought in to avoid accumulation of dangerous products in the environment.
- **Tradable permits:** Under this system, firms that achieve the emission levels below their allotted level may sell the surplus permits. Similarly, the firms, which are

required to spend more to attain the required degree of treatment/allotted levels, can purchase permits from others at lower costs and may be benefited.

- **Market barrier reductions:** Three known market barrier reduction types are as follows:
  - Market creation: Measures that facilitate the voluntary exchange of water rights and thus promote more efficient allocation of scarce water supplies
  - Liability concerns: Encourage firms to consider potential environmental damages of their decisions
  - Information programmes: Eco-labeling and energy efficiency product labeling requirements
- **Government subsidy reduction:** Subsidies are the mirror images of taxes and, in theory, can provide incentive to address environmental problems. However, it has been reported that the subsidies encourage economically inefficient and environmentally unsound practices, and often leads to market distortions due to differences in the area. However, these are important to sustain the expansion of production, in the national interests. In such cases, the subsidy may be comparable to the net social benefit.

2.3.2.3 Innovative funding mechanism

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

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

2.3.2.4 EMS and ISO certification

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

2.3.2.5 Total environmental quality movement

Quality is regarded as

- A product attribute that had to be set at an acceptable level and balanced against the cost
- Something delivered by technical systems engineered by experts rather than the organization as a whole
- Assured primarily through the findings and correction of mistakes at the end of the production process

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

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

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

2.3.2.6 Eco-labeling

Eco-labeling is the practice of supplying information on the environmental characteristics of a product or service to the general public. These labeling schemes can be grouped in to three types:

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

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

2.3.2.7 Cleaner production

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

2.3.2.8 4-R concept

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

2.3.2.9 Eco-efficiency

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

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

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

2.3.2.10 Industrial ecosystem or metabolism

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

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

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

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

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

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

2.3.2.11 Voluntary agreements

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

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

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

2.3.3 Tools for communication

2.3.3.1 State of environment

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

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

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

2.3.3.2 Corporate environmental reporting

Corporate environmental reports (CERs) are only one form of environmental reporting defined as publicly available, stand alone reports, issued voluntarily by the industries on their environmental activities. CER is just a means of environmental improvement and greater accountability, not an end in itself.

Three categories of environmental disclosure are:

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

2.4 Objectives of EIA

Objectives of EIA include the following:

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

2.5 Types of EIA

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

Strategic environmental assessment

Strategic Environmental Assessment (SEA) refers to systematic analysis of the environmental effects of development policies, plans, programmes and other proposed strategic actions. SEA represents a proactive approach to integrate environmental considerations into the higher levels of decision-making – beyond the project level, when major alternatives are still open.

Regional EIA

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

Sectoral EIA

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

Project level EIA

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

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

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

2.6 Basic EIA Principles

By integrating the environmental impacts of the development activities and their mitigation early in the project planning cycle, the benefits of EIA could be realized in all stages of a project, from exploration and planning, through construction, operations, decommissioning, and beyond site closure.

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

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

Ideally an EIA process should be:

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

- Integrated - should address the interrelationships of social, economic and biophysical aspects.
- Transparent - should have clear, easily understood requirements for EIA content; ensure public access to information; identify the factors that are to be taken into account in decision making; and acknowledge limitations and difficulties.
- Systematic - should result in full consideration of all relevant information on the affected environment, of proposed alternatives and their impacts, and of the measures necessary to monitor and investigate residual effects.

2.7 Project Cycle

The generic project cycle including that of the synthetic organic chemicals industry has six main stages:

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

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

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

2.8 Environmental Impacts

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

- Beneficial or detrimental
- Naturally reversible or irreversible
- Repairable via management practices or irreparable
- Short term or long term
- Temporary or continuous
- Occurring during construction phase or operational phase

- Local, regional, national or global
- Accidental or planned (recognized before hand)
- Direct (primary) or Indirect (secondary)
- Cumulative or single

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

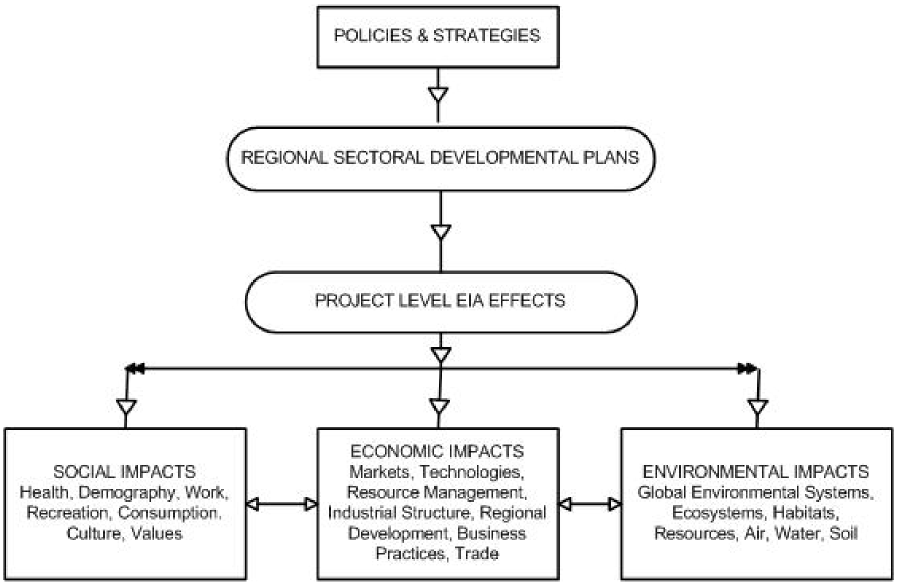


Figure 2-2: Types of Impacts

The nature of impacts could fall within three broad classifications *i.e.*, direct, indirect and cumulative, based on the characteristics of impacts. The assessment of direct, indirect and cumulative impacts should not be considered in isolation or considered as separate stages in the EIA. Ideally, the assessment of such impacts should form an integral part of all stages of the EIA. The TGM does not recommend a single method to assess the types of impacts, but suggests a practical framework/approach that can be adapted and combined to suit a particular project and the nature of impacts.

2.8.1 Direct impacts

Direct impacts occur through direct interaction of an activity with an environmental, social, or economic component. For example, a discharge from synthetic organic chemicals industry or effluent from the Effluent Treatment Plant (ETP) into river may lead to a decline in water quality in terms of high biochemical oxygen demand (BOD) or dissolved oxygen (DO) or rise of water toxins.

2.8.2 Indirect impacts

Indirect impacts on the environment are those which are not a direct result of the project, often produced away from or as a result of a complex impact pathway. The indirect impacts are also known as secondary or even tertiary level impacts. For example, ambient air SO_2 rise due to stack emissions may deposit on land as SO_4 and cause acidic soils. Another example of indirect impact, is the decline in water quality due to rise in temperature of water bodies receiving cooling water discharge from the nearby industry.

This, in turn, may lead to a secondary indirect impact on aquatic flora in that water body and may further cause reduction in fish population. Reduction in fishing harvests, affecting the incomes of fishermen is a third level impact. Such impacts are characterized as socio-economic (third level) impacts. The indirect impacts may also include growth-inducing impacts and other effects related to induced changes to the pattern of land use or additional road network, population density or growth rate. In the process, air, water and other natural systems including the ecosystem may also be affected. Many indirect impacts may also be positive such as greening of the area; improved recreational, health and educational facilities; employment generation and enhanced economic activity of a region.

2.8.3 Cumulative impacts

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

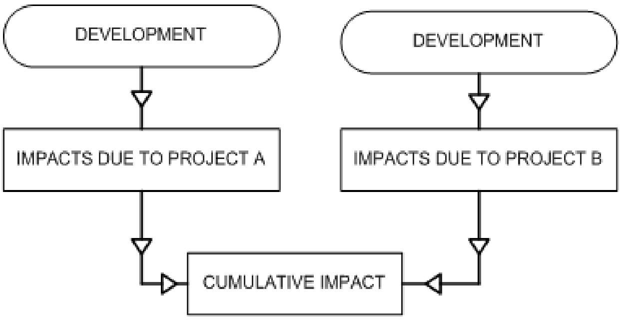


Figure 2-3: Cumulative Impact

2.8.4 Induced impacts

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

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

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

2.9 Significance of Impacts

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

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

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

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

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

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

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

The criteria can be determined by answering some questions regarding the factors affecting the significance. This will help the EIA stake-holders, the practitioner in particular, to determine the significance of the identified impacts eventually. Typical examples of such factors include the following:

- Exceeding threshold Limit: Significance may increase if a threshold is exceeded. *e.g.*, particulate matter emissions exceed the permissible threshold.
- Effectiveness of mitigation: Significance may increase as the effectiveness of mitigation measures decreases. *e.g.*, control technologies, which may not assure consistent compliance to the requirements.
- Size of study area: Significance may increase as the zone of effects increases.
- Incremental contribution of effects from action under review: Significance may increase as the relative contribution of an action increases.
- Relative contribution of effects of other actions: Significance may decrease as the significance of nearby larger actions increase.
- Relative rarity of species: Significance may increase as species becomes increasingly rare or threatened.
- Significance of local effects: Significance may increase as the significance of local effects is high.
- Magnitude of change relative to natural background variability: Significance may decrease if effects are within natural assimilative capacity or variability.
- Creation of induced actions: Significance may increase as induced activities also highly significant.
- Degree of existing disturbance: Significance may increase if the surrounding environment is pristine.

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

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

3.

ABOUT SYNTHETIC ORGANIC CHEMICALS INDUSTRY INCLUDING PROCESS AND POLLUTION CONTROL TECHNOLOGIES

3.1 Introduction

Synthetic organic chemicals (SOCs) are man-made (anthropogenic) organic compounds created through industrial synthesis. Some SOCs evapourate easily (are volatile) whereas others tend to remain dissolved in water or other solvents with little or no evaporation.

Chemical synthesis is a process of creating a desired substance by means of one or more controlled chemical reactions. The products of SOC sector represent the penultimate goal of much of the chemical industry— the manufacture of chemicals tailored such that they are directly useful to the final customer (in contrast to inorganic chemicals and petrochemicals sectors, which mostly produce intermediate materials) The industrial sequence and the connections between this sector and those of inorganic minerals, chemicals sector and the petrochemical sector are obvious.

The diversity of the synthetic organic chemical sector may be appreciated by listing some of its sub-sectors, though even this list is far from exhaustive:

- Basic organic chemicals
- Dyes and dye intermediates
- Bulk drugs and intermediates
- Synthetic rubbers
- Other synthetic organic chemicals and chemical intermediates

The products of the SOC sector may contain inorganic materials as well as organics; this is especially true for paints, in which inorganic molecules are used as pigments (colorants). Lead, chromium, and other potentially hazardous metals are common pigment constituents, and paints must therefore be used with discretion.

For the purpose of this Notification, coverage of chemicals include all the organic chemicals excluding those, which are covered under other developmental activities listed in the EIA Notification *i.e.* Technical Guidance Manuals coverage in respect of petrochemicals, petrochemical based products, pesticides, manmade fibers and paints sectors. Classification of synthetic organic chemicals may include, but not limited to the list given in Figure 3-1.

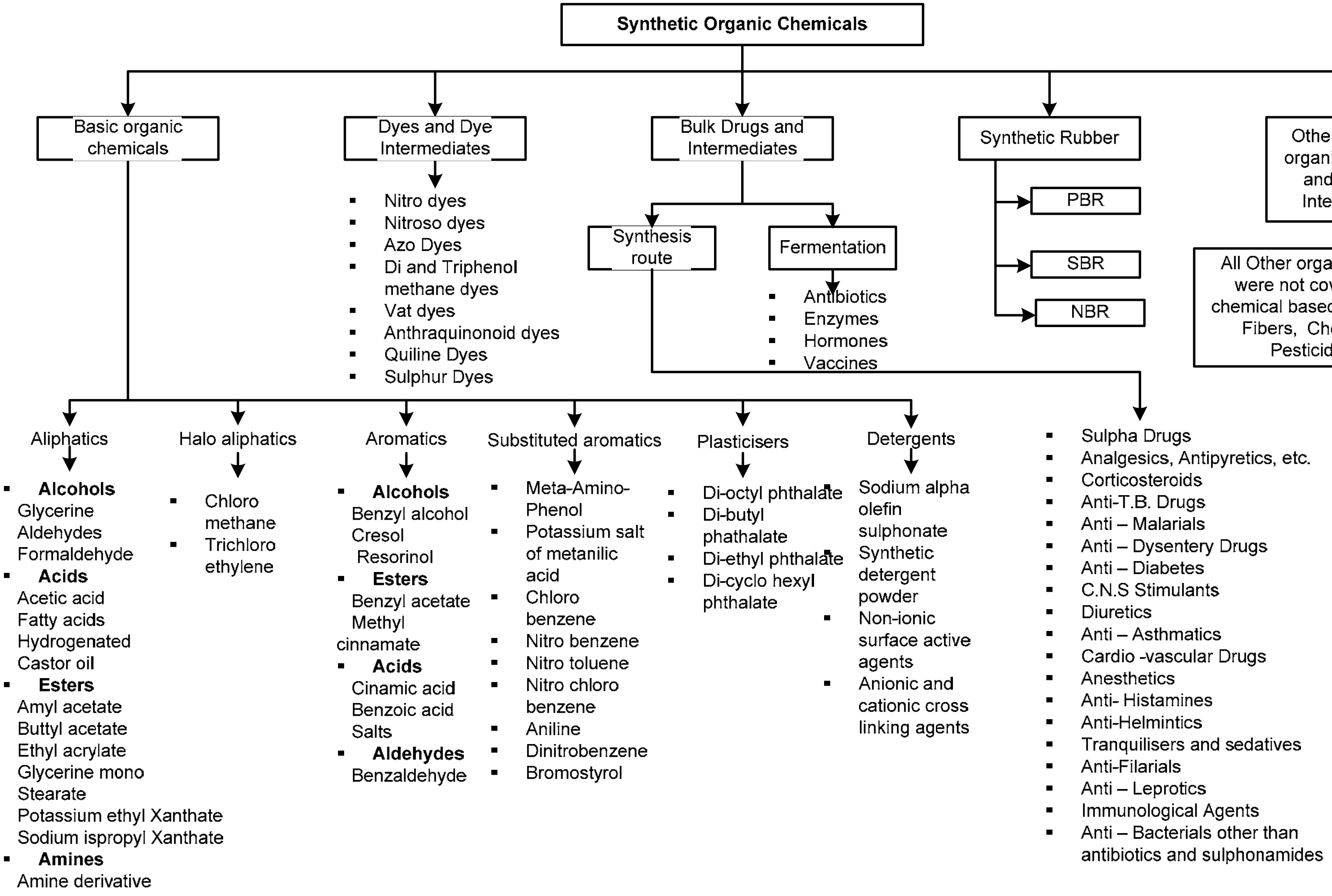


Figure 3-1: Classification of Synthetic Organic Chemicals

3.1.1 Common unit processes and operations

The primary chemicals used for the manufacture of products such as dyes, pharmaceuticals are called intermediates. These are prepared on an industrial scale from basic organic (usually aromatic) raw materials by various chemical procedures (unit processes). The choice of physical procedures, which are applied, is limited in a similar way (unit operations). The main unit processes and operations are:

- Acetylation
- Acylation
- Addition
- Alkylation
- Amination
- Bromination
- Carboxylation
- Carboxylation
- Carboxymethylation
- Chlorination
- Condensation
- Coupling
- Diazotisation
- Diazotisation and modification of the diazo group
- Esterification
- Fusion
- Halogenation
- Hydrochlorination
- Hydrolysis
- Kalization
- Neutralisation
- Nitration
- Oxidation
- Phosgenation
- Rearrangements
- Reduction
- Substitution
- Sulphation
- Sulphitation
- Sulphonation
- Thionation

Some of the above listed unit processes and operations are explained in **Annexure I**. There are 35 different types of chemical reactions that are used to produce organic chemicals. Some reactions (*e.g.,* oxyhalogenation) are specific to one or two products, whilst others (*e.g.,* oxidation, halogenation, and hydrogenation) are used widely in many processes.

Table 3-1 gives an overview of some important features of the most environmentally important unit processes. This is followed by brief descriptions of the main unit processes with generic consideration of their potential environmental impacts.

Table 3-1: Some of Unit Processes used in Organic Chemical Production

Process	Feed material		Conditions		Products
	Reagents	Substrates	Catalysis	Phase	
Oxidation	Oxygen (Air)	Paraffins, Olefins, BTX-Aromatics	Heterogeneous	Gas	Acids, anyhydrides, Epoxides
			Homogeneous	Gas-Liquid	Alcohols, Aldehydes, Ketones, Acids
			None	Gas- Liquid	Hydroperoxides
Ammoxidation	Oxygen, NH_3	Olefin, Alkyl-aromatics	Heterogeneous	Gas	Nitriles
Chlorination	Chlorine	Olefins, Aromatics	Homogeneous	Gas-Liquid	Chloro-organics

Process	Feed material		Conditions		Products
	Reagents	Substrates	Catalysis	Phase	
		Olefins, Paraffins	None		
Hydrogenation	Hydrogen	CO, Aldehydes, Nitriles, Nitro-compound	Heterogeneous	Gas	Alcohols, Amines
Hydroformylation (Oxo-Synthesis)	H_2, CO	Olefins	Homogeneous	Gas-Liquid	Aldehydes, Alcohols
Dehydrogenation	-	Paraffins, Olefins, Alkyl-aromatics, Alcohols	Heterogeneous	Gas	Olefins, Diolefins, Aromatics, Aldehydes, Ketones
Alkylation	Olefins, alcohols, Chloro-organics	Aromatics	Heterogeneous	Gas	Alkyl-aromatics
			Heterogeneous	Gas-Liquid	Alkyl-aromatics

Unit operations mainly deal with the physical transfer of energy and materials between the six possible combinations of states (*i.e.* gas-gas; gas-liquid; gas-solid; liquid-liquid; liquid-solid; solid-solid). Not all unit processes have widespread application and most organic chemical process emissions originate only from a few unit operations.

The reactions used in the production of organic chemicals never achieve perfect selectivity of the target product, so there is considerable importance on unit operations to separate wastes from products. Many production processes need either to separate individual substances from a homogeneous liquid mixture or to completely fractionate such mixtures into the component parts. Separation can be usually categorized into the following:

- liquid-vapour separation (by distillation, evapouration, steam/gas stripping)
- liquid-liquid separation (by extraction, centrifuging, multi-stage contacting)
- solid-liquid separation (by centrifuging, filtration, sedimentation, drying, and crystallisation)
- solid-gas (stripping)
- solid-solid separation (in appropriate fractional cristalisation solvents media).

The application of unit operations in the chemical industry is determined by the physical and chemical properties of the substances that are being handled. The environmental impact of the different operations varies according to the conditions under which these operations are carried out (*e.g.,* vacuum distillation has fewer diffuse emissions than distillation at elevated pressure, but may involve additional point of source emissions to air or to water). The unit operations of separation can have an environmental impact because they are rarely 100 % effective (*i.e.,* some product is lost with the reject stream) and they often introduce new materials that require recovery/treatment (*e.g.,* solvent or wash water).

Summary of the application of separation techniques is provided in Table 3-2. This is followed by brief outlines of the most environmentally important unit operations together with an indication of their main environmental issues.

Table 3-2: Applications of Some Selected Separation Techniques

Technique	Separation Principle	Application
Fractional distillation	Different boiling points	Base materials, intermediates, final products
Extractive distillation	Different polarities	Unsaturates from saturates
Liquid-Liquid-extraction	Different polarities	Aromatics from saturates
Molecular sieve techniques	Different diameters of molecules	n-Alkenes from branched and cyclic hydrocarbons
	Different polarization of molecules	n-Alkenes from n-alkenes; p-xylene from m-xylene
Crystallization	Different solubilities	Re-crystalisation for purification
	Different melting points	p-Xylene from m-xylene

Common unit operations

- Absorption
- Adsorption
- Apparatus cleaning
- Centrifugation
- Charging reactants and solvents
- Coagulation
- Coalescence
- Crystallisation
- Discharging
- Distillation
- Drying
- Electro dialysis
- Evapouration
- Extraction
- Filtration
- Floatation
- Fractionation
- Inerting
- Milling
- Phase separation
- Precipitation
- Product washing
- Quenching
- Reaction
- Separation
- Stripping
- Ultrafiltration

A) Distillation

Distillation is the most important industrial method of phase separation. Distillation involves partial evaporation of a liquid phase followed by condensation of vapour. This separates the starting mixture (the feed) into two fractions with different compositions; namely a condensed vapour (the condensate or distillate) that is enriched in more volatile components and a remaining liquid that is depleted of volatiles. Distillation can be divided into following sub-categories:

- operating mode (continuous or batch)
- operating pressure (vacuum, atmospheric or pressurised)
- number of distillation stages (single or multi-stage)
- introduction of inert gases (for example steam, to aid separation)
- use of additional compounds to aid separation (azeotropic and extractive distillation)

Only a limited number of separation problems may be solved by simple distillation and it is unsuitable for feeds containing components with similar boiling temperatures. Higher efficiency can be achieved by increasing the contact surface area or by contacting the liquid and vapour phases. Rectification columns provide intensive mass transfer by repeated countercurrent contacting vapour and liquid streams in multiple stages. Rectification columns are of plate or packed design, and may involve more than 100 distillation steps. The internal structure provides a large mass transfer contact surface, which is constantly regenerated. The mass transfer contact area is maximised by ensuring that the column packing is fully wetted. Heat is required at the bottom of a distillation column for evaporating the feed and condensation energy is needed at the top of the column. The condensation energy is often transferred into cooling water or air, and this may provide an opportunity for energy recovery.

Distillation is a method of separating mixtures based on differences in their volatilities in a boiling liquid mixture. Distillation is a unit operation or a physical separation process, and not a chemical reaction.

Commercially, distillation has a number of applications. It is used to separate crude oil into more fractions for specific uses such as transport, power generation and heating. Water is distilled to remove impurities, such as salt from seawater. Air is distilled to separate its components—notably oxygen, nitrogen, and argon—for industrial use. Distillation of fermented solutions has been used since ancient times to produce distilled beverages with higher alcohol content.

Environmental issues of distillation operations

Distillation columns may contribute to emissions in three ways: by allowing impurities to remain in the product; through polymer formation in the still due to excessive temperature; and by inadequate condensing.

Air: Off-gases from distillation may contain volatile organic material in the form of vapour or entrained droplets/mist, although this can be reduced by the use of additional condensing areas. Non-condensable substances (*e.g.,* oxygen, nitrogen, carbon dioxide, and low-boiling organics) are not usually cooled to their condensation temperature and will exit the condenser. Emission points from distillation are typically: the condenser, accumulator, hot wells, steam jet ejectors, vacuum pump and pressure relief valve. The total volume of gases emitted from a distillation operation depends upon air leaks into the column (increases with reduced pressure and increased size); volume of inert carrier gas; gases dissolved in the feed; efficiency/operation of the condenser or other recovery equipment; and physical properties of the organic constituents.

Water: Depending on the boiling point of components, effluents may result either from aqueous bottom residues or from the top after condensation. Discharge depends on the efficiency of the distillation process and of additional steps for phase separation (preferably fractionated-condensation of top effluent, stripping of bottom residues)

Wastes: Highly concentrated still bottoms are often incinerated if recovery of organic components is not possible.

B) Filtration

Filtration is separation of fluid-solids mixture involving passage of most of the fluid through a porous barrier (the filter medium), which retains most of the solid particulates contained in the mixture. In pharmaceutical industry, "filtration is used to remove solids from a liquid, whether these solids be of product, process intermediates, catalysts or carbon particulates (*e.g.*, from a decoloring step)". Batch filtration systems widely used by the pharmaceutical industry are the plate-and-frame filter, cartridge filters, the nutsche filter, and combination filter/dryers.

"The normal filtration procedure is simply to force or draw the mother liquor through a filtering medium. Following filtration, the retained solids are removed". The wet cake may then go through a reslurry process where it is washed and filtered again. "This option is usually carried out when a highly specialised product requiring high purity is desired or when solvents were not removed as part of the original slurry filtration.

C) Stripping:

Stripping is a physical separation process where one or more components are removed from a liquid stream by a vapour stream. In industrial applications the liquid and vapour streams can have co-current or countercurrent flows. Stripping is usually carried out either in a packed or trayed column

D) Evaporation

This process is widely used to concentrate solutions. The evaporation techniques could be natural using sunlight or forced evaporation using energy. Multiple effect evaporators are widely used across the synthetic chemical industry for handling wastewaters with high inorganic dissolved solids.

E) Crystallization

Crystallization is one of the most common separation techniques and is often used alone or in combination with one or more of the separation techniques described above. Through crystallization, the intermediate or final bulk substance (which is usually in solid form) can be separated from the reaction solution. In crystallization, a supersaturated solution is created in which crystals of the desired compounds are formed. Supersaturation depends on the solubility of the desired compound. If the compound's solubility increases with temperature, supersaturation can be achieved by cooling the solution. If the solubility is independent of temperature or decreases with temperature, then evaporating a portion of the solvent will create supersaturation. If neither cooling nor evaporation is desirable, supersaturation may be induced by adding a third component. The third component forms a mix with the original solvent in which the solute is considerably less soluble. If crystallization is done through cooling a solution there will be relatively little VOC emissions, especially if the equipment is fully enclosed. However, when crystallization is done by solvent evaporation in vacuum, there is a greater potential for emissions. Further separation of crystals from the supersaturated solution can be done by centrifuging or filtration.

F) Centrifugation

Centrifuges are used to remove the intermediate or product solids from a liquid stream. Centrifuges work on the principle of centrifugal force, in which an outward force is exerted on a rotating object. Centrifuges are cylinders with rotating baskets within them. The sides of the basket are perforated and covered with filter medium such as woven fabric or metal. As the basket rotates, a slurry solution is fed into the centrifuge *via* an inlet pipe. The centrifugal force pushes the slurry against the rotating basket, forcing the liquid to pass through the perforations, and the solids or filter cake to remain behind, accumulating on the sides of the basket. After all the slurry has been fed to the chamber, a wash liquid may be introduced to force the remaining slurry liquid through the cake and filter medium. Once the centrifuge is turned off, the solids (*i.e.*, the intermediates or the final bulk substance) are scraped off the sides with an internal scraper or manually scooped out.

The extremely high speeds and frictional forces involved in centrifuging, combined with the potential build-up of combustible solvent vapours, create a potential explosive environment to develop within the centrifuge. To control this, an inert gas, usually nitrogen, may be introduced into the unit before the slurry is fed in. Centrifuges must be carefully operated to avoid air infiltration by vortex entrainment. Therefore, they usually are operated under nitrogen blanket and kept sealed under operation. VOC emissions may occur when purging the vessel before loading and unloading .

G) Extraction

Extraction is used to separate liquid mixtures by taking advantage of differences in the solubility of the mixture components. A solvent that preferentially combines with only one of the components is added to the mixture. The resulting mixture consists of an extract (containing the preferentially combined material) and a raffinate (containing the residual phase). Extraction may take place in an agitated reaction vessel (mixer-settler), in a vertical cylinder (where the solvent flows upward or downward through the liquid mixture), or in a column with internals to mechanically enhance the contact between the two liquid phases.

Extraction is the most important liquid separation process used in industrial chemistry. It is used mainly where other separation methods or direct distillation are ineffective or too expensive. Its typical uses include:

- separation of components with similar boiling points (*e.g.,* separating aromatics from hydrocarbons)
- separation of high boilers from aqueous solution
- separation of mixtures with high boiling points
- separation of temperature sensitive compounds
- separation of azeotropic mixtures (*e.g.,* extraction of acetic acid from aqueous media)
- separation of pollutants for the minimisation of wastewater streams.

In order to extract a substance, an extraction solvent must be added to form a second liquid phase solution. Generally, the desired substance is then separated from the solvent by distillation and the solvent is recycled. Sometimes the selective action of the solvent is used in combination with distillation (extractive distillation or azeotropic distillation), for example in the manufacture of very pure, light aromatics. Extraction solvents like dimethyl sulfoxide, morpholines, sulfolane and diethylene glycol are widely used in the production of aromatics. Methyl-pyrrolidone, dimethylformamide and acetonitrile are also important solvents, especially for the extraction and separation of butenes and butadienes. Various types of mixer-settlers, centrifugal extractors and columns are used as extraction apparatus. All of them add the light phase at the bottom of the column, and the heavy phase is removed from the top. The density difference causes the light phase to rise through the heavy phase and affects the mass transfer between the two phases.

Environmental issues of extraction operations

Water: The extracting agent (raffinate) is generally recycled and only a small amount of liquid waste is generated. If water is used as the solvent, then it can be biologically treated, once the highly-concentrated waste components have been separated. Other extracting agents may require incineration.

H) Decanting

Decanting is a simple process used to separate mixtures of liquid and insoluble solid that has settled to the bottom of a reactor or settling vessel. The liquid over the solid is either pumped out of the vessel or poured from the vessel leaving behind the insoluble solid and a certain amount of liquid.

I) Solids separation

Solid-liquid and solid-gas separations have industrial importance for product finishing and for minimising emissions of particulate matter to the atmosphere. Product finishing applications include separating heterogeneous catalysts from a product stream or separating solid products, by-products or intermediates (*e. g.* ammonium sulphate in the acrylonitrile-process, BTX aromatics at low temperatures). The principal solid-gas separation techniques are cyclones, fabric filters, ceramic filters, wet collection devices, electrostatic precipitators, dust separation equipment and high efficiency venturi scrubbers. The main solid-liquid techniques are centrifuging, filtration, sedimentation & clarification, drying and crystallisation. The choice of technique depends on:

- characteristics of particles and carrier gas stream
- process factors such as temperature and pressure
- operational factors such as floor space and headroom

Environmental issues of solids separation operations

Wastes: It is often possible to re-use solids that are collected by separating devices, although often for lower grade applications.

J) Absorption

Absorption is the process uptake of one substance into the inner structure of another; most typically a gas into a liquid solvent. Absorption is a unit operation not only for chemical production, but also for environmental protection in the abatement of gaseous emissions (where it may be known as washing or scrubbing). The interaction of absorbed materials with the solvent can be physical or chemical in nature. In physical absorption, the gas molecules are polarized, but remain otherwise unchanged. The concentration of dissolved gases in the solvent increased in proportion to the partial pressure of the gases. In chemical absorption, they are also chemically converted. Reactions and conversions between gaseous and liquid phases are much slower than those between one-phase mixtures, and so relatively large reaction volumes are required in gas absorption installations. Absorption equipment generally consists of a column with internals for heat and material exchange in which the feed gas is brought into counter-current contact with the regenerated absorbent. The internals direct the liquid and gas streams and increase the contact area between the two phases. Various designs are used, especially absorption plates, randomly poured packing and structured packing.

Environmental issues of absorption operations

Air: Purified gas is taken from the top of the column and is preferably re-used in the process. If reuse is not viable, then the gas stream may require further abatement (*e.g.,* incineration).

Water: The absorbent loaded with the removed component (the so-called absorbate) leaves the bottom of the column and is regenerated by desorption. The solvent can be recovered (to minimise waste and reduce raw material costs). Water is often used as the solvent and the pollutants may be removed (*e.g.,* by steam distillation, adsorption on activated carbon, extraction) to enable re-use in the process. Water that cannot be re-used is usually biologically treated. In some cases, the absorbate itself is a commercial or intermediate product (*e.g.,* hydrochloric acid solutions from acid gas

K) Separation

Several separation mechanisms are employed by the pharmaceutical industry including extraction, decanting, centrifugation, and filtration. These mechanisms may be employed jointly or individually, in multiple stages, to separate the intermediate or bulk substance from the reaction solution and to remove impurities. Crystallization is another common technique used to separate the desired active ingredient or intermediate from the reaction mixture.

L) Adsorption

Adsorption is the physical accumulation of material (usually a gas or liquid) on the surface of a solid adsorbent. Industrial adsorption processes are used to remove certain components from a mobile phase (*e.g.,* air or water) or to separate mixtures. The applications can be production or abatement related and may include the removal of water from gases or the removal of organics from air streams or flue gas. The best adsorbents are characterised by a large number of different sized pores and so activated carbon, zeolites, silica gel and aluminium oxide are the most commercially important. Zeolites (molecular sieves) have a very narrow distribution of micro-pores and preferentially adsorb polar or polarisable materials (*e.g.,* water or carbon dioxide). By contrast, activated carbon has a hydrophobic character and is especially suitable for the removal of organic substances.

Environmental issues of adsorption operations

Air: Off gases created by desorption during adsorbent regeneration.

Wastes: Spent adsorbents that can no longer be regenerated.

M) Purification

Once the intermediate or the bulk substance has been separated, it may need to be purified. Depending on the intermediate or the bulk substance produced, there may be several purification steps involved to produce the desired active ingredient. In vitamin production, for example, there are at least three to four purification steps. Purification typically is achieved through additional separation steps such as those described above. Purification is often achieved through recrystallization. Washing with additional solvents and filtration may also be used.

N) Drying

The final step in the chemical synthesis process is drying of the intermediate or final bulk substance. Drying is done by evaporating the solvents from the solids. Solvents released from drying operations may be condensed for reuse or disposal.

There are several different types of dryers used by the pharmaceutical industry including tray dryers, rotary dryers, drum or tumble dryers, or pressure filter dryers. “The selection of the dryer type depends primarily on the characteristics of the solid”.

O) Condensation

Components from gaseous mixtures can be separated into liquids (or solids) by fractional condensation. Either the residual gas or the condensate may be the desired product. The temperature, the partial pressure of the condensing substances and their vapour pressure are linked. The recovery of 100 % of the condensing substances is not possible, whatever the temperature, when inerts are present with the condensing substances. Condensation may be used to separate products from waste streams and this often enables valuable feedstock or solvent to be returned to the production process. Condensation of volatile species is also used to minimise the emission of air pollutants, but this may require the use of cryogenic condensation to achieve the desired lower emissions.

Environmental issues of condensation

- **Air:** Residual components that are not condensed
- **Water:** The condensed products might be wastewater
- **Wastes:** Condensation generates no wastes, but the condensed products might be a waste

3.1.2 Chemical synthesis

Most of the compounds used today as pharmaceutical products are prepared by chemical synthesis, generally by batch processes. The manufacture of pharmaceutical compounds using chemical synthesis involves a complex series of processes including many intermediate stages and chemical reactions performed in a step-by-step fashion. Depending on the process, the operator adds reagents, increases or decreases the flow rate of chilled water or steam, and starts and stops pumps to draw the reactor contents into another vessel. At other stages in the process, solutions may be pumped through filters or centrifuges, recycled within the process, or pumped to recycling or disposal facilities. Co-products, such as salts, may be sold for reuse. Spent acids, metals, and catalysts may be recovered and reused onsite or sold for reuse.

The material from each intermediate step may be isolated, purified and then transferred to the next step of the process for continued processing until the final compound is derived. All these steps may be conducted at the same manufacturing site, or if the intermediate is isolated, it may be transferred to another site for further processing.

A single process flow diagram will not represent the industry, since each bulk pharmaceutical substance is different in its manufacture and several intermediates may be produced in a step-wise fashion prior to the manufacture of the final active ingredient.

However, an example of chemical synthesis process has been provided as Figure 3-2 to show the equipment used and where wastes or emissions might be generated.

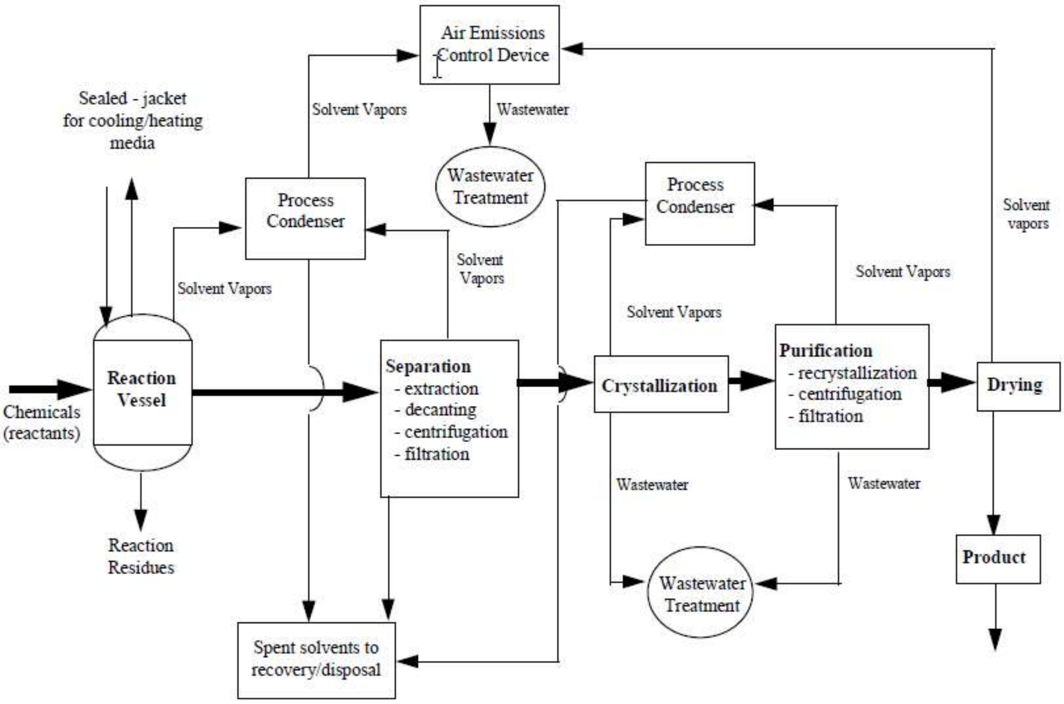


Figure 3-2: Simplified Process Flow Diagram for Chemical Synthesis

Source: Adapted from Economic Impact and Regulatory Flexibility Analysis of Proposed Effluent Guidelines for the Pharmaceutical Manufacturing Industry, 1995.

3.1.2.1 Production of bulk pharmaceutical substances

Bulk pharmaceutical substances typically consist of structurally complex organic chemical compounds, which are manufactured *via* a series of intermediate steps and reactions under precise conditions. These substances are used in the manufacture of the dosage form of a formulated pharmaceutical product and are manufactured by: (1) chemical synthesis; (2) fermentation; (3) isolation/recovery from natural sources, or (4) a combination of these processes. Examples of different drugs produced by each of these processes are presented in Table 3-3.

Table 3-3: Some Examples of Pharmaceutical Products by Bulk Manufacturing Process

Chemical Synthesis	Natural Product Extraction	Fermentation
▪ Antibiotics ▪ Antihistamines ▪ Cardiovascular Agents ▪ Central Nervous System (CNS) ▪ Stimulants ▪ CNS Depressants ▪ Hormones ▪ Vitamins	▪ Antineoplastic Agents ▪ Enzymes and Digestive Abids ▪ CNS Depressants ▪ Hemtological Agents ▪ Insulin ▪ Vaccines	▪ Antibiotics ▪ Antineoplastic Agents ▪ Therapeutic Nutrients ▪ Vitamins ▪ Steroids

Almost all pharmaceutical substances are manufactured utilizing “batch” processes. In a batch process, particular substance or “intermediate” is manufactured in “campaign” for periods ranging from a few days to several months until sufficient material is manufactured to satisfy the projected sales demand. At the end of the manufacturing campaign, another pharmaceutical intermediate or substance is made. The same equipment with potentially different configurations and the same operating personnel are often used to make a different intermediate or substance, utilizing different raw materials, executing different processes, and generating different waste streams.

When the same equipment is used for manufacturing different intermediates and/or different bulk substances, the equipment is thoroughly cleaned and validated prior to its reuse. If there is a difficulty in cleaning a specific type of equipment, or if sufficient volume of a certain intermediate/bulk substance is made every year, the equipment may be dedicated to the batch manufacturing of a particular intermediate/bulk substance.

The specific methods and materials (*e.g.*, water, steam, detergents, and/or organic solvents) used to clean the equipment are based on the ability of the cleaning process to remove residues of raw materials, intermediates, precursors, degradation products, and isomers. Raw materials are checked for their identity and quality before use in the manufacturing processes. Additionally, in-process testing, as well as quality assurance/quality control (QA/QC) testing in onsite laboratories, is performed during drug product manufacturing. In-process testing may include simple pH measurements or checks on color, while QA/QC testing typically includes more sophisticated analyses such as chromatography.

3.1.2.2 Equipments for synthesis

i) Reactors

The most common type of reactor vessel is the kettle-type reactor. These reactors typically range in capacity from 50 to several thousand gallons. The vessels are made of either stainless steel or glass-lined carbon steel.

A diagram of a typical reactor vessel is shown in Figure 3-3. “Reactors are equipped to provide a range of capabilities that may be required during the batch reaction step. This equipment may include: a jacket for heating and cooling, hookups for charging raw materials and for discharging the contents of the reactor, an agitation and recycle line for mixing, control systems for temperature and pressure, a condenser system for controlling vent losses, a return line for refluxing condensables, a steam ejector for vacuum operation, a nitrogen supply for padding and purging the reactor, and a man way for taking samples and adding solid catalysts, reactants, and other solid materials to the reactor”

Raw materials or ingredients, including solvents, used to produce the intermediate or bulk substances are charged into the reactor vessel. Liquid ingredients are drawn into the reactor either by pumping or through vacuum from drums and storage tanks. Solids may be charged manually or *via* mechanical means such as through a vacuum system.

Once the reactor vessels are charged with the raw materials, the reaction takes place. The reactor can be operated at atmospheric pressure, elevated pressure, or under vacuum. Because of their flexibility, reactors may be used in a variety of ways. Besides hosting chemical reactions, they can act as mixers, heaters, holding tanks, crystallizers, and evaporators. Typical reactions performed include alkylations, hydrogenations, and brominations, *etc.* Temperature, pressure, and the degree of mixing are carefully monitored to achieve the desired product and to ensure worker safety.

Reactors are often attached to process condensers to recover solvents from process operations. They are also often attached to other air pollution control devices to remove volatile organics or other compounds from vented gases. Depending on the reaction being carried out, a reactor may also be attached to a distillation column for solvent separation and recovery.

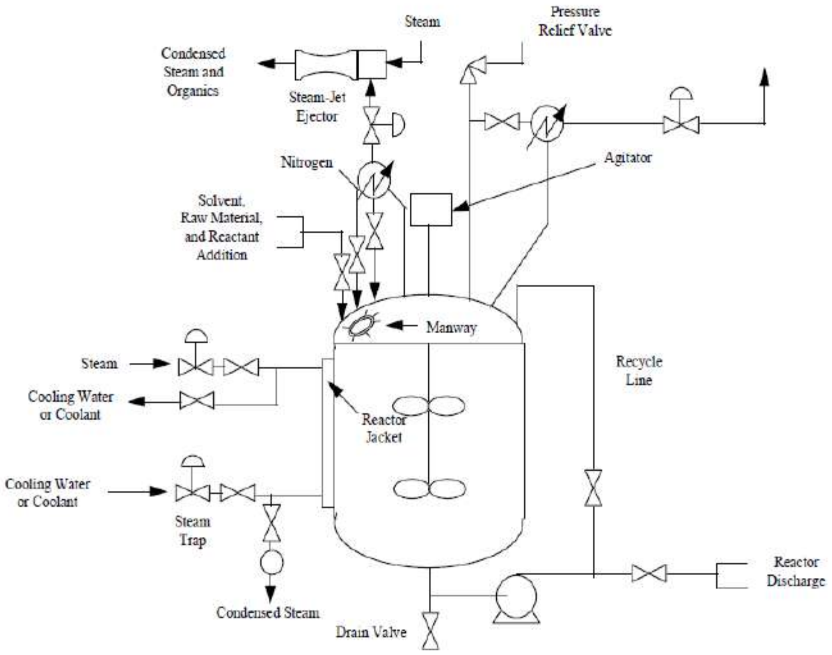


Figure 3-3: Typical Design of a Kettle-Type Batch Reactor

Source: Adapted from Control of Volatile Organic Compound Emissions from Batch Processes, EPA Guideline Series, 1993.

Stirred tank reactor is the main equipment in multipurpose plants (shown in Figure 3-4), which fulfils the flexibility requirements arising from the varied physical states of the materials being used (*e.g.,* dry powders, wet solids, pastes, liquids, emulsions, gases). The vessels are required to withstand a range of process conditions (e.g., temperature, pressure, corrosion) and are thus usually made of stainless steel, rubber- or glass-lined steel, enamel coated, or other special materials. The mechanical design of the agitator baffles and cooling systems is constrained by the need to attach and maintain the rubber or glass lining.

Other characteristics

- used for both batch and continuous mode, as well as in cascades
- sized up to 60 m^3 (fermentation reactors up to about 1000 m^3)
- usually dished bottom (reactions may be carried out under pressure) equipped with one or more stirrers to ensure the requested mixing degree, heat-exchange performance, *etc.*

- jackets or half pipe coils are often fitted around the vessel to provide heat transfer wall baffles are installed inside to prevent the gross rotation ("swirl") of the contents with the stirrer.

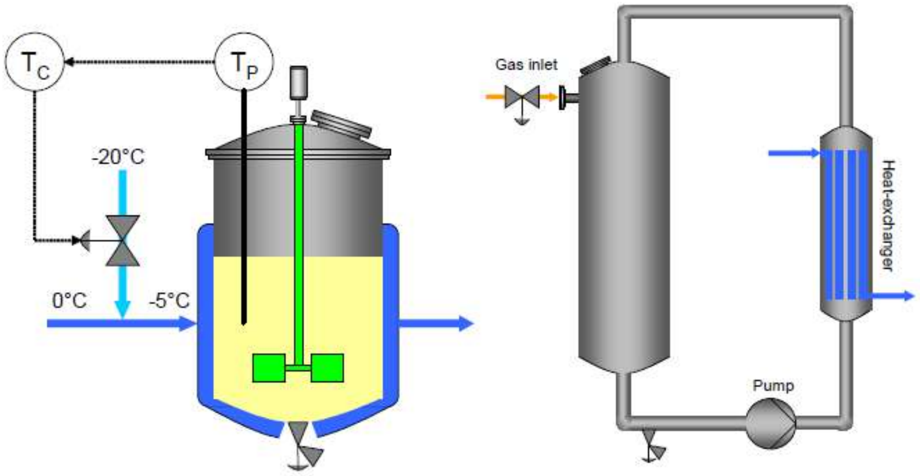


Figure 3-4: Stirred tank reactor (conventional temperature control, left) and loop reactor (right)

Other used reactor types are, e.g.:

- loop reactors (closed loop or continuous loop)
- bubble columns (closed loop or continuous loop)
- pipe reactors
- tubular reactors

3.2 Basic Organic Chemicals

Basic organic chemicals are defined as those chemicals, which are substituted aliphatic and aromatic compounds of various functional groups such as halogens, esters, amines, nitro, sulphur, and carbonyl compounds *etc.* These organic chemicals are used as basic ingredients to downstream synthetic organic chemicals such as dye and dye intermediates, paints, bulk drugs, pesticides *etc.* Basic organic chemical manufacturing industries, which produce various types of halo-aliphatic, aromatic, substituted aromatics, plasticizers, and detergents, contribute to the environmental pollution to a considerable extent.

The three main sources of raw materials for all the organic chemicals are as follows:

- Naturally occurring oil and gas
- Coal tar derivatives and
- Products obtained from molasses, alcohol and other agricultural products as well as edible oils/fats
- Sulphur, phosphorus and other similar basic building blocks

Production Profile

The organic chemical industry registered phenomenal growth in India over the last few decades. A wide range of products are manufactured by diverse industries. As such, about 150 chemicals production falls under the basic organic chemical industry, which is produced by about 190 industrial units in the country.

3.2.1 Manufacturing process of basic organic chemicals

Basic organic chemicals are produced by chemical reactions of organic materials, which seldom go to completion. The degree of completion of organic reactions is generally very much less than those involving inorganic reactions. The law of mass action states that in order to transform one reactant fully, the other reactant must be present far in excess in weight than the stoichometric requirement. This law is applied in practical field. As a result, the final mass of an organic reaction is associated with not only the desired product of its intermediates, but also untreated reactants and undesired products of side reactions or partially completed reaction. The manufacture of organic chemicals is hardly accomplished in one reaction; multi-reactions are involved in most cases. It involves various unit processes and unit operations.

In each reaction state, some raw materials remain unreacted and some unwanted products are formed, which remain in the system. Desired products are carefully recovered in each step from the system. Unwanted products are discarded. These inevitably become pollutants in wastewater and solid waste. Some are vented out in the atmosphere. Although, in some cases some recyclable materials are also profitably taken back into the system. Impurities present in raw materials may also react with one another and in many cases show up as a scum, froth or tar or simply as unreacted raw material. In order to understand the generation of wastewater, solid waste and emission, understanding of unit process and operation is required.

3.2.2 Raw material inputs and pollution outputs

Industrial organic chemical manufacturers use and generate both large numbers and quantities of chemicals. The industry releases chemicals to all media including air (through both fugitive and direct emissions), water (direct discharge and runoff) and land. The types of pollutants a single facility will release depend on the feedstocks, processes, equipment in use and maintenance practices. These can vary from hour to hour and can also vary with the part of the process that is underway. For example, the batch reaction is a closed vessel, the chemicals are more likely to be emitted at the beginning and end of a reaction step (associated with vessel loading and product transfer operations), than during the reaction. The potential sources of pollutant outputs by media are shown below in Table 3-4.

Table 3-4: Potential Releases During Organic Chemical Manufacturing

Media	Potential Sources of Emission
Air	▪ Point source emissions: stack, vent (*e.g.,* laboratory hood, distillation unit, reactor, storage tank vent), material loading/unloading operations (including rail cars, tank trucks, and marine vessels).- ▪ Fugutive emissions: pumps, valves, flanges, sample collection, mechanical seals, relief devices, tanks. ▪ Secondary emissions: waste and wastewater treatment units, cooling tower, process sewer, sump, spill/leak areas.
Liquid wastes (Organic or	▪ Equipment wash solvent/water, lab samples, surplus chemicals, product washes/purifications, seal flushes, scrubber blowdown, cooling water, steam jets, vacuum pumps, leaks, spills, spent/used

Media	Potential Sources of Emission
Aqueous)	solvents. Housekeeping (pad washdown), waste oils/lubricants from maintenance
Solid wastes	▪ Spent catalysts, spent filters, sludges, wastewater treatment biological sludge, contaminated soil, old equipment/insulation, packaging material, reaction by-products, spent carbon/resins, drying aids
Ground Water Contamination	▪ Unlined ditches, process trenches, sumps, pumps/valves/fittings. Wastewater treatment ponds, product storage areas, tanks and tank farms, aboveground and underground piping, loading/unloading areas/racks, manufacturing maintenance facilities.

Source: Chemical Manufacturers Association, 1993.

3.2.3 Control technology available for BOC

Table 3-5: Control technologies for basic organic chemicals

Air (Control Equipment)	▪ Thermal oxidation ▪ Absorption ▪ Incinerator ▪ Pyrolysis ▪ Water Scrubber *etc.*
Water	Biological Treatment (Aerobic/Anaerobic)
Treatment and disposal Technologies available for Hazardous Waste	
Physiochemical Treatment	▪ Chemical Precipitation ▪ Chemical Oxidation/Reduction ▪ Seperation/Filteration ▪ Evapouration ▪ Solidification ▪ Hydrolysis *etc.*
Thermal Systems	▪ Wet Oxidation ▪ Pyrolysis ▪ Steam Boiler *etc.*

Table 3-6: Process/Product Modifications for Pollution Prevention Opportunities

Area	Potential Problem	Possible Approach
By-products **Co-products**		
Quantity and Quality	▪ Process inefficiencies result in the generation of undesired by-products and co-products. Inefficiencies will require larger volumes of raw materials and result in additional secondary products. ▪ Inefficiencies can also increase fugitive emissions and wastes generated through material handling.	▪ Increase product yield to reduce by-product and co-product generation and raw material requirements.
Uses and Outlets	▪ By-products and co-products	▪ Identify uses and develop a

Area	Potential Problem	Possible Approach
	are not fully utilized, generating material or waste that must be managed.	sales outlet. Collect information necessary to firm up a purchase commitment such as minimum quality criteria, maximum impurity levels that can be tolerated, and performance criteria.
Catalysts		
Composition	▪ The presence of heavy metals in catalysts can result in contaminated process wastewater from catalyst handling and separation. These wastes may require special treatment and disposal procedures or facilities. Heavy metals can be inhibitory or toxic to biological wastewater treatment units. ▪ Sludge from wastewater treatment units may be classified as hazardous due to heavy metals content. Heavy metals generally exhibit low toxicity thresholds in aquatic environments and may bioaccumulate.	▪ Catalysts comprised of noble metals, because of their cost, are generally recycled by both onsite and offsite reclaimers.
Preparation and Handling	▪ Emissions or effluents are generated with catalyst activation or regeneration. ▪ Catalyst attrition and carryover into product requires de-ashing facilities, which are a likely source of wastewater and solid waste. ▪ Catalyst is spent and needs to be replaced. ▪ Pyrophoric catalyst needs to be kept wet, resulting in liquid contaminated with metals. ▪ Short catalyst life	▪ Obtain catalyst in the active form. ▪ Provide insitu activation with appropriate processing /activation facilities. ▪ Develop a more robust catalyst or support. ▪ In situ regeneration eliminates unloading/loading emissions and effluents versus offsite regeneration or disposal. ▪ Use a nonpryrophoric catalyst. Minimise amount of water required to handle and store safely. ▪ Study and identify catalyst deactivitation mechanisms. Avoid conditions which promote thermal or chemical deactivation. By extending catalyst life, emissions and effluents associated with catalyst handling and regeneration can be reduced.
Effectiveness	▪ Catalyzed reaction has by-product formation, incomplete conversion and	▪ Reduce catalyst consumption with a more active form. A higher concentration of active

Area	Potential Problem	Possible Approach
	less-than-perfect yield. ▪ Catalyzed reaction has by-product formation, incomplete conversion and less-than perfect yield.	ingredient or increased surface area can reduce catalyst loadings. ▪ Use a more selective catalyst which will reduce the yield of undesired by-products. ▪ Improve reactor mixing/contacting to increase catalyst effectiveness. ▪ Develop a thorough understanding of reaction to allow optimization of reactor design. Include in the optimization, catalyst consumption and by-product yield.
Intermediate Products		
Quantity and Quality	▪ Intermediate reaction products or chemical species, including trace levels of toxic constituents, may contribute to process waste under both normal and upset conditions. ▪ Intermediates may contain toxic Constituents or have characteristics that are harmful to the environment.	▪ Modify reaction sequence to reduce amount or change composition of intermediates. ▪ Modify reaction sequence to change intermediate properties. ▪ Use equipment design and process control to reduce releases.
Process Conditions/ Configuration		
Temperature	▪ High heat exchange tube temperatures cause thermal cracking/decomposition of many chemicals. These lower molecular weight by-products are a source of "light ends" and fugitive emissions. High localized temperature gives rise to polymerization of reactive monomers, resulting in "heavies" or "tars." Such materials can foul heat exchange equipment or plug fixed-bed reactors, thereby requiring costly equipment cleaning and production outage. ▪ Higher operating temperatures imply "heat input" usually via combustion which generates emissions. ▪ Heat sources such as furnaces and boilers are a source of combustion emissions. ▪ Vapour pressure increases with increasing temperature. Loading/unloading, tankage	▪ Select operating temperatures at or near ambient temperature whenever possible. ▪ Use lower pressure steam to lower temperatures. ▪ Use intermediate exchangers to avoid contact with furnace tubes and walls. ▪ Use staged heating to minimise product degradation and unwanted side reactions. ▪ Use superheat of high-pressure steam in place of furnace. ▪ Monitor exchanger fouling to correlate process conditions which increase fouling, avoid conditions which rapidly foul exchangers. ▪ Use online tube cleaning technologies to keep tube surfaces clean to increase heat transfer. ▪ Use scraped wall exchangers in viscous service. ▪ Use falling film reboiler, pumped recirculation reboiler or

Area	Potential Problem	Possible Approach
	and fugitive emissions generally increase with increasing vapour pressure. ▪ Water solubility of most chemicals increases with increasing temperature	high-flux tubes. ▪ Explore heat integration opportunities (*e.g.*, use waste heat to preheat materials and reduce the amount of combustion required.) ▪ Use thermocompressor to upgrade low-pressure steam to avoid the need for additional boilers and furnaces. ▪ If possible, cool materials before sending to storage. ▪ Use hot process streams to reheat feeds. ▪ Add vent condensers to recover vapours in storage tanks or process. ▪ Add closed dome loading with vapour recovery condensers. ▪ Use lower temperature (vacuum processing).
Pressure	▪ Fugitive emissions from equipment. ▪ Seal leakage potential due to pressure differential. ▪ Gas solubility increases with higher pressures.	▪ Equipment operating in vacuum service is not a source of fugitives; however, leaks into the process require control when system is degassed. ▪ Minimise operating pressure. ▪ Determine whether gases can be recovered, compressed, and reused or require controls.
Corrosive Environment	▪ Material contamination occurs from corrosion products. Equipment failures result in spills, leaks and increased maintenance costs. ▪ Increased waste generation due to addition of corrosion inhibitors or neutralization.	▪ Improve metallurgy or provide coating or lining. ▪ Neutralize corrosivity of materials contacting equipment. ▪ Use corrosion inhibitors. ▪ Improve metallurgy or provide coating or lining or operate in a less corrosive environment.
Batch vs. Continuous Operations	▪ Vent gas lost during batch fill. ▪ Waste generated by cleaning/purging of process equipment between production batches. ▪ Process inefficiencies lower yield and increase emissions. ▪ Continuous process fugitive emissions and waste increase over time due to equipment failure through a lack of maintenance between turnarounds.	▪ Equalize reactor and storage tank vent lines. ▪ Recover vapours through condenser, adsorber, *etc.* ▪ Use materials with low viscosity. Minimise equipment roughness. ▪ Optimize product manufacturing sequence to minimise washing operations and cross-contamination of subsequent batches. ▪ Sequence addition of reactants and reagents to optimize yields and lower emissions. ▪ Design facility to readily allow maintenance so as to avoid

Area	Potential Problem	Possible Approach
		unexpected equipment failure and resultant release.
Process Operation/Design	▪ Numerous processing steps create wastes and opportunities for errors. ▪ Nonreactant materials (solvents, absorbants, *etc.*) create wastes. Each chemical (including water) employed within the process introduces additional potential waste sources; the composition of generated wastes also tends to become more complex. ▪ High conversion with low yield results in wastes. ▪ Non-regenerative treatment systems result in increased waste versus regenerative systems.	▪ Keep it simple. Make sure all operations are necessary. More operations and complexity only tend to increase potential emission and waste sources. ▪ Evaluate unit operation or technologies (*e.g.*, separation) that do not require the addition of solvents or other nonreactant chemicals. ▪ Recycle operations generally improve overall use of raw materials and chemicals, thereby both increasing the yield of desired products while at the same time reducing the generation of wastes. A case-in-point is to operate at a lower conversion per reaction cycle by reducing catalyst consumption, temperature, or residence time. Many times, this can result in a higher selectivity to desired products. The net effect upon recycle of unreacted reagents is an increase in product yield, while at the same time reducing the quantities of spent catalyst and less desirable by-products. ▪ Regenerative fixed bed treating or desiccant operation (*e.g.*, aluminum oxide, silica, activated carbon, molecular sieves, *etc.*) will generate less quantities of solid or liquid waste than nonregenerative units (*e.g.*, calcium chloride or activated clay). With regenerative units though, emissions during bed activation and regeneration can be significant. Further, side reactions during activation /regeneration can give rise to problematic pollutants.
Product		
Process Chemistry	▪ Insufficient R&D into alternative reaction pathways may miss pollution opportunities such as waste reduction or eliminating a hazardous constituent.	▪ R&D during process conception and laboratory studies should thoroughly investigate alternatives in process chemistry that affect pollution prevention.
Product	▪ Product based on end-use	▪ Reformulate products by

Area	Potential Problem	Possible Approach
Formulation	performance may have undesirable environmental impacts or use raw materials or components that generate excessive or hazardous wastes.	substituting different material or using a mixture of individual chemicals that meet end-use performance specifications.
Raw Materials		
Purtiy	▪ Impurities may produce unwanted by-products and waste. Toxic impurities, even in trace amounts, can make a waste hazardous and therefore subject to strict and costly regulation. ▪ Excessive impurities may require more processing and equipment to meet product specifications, increasing costs and potential for fugitive emissions, leaks, and spills. ▪ Specifying a purity greater than needed by the process increases costs and can result in more waste generation by the supplier. ▪ Impurities in clean air can increase inert purges. ▪ Impurities may poison catalyst prematurely resulting in increased wastes due to yield loss and more frequent catalyst replacement.	▪ Use higher purity materials. ▪ Purify materials before use and reuse if practical. ▪ Use inhibitors to prevent side reactions. ▪ Achieve balance between feed purity, processing steps, product quality and waste generation. ▪ Specify a purity no greater than what the process needs. ▪ Use pure oxygen. ▪ Install guard beds to protect catalysts.
Vapour Pressure	▪ Higher vapour pressures increase fugitive emissions in material handling and storage. ▪ High vapour pressure with low odor threshold materials can cause nuisance odors.	▪ Use material with lower vapor pressure. ▪ Use materials with lower vapour pressure and higher odor threshold.
Water Solulality	▪ Toxic or nonbiodegradable materials that are water soluble may affect wastewater treatment operation, efficiency, and cost. ▪ Higher solubility may increasepotential for surface and groundwater contamination and may require more careful spill prevention, containment, and cleanup (SPCC) plans. ▪ Higher solubility may increase potential for storm water contamination in open areas.	▪ Use less toxic or more biodegradable materials. ▪ Use less soluble materials. ▪ Use less soluble materials. ▪ Prevent direct contact with storm water by diking or covering areas. ▪ Minimise water usage. ▪ Reuse wash water. ▪ Determine optimum process conditions for phase separation. ▪ Evaluate alternative separation technologies (coalescers, membranes, distillation, *etc.*)

Area	Potential Problem	Possible Approach
	▪ Process wastewater associated with water washing or hydrocarbon/water phase separation will be impacted by containment solubility in water. Appropriate wastewater treatment will be impacted.	
Toxicity	▪ Community and worker safety and health concerns result from routine and non-routine emissions. Emissions sources include vents, equipment leaks, wastewater emissions, emergency pressure relief, *etc.* ▪ Surges or higher than normal continuous levels of toxic materials can shock or miss wastewater biological treatment systems resulting in possible fines and possible toxicity in the receiving water.	▪ Use less toxic materials. ▪ Reduce exposure through equipment design and process control. Use systems which are passive for emergency containment of toxic releases. ▪ Use less toxic material. ▪ Reduce spills, leaks, and upset conditions through equipment and process control. ▪ Consider effect of chemicals on biological treatment; provide unit pretreatment or diversion capacity to remove toxicity. ▪ Install surge capacity for flow and concentration equalization.
Regulatory	▪ Hazardous or toxic materials are stringently regulated. They may require enhanced control and monitoring; increased compliance issues and paperwork for permits and record keeping; stricter control for handling, shipping, and disposal; higher sampling and analytical costs; and increased health and safety costs.	▪ Use materials which are less toxic or hazardous. ▪ Use better equipment and process design to minimise or control releases; in some cases, meeting certain regulatory criteria will exempt a system from permitting or other regulatory requirements.
Form of Supply	▪ Small containers increase shipping frequency which increases chances of material releases and waste residues from shipping containers (including wash waters). ▪ Nonreturnable containers may increase waste.	▪ Use bulk supply, ship by pipeline, or use “jumbo” drums or sacks. ▪ In some cases, product may be shipped out in the same containers the material supply was shipped in without washing. ▪ Use returnable shipping containers or drums.
Handling and Storage	▪ Physical state (solid, liquid, gaseous) may raise unique environmental, safety, and health issues with unloading operations and transfer to process equipment. ▪ Large inventories can lead to spills, inherent safety issues and material expiration.	▪ Use equipment and controls appropriate to the type of materials to control releases. ▪ Minimise inventory by utilizing just-in-time delivery.

Area	Potential Problem	Possible Approach
Waste Streams		
Quantity and Quality	▪ Characteristics and sources of waste streams are unknown. ▪ Wastes are generated as part of the process.	▪ Document sources and quantities of waste streams prior to pollution prevention assessment. ▪ Determine what changes in process conditions would lower waste generation of toxicity. ▪ Determine if wastes can be recycled back into the process.
Composition	▪ Hazardous or toxic constituents are found in waste streams. Examples are: sulfides, heavy metals, halogenated hydrocarbons, and polynuclear aromatics.	▪ Evaluate whether different process conditions, routes, or reagent chemicals (*e.g.*, solvent catalysts) can be substituted or changed to reduce or eliminate hazardous or toxic compounds.
Properties	▪ Environmental fate and waste properties are not known or understood	▪ Evaluate waste characteristics using the following type properties: corrosivity, ignitability, reactivity, BTU content (energy recovery), biodegradability, aquatic toxicity, and bioaccumulation potential of the waste and of its degradable products, and whether it is a solid, liquid, or gas.
Disposal	▪ Ability to treat and manage hazardous and toxic waste unknown or limited	▪ Consider and evaluate all onsite and offsite recycle, reuse, treatment, and disposal options available. Determine availability of facilities to treat or manage wastes generated.

Table 3-7: Modifications to Equipment for Prevent Pollution

Equipment	Potential Environmental Problem	Possible Approach	
		Design Related	Operational Related
Compressors, blowers, fans	▪ Shaft seal leaks, piston rod seal leaks, and vent streams	▪ Seal-less designs (diaphragmatic, hemetic or magnetic) ▪ Design for low emissions (internal balancing, double inlet, gland eductors) ▪ Shaft seal designs (carbon rings, double mechanical seals, buffered seals) ▪ Double seal with barrier fluid vented to control device	▪ Preventive maintenance program
Concrete	▪ Leaks to groundwater	▪ Water stops ▪ Embedded metals	▪ Reduce unnecessary

Equipment	Potential Environmental Problem	Possible Approach	
		Design Related	**Operational Related**
pads, floors, sumps		plates ▪ Epoxy sealing ▪ Other impervious sealing	purges, transfers, and sampling ▪ Use drip pans where necessary
Controls	▪ Shutdowns and start-ups generate waste and releases	▪ Improve on-line controls ▪ On-line instrumentatio ▪ Automatic start-up and shutdown ▪ On-line vibration analysis Use “consensus” systems (*e.g.*, shutdown trip requires 2 out of 3 affirmative responses)	▪ Continuous versus batch ▪ Optimize on-line run time ▪ Optimize shutdown interlock inspection frequency ▪ Identify safety and environment critical instruments and equipment
Distillation	▪ Impurities remain in process streams ▪ Impurities remain in process steam ▪ Large amount of contaminated water condensate from stream stripping	▪ Increase reflux ration ▪ Add section to column ▪ Column intervals ▪ Change feed tray ▪ Insulate to prevent heat loss ▪ Preheat column feed ▪ Increase vapor line size to lower pressure drop ▪ Use reboilers or inert gas stripping agents	▪ Chage column operation conditions ▪ Reflux ratio ▪ Feed tray ▪ Temperature ▪ Pressure *etc*.., ▪ Clean column to reduce fouling ▪ Use higher temperature steam
General manufacturing equipment areas	▪ Contaminated rainwater ▪ Contaminated sprinkler and fire water ▪ Leaks and emissions during cleaning	▪ Provide roof over process facilities ▪ Segregate process sewer from storm sewer (diking) ▪ Hard-pipe process streams to process sewer ▪ Seal floors ▪ Drain to sump ▪ Route to waste treatment ▪ Design for cleaning ▪ Design for minimum rinsing ▪ Design for minimum sludge ▪ Provide vapour enclosure ▪ Drain to process	▪ Return samples to process ▪ Monitor stormwater discharge ▪ Use drip pans for maintenance activities ▪ Rinse to sump ▪ Reuse cleaning solutions
Heat exchangers	▪ Increased waste due to high localized	▪ Use intermediate exchangers to avoid contact with furnace	▪ Select operating temperatures at or near ambient

Equipment	Potential Environmental Problem	Possible Approach	
		Design Related	Operational Related
	temperatures ▪ Contaminated material due to tubes leaking at tube sheets ▪ Furnace emissions	tubes and walls ▪ Use staged heating to minimise product degradation and unwanted side reactions. (waste heat >>low pressure steam >>high pressure steam) ▪ Use scraped wall exchangers in viscous service ▪ Using falling film reboiler, piped recirculation reboiler or high-flux tubes ▪ Use lowest pressure steam possible ▪ Use welded tubes or double tube sheets with inert purge. Mount vertically ▪ Use superheat of high-pressure steam in place of a furnace	temperature when-ever possible. These are generally most desirable from a pollution prevention standpoint ▪ Use lower pressure steam to lower temperatures ▪ Monitor exchange fouling to correlate process conditions which increase fouling , avoid conditions which reapidly foul exchangers ▪ Use on-line tube cleaning techniques to keep surfaces clean ▪ Monitor for leaks
Piping	▪ Leaks to groundwater; fugitive emissions ▪ Releases when cleaning or purging lines	▪ Design equipment layout so as to minimise pipe run length ▪ Eliminate underground piping or design for cathodic protection if necessary to install underground ▪ Welded fittings ▪ Reduce number of flanges and valves ▪ All welded pipe ▪ Secondary containment ▪ Spiral-wound gaskets ▪ Use plugs and double valves for open end lines ▪ Change metallurgy ▪ Use lined pipe ▪ Use "pigs" for cleaning ▪ Slope to low point drain ▪ Use heat tracing and insulation to prevent	▪ Monitor for corrosion and erosion ▪ Paint to prevent external corrosion ▪ Flush to product storage tank

Equipment	Potential Environmental Problem	Possible Approach	
		Design Related	Operational Related
		freezing ▪ Install equalizer lines	
Pumps	▪ Fugitive emissions from shaft seal leaks ▪ Fugitive emissions from shaft seal leaks ▪ Resedual “heal” of liquid during pump maintenance ▪ Injection of seal flush fluid into process stream	▪ Mechanical seal in lieu of packing ▪ Double mechanical seal with inert barrier fluid ▪ Double machined seal with barrier fluid vented to control device ▪ Seal-less pump (canned motor magnetic drive) ▪ Vertical pump ▪ Use pressure transfer to eliminate pump ▪ Low poing drain on pump casing ▪ Use double mechanical seal with inert barrier fluid where practical	▪ Seal installation practices ▪ Monitor for leaks ▪ Flush casing to process sewer for treatment ▪ Increase the mean time between pump failures by: ▪ - selecting proper seal material; ▪ - good alignment; ▪ - reduce pipe-induced stress ▪ - Maintaining seal lubrication
Reactors	▪ Poor conversion or performance due to inadequate mixing ▪ Waste by-product formation	▪ Static mixing ▪ Add baffles ▪ Change impellers ▪ Add horsepower ▪ Add distributor ▪ Provide separate reactor for converting recycle streams to usable products	▪ Add ingredients with optimum sequence ▪ Allow proper head space in reactor to enhance vortex effect ▪ Optimize reaction conditions (temperature, pressure, *etc.*,)
Relief valve	▪ Leaks ▪ Fugitive emissions ▪ Discharge to environment from over pressure ▪ Frequent relief	▪ Provide upstream rupture disc ▪ Vent to control or recovery device ▪ Pump discharges to suction of pump ▪ Thermal relief to tanks ▪ Avoid discharge to roof areas to prevent contamination of rainwater ▪ Use pilot operated relief valve ▪ Increase margin between design and operating pressure	▪ Monitor for leaks and for control efficiency ▪ Monitor for leaks ▪ Reduce operating pressure ▪ Review system performance
Sampling	▪ Waste generation due	▪ In-line analyzers ▪ System for return to	▪ Reduce number and size of sample

Equipment	Potential Environmental Problem	Possible Approach	
		Design Related	Operational Related
	to sampling (disposal, containers, leaks, fugitives, *etc.*)	process ▪ Closed loop ▪ Drain to sump	required ▪ Sample at the lowest possible temperature ▪ Cool before sampling
Tanks	▪ Tank breathing and working losses ▪ Leak to groundwater	▪ Cool materials before storage ▪ Insulate tanks ▪ Vent to control device (flare, condenser, *etc.*) ▪ Vapour balancing ▪ Floating roof ▪ Higher design pressure ▪ All above ground (situated so bottom can routinely be checked for leaks) ▪ Secondary containment ▪ Improve corrosion resistance ▪ Design for 100% de-inventory	▪ Optimize storage conditions to reduce losses ▪ Monitor for leaks and corrosion ▪ Recycle to process if practical
Vacuum systems	▪ Waste discharge from jets	▪ Substitute mechanical vacuum pump ▪ Evaluate using process fluid for powering jet	▪ Monitor for air leaks ▪ Recycle condensate to process
Valves	▪ Fugitive emissions from leaks	▪ Bellow seals ▪ Reduce number where practical ▪ Special packing sets	▪ Stringent adherence to packing procedures ▪
Vents	▪ Release to environment	▪ Route to control or recovery device	▪ Monitor performance

3.2.4 Wastewater generation, characterization and treatment

The sources of wastewater generation are generally correlated with the pattern of water consumption. A typical mass balance of water consumption and effluent generation in industries is depicted in figure in its abstract form. The close examination of Figure 3-5 reveals that the water consumption pattern can be classified in to following classes.

- Make up for cooling water system
- Feed to DM plant
- Industrial use
- Service water
- Potable/sanitary water

The same pattern is repeated in case of wastewater generation which can be classified as

- Cooling tower blowdown
- DM plant regeneration wastewater
- Process wastewater
- Service water
- Sanitary wastewater

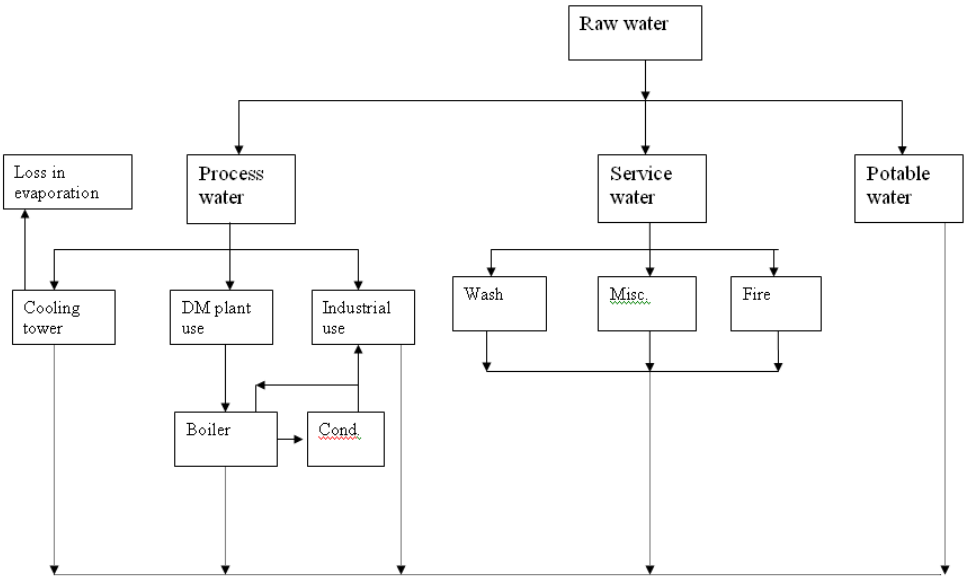


Figure 3-5: Typical water balance diagram for effluent generation

Product-wise water consumption and wastewater generation per tonne of product for basic organic chemicals manufacturing industry is summarised in Table 3-8 and Table 3-9 respectively.

Table 3-8: Water Consumption per Tonne of Product for Selected Basic Organic Chemicals

Sl. No.	Product	Water consumption per tonne of product (m^3/T) (IICT)
1	Methyl amines (Mono, Di, Tri)	1.6
2	Ethyl amines (Mono, Di, Tri)	1.94
3	Potassium Ethyl Xanthate	0.17
4	Methyl chloride, Methylene chloride, Chloroform, Carbon tetrachloride	4.75 (L/T)
5	Trichoro ethylene	6.16 (L/T)
6	Sodium alpha olefin sulphonate	0.47
7	Glycerine	0.42
8	Acetaldehyde	2.22
9	Acetic acid	0.13
10	Ethyl acetate	1.68
11	Dioctyl pthalate	0.83

Sl. No.	Product	Water consumption per tonne of product (m^3/T) (IICT)
12	Benzaldehyde	1.55
13	Benzyl chloride	0.45
14	Benzyl alcohol	0.85
15	Detergent powder	
16	Para chloro meta cresol	22.5

Table 3-9: Wastewater Generated per Tonne of Product for Selected Basic Organic Chemicals

Sl. No.	Product	Wastewater generation per tonne of product (m^3/T) (IICT)
1	Methyl amines (Mono, Di, Tri)	0.7
2	Ethyl amines (Mono, Di, Tri)	1.62
3	Potassium Ethyl Xanthate	0.950
4	Methyl chloride, Methylene chloride, Chloroform, Carbon tetrachloride	1 (KL/T)
5	Trichoro ethylene	
6	Sodium alpha olefin sulphonate	0.078
10	Acetaldehyde	3.42 (KL/T)
11	Acetic acid	0.225 (KL/T)
12	Ethyl acetate	1.8 (KL/T)
13	Nitrobenzene	1.66
14	Nitrotoluene	3
15	Aniline	1
16	Dioctyl phthalate	1
17	Acetone	4.64
18	Para chloro meta cresol	9

3.2.4.1 Wastewater characterization

The product-wise pollution potential (air pollution, water pollution and solid waste generation) from various sources has been summarised in Table 3-10. Close examination of this table reveals that the sources of water pollution are as follows.

- Spent acid
- Wastewater from washing
- Scrubbing liquid
- Reactor washing
- Mother liquor

Wastewater is also generated from those unit operations which, separates products from aqueous solutions such as centrifugation, crystallization *etc.* In view of above, the characteristics of the wastewater shall be as follows.

- Acidic streams from the spent acid
- Total dissolved solids from the scrubbing liquid
- High COD wastewater from mother liquor and reactor washing

Wastewater generation and organic pollutants identified in wastewaters from basic organic chemicals industry are given in Table 3-10, 3-11 and Table 3-12 respectively.

Table 3-10: Product-wise Pollution Potential and its Sources

Sl. No	Name of the Basic Organic Chemical	Water Pollution
1	Chloromethanes	Bleed from methyl chloride quench tower, scrubbing liquid from water scrubber, spent dilute caustic liquor
2	Trichloroethylene	Scrubbing liquid
3	Plasticisers	Bisulphite washings, reactor washings, spent caustic solution, aqueous waste from condensation
4	Benzyl chloride, Benzyl alcohol, Benzaldehyde, Benzyl acetate	Scrubbing liquid, Nacl
5	Cresol	Wastewater from neutralisation, filtration, concentration,
6	Benzoic acid	Aqueous waste from crystalliser, centrifugation
7	Bromostyrol	
8	Nitrobenzene	Spent acid, wash water (acidic and alkaline)
9	Dinirobenzene	Spent acid, wastewater from washing
10	Nitrochlorobenzene	Spent acid, scrubbing liquid, aqueous waste from crystallisation, washer wastewater
11	Aniline	Wastewater from separator containing aniline
12	Potassium salt of metanilic acid	Mother liquor, Evapouration water
13	m- Meta aminophenol	Acidic and alkaline wastewater, , aqueous waste from crystallisation
14	Nitrotoluene	
15	Glycerine	Filter wastewater
16	Acetic acid	Scrubbing liquid
17	Fatty acid	
18	Ethyl acetate	Neutralisation waste, ethyl alcohol recycle
19	Ethyl acrylate	

Sl. No	Name of the Basic Organic Chemical	Water Pollution
20	Amine and amine derivatives	Scrubber, Condensate water
21	Detergent	Neutralisation, spent acid
22	Soap	
23	Sodium alphaolefin sulphonate	Neutralisation

Table 3-11: Wastewater Generation from Some of Products

S.No.	Products	Sources of Wastewater
1.	Plasticizers-I] (DOP, DBP)	Wash water after neutralisation of reaction products
	Plasticizers-II (EEP, DCHP)	Washing of the reactors, aqueous layer in condensate of stripper during recovery of unreacted alcohols
2.	Ethanolamine	Wastewater mainly from dehydration tower
3.	Acetic acid	Washings from ethanol column after evapouration
4.	Benzyl alcohol	Scrubber solution, residue from distillation columns
5.	Benzyl acetate	- do -
6.	Benzaldehyde	- do -
7.	meta-Aminophenol	Acidic wastewater from the washings of the intermediate after sulphonation and alkaline wastewater from salting out the washing of product MAP before crystallisation
8.	Nitrobenzene	Mainly wash waters acidic and alkaline
9.	Nitro toluene	Acidic & alkaline wastewaters mainly wash waters and barometric condenser
10.	Nitrochloro-benzene	Wastewater from caustic and water washes in the purification process Water scrubbing of nitrator fumes
11.	Aniline	Wastewater is effluent from dehydrator (slightly alkaline to neutral)
12.	Ethyl Acrylate	Wastewater mainly from washing
13.	Benzoic Acid	No wastewater except for reactor washing *etc.*
14.	Cresols	Wash water from filtration unit after neutralisation with soda ash (acidic)
15.	Potassium salt of metanilic acid	Mother liquor from filtration unit (acidic) wash waters from other filtration units, wastewater after evapouration to get final product
16.	Chloromethanes	Wash water from thermal chlorination plant, hydro-chlorination plant, Bleed from methyl chloride quency tower : spent dilute caustic liquor
17.	Trichloroethylene	Two streams of wastewaters, one from barometric condenser with 1.5 – 2% HCL and other from vent gas

S.No.	Products	Sources of Wastewater
		scrubber
18.	Synthetic detergents	Mainly wash waters, Scrubber solutions, wash waters after neutralisation in sulphonation process
19.	Amines & their derivatives	Wash waters from reactors floor washings *etc.*

Table 3-12: Organic Pollutants Identified in Wastewaters of Basic Organic Chemicals

S.No.	Wastewater Source	Method of Analysis	Compounds Identified
1.	Plasticizers	HPLC	▪ p-Toluene sulphonic acid ▪ Dibutyl phthalate *
2.	Plasticizers & Aromatics	HPLC	▪ Dibutyl phthalate *
3.	Dinitrobenzene	GC	▪ m-Dinitrobenzene ▪ o-Nitrophenol* ▪ m-Nitrophenol ▪ p-Nitrophenol * ▪ Nitrobenzene *
4.	Nitrochlorobenzene	GC	▪ o-Nitrochlorobenzene ** ▪ m-Nitrochlorobenzene ▪ p-Nitrochlorobenzene ** ▪ Nitrobenzene
5.	Aniline	GC	▪ Aniline ▪ Nitrobenzene *
6.	Meta aminophenol		
a)	Acidic	HPLC	▪ m-Nitrobenzene sulphonic acid
b)	Alkaline	HPLC	▪ m-Nitrobenzene sulphonic acid ▪ m-Aminophenol ▪ Resorcinol
7.	Nitrotoluene		
a)	Acidic	GC	▪ o-Nitrotoluene ▪ m-Nitrotoluene ▪ p-Nitrotoluene
b)	Alkaline	GC	▪ o-Nitrotoluene ▪ m-Nitrotoluene ▪ p-Nitrotoluene
8.	Nitrobenzene		
a)	Acidic	GC	▪ Nitrobenzene * ▪ o-Nitrophenol * ▪ m-Nitrophenol
b)	Alkaline	GC	▪ Nitrobenzene * ▪ o-Nitrophenol * ▪ m-Nitrophenol
9.	Cresols and metanilic acid	HPLC	▪ p-Cresol ▪ m-Nitrobenzene sulphonic acid (Pot. Salt)
10.	Chloromethanes	GC	▪ Methyl chloride ***

S.No.	Wastewater Source	Method of Analysis	Compounds Identified
			▪ Methanol

3.2.4.2 Wastewater treatment

There is considerable variation in the nature of pollutants normally generated in a basic organic chemical industry. Before designing treatment system the following aspects should be considered.

- Segregation of wastewater based on type and strength
- Reduction of quantity and strength of wastewater by adopting in process and in plant control methods
- Treatability studies of various wastewaters to decide the best combining treatment systems

3.2.4.3 Segregation of effluent streams

When the member industries of CETP comprise chemical industries or multiple industrial categories, the complexity w.r.t the O&M is high and thus demands specific skills. It has been largely felt that the member industries need to have qualitative assessment of their effluent streams and must segregate the effluent generated into the following streams:

- highly inorganic streams (TDS)
- highly concentrated effluents/non-degradable/toxics
- mixed (organic & inorganic) streams

As discussed earlier, the treatment envisaged at CETP is primarily for the separation of suspended solids and organic matter through biological treatment systems (pre-treatment standards refer to just this expectation). Therefore, only those streams which can be treated at CETPs may be sent and others require specific treatment at the individual industry level. In other words, additional treatment either at CETP or at individual member industries is required. An example of effluent segregation and corresponding treatment in a synthetic organic chemical unit is shown in Figure.3-6.

If such segregation is not practiced at the individual-member-industry-level, effluent treatment at common treatment facilities gets complicated with only primary and secondary (biological) treatment facilities (general condition of effluent standards for CETP inlet).

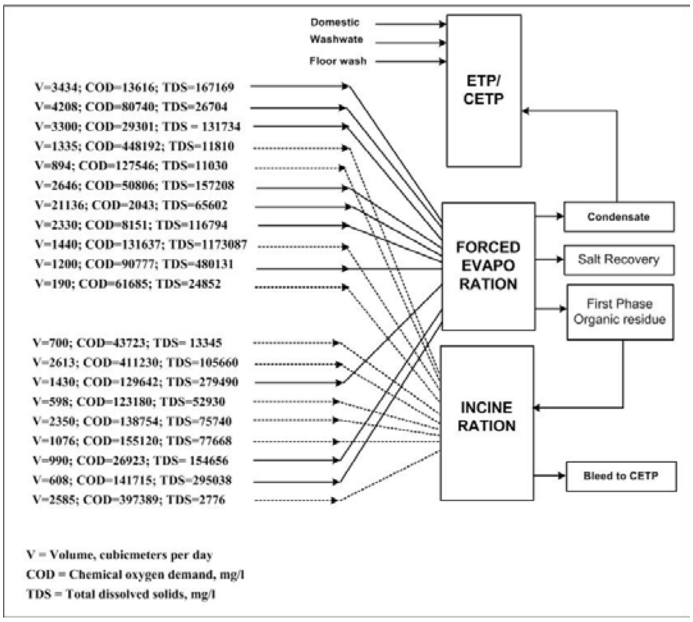


Figure 3-6: Effluent stream-specific choice of treatment: A model case study

3.2.5 Sources of air pollution

Air emission sources can be broadly classified into four groups

- i) Process units
- ii) Utilities
- iii) Fugitive
- iv) Storage and handling

In addition, during treatment of wastewater biological treatment system and treatment of hazardous wastes by incineration secondary emissions are generated.

The process emission mainly originates at the inert gas purge vent. Besides, all organic chemical industries have steam boilers which constitute as a major stack emission source.

3.2.5.1 Emissions from amines and plasticizers plant

There are two process vent emissions sources in ethanolamine plant. The ammonia vent purges small amount of nitrogen gas besides ammonia. No VOC emissions are reported from this vent.

3.2.5.2 Emissions from acetic acid and acetic anhydride plants

Uncontrolled VOC emissions are reported from reactor by product gas vent and column vents of acetic anhydride unit besides acetaldehyde oxidation plant in acetic acid plant. The emissions contain methane, CO, CO_2 in addition to high amount of VOCs including benzene. The total uncontrolled emission rates estimated for total VOC and benzene for the plants using process variation are 2.13 g/kg and 0.217 g/kg respectively. Table gives the composition of the vent gases from the reaction section. The VOC emitted are acetaldehyde, ethanol, ethyl acetate, ethyl formate and n-propyl acetate.

3.2.5.3 Emissions from plants manufacturing nitro compounds

Benzene constitutes the bulk of the emissions from the process. Organics are stripped from the waste acid for recycle and benzene is stripped from nitrobenzene and non condensables. Oxides of nitrogen are generated by side reactions involving nitric acid and must be purged from the process. Fugitive emissions result from the storage of benzene, waste acid (which contains benzene) and nitrobenzene. Secondary VOC emissions result from acid stripper, wastewater from the nitrobenzene and waste caustic from the nitrobenzene neutralizer. There are three potential sources of secondary emissions from aniline unit *viz.*, spent catalyst handling, wastewaters and tars from purification column. Name of the basic organic chemicals and concerned air pollutants are given in Table 3-13:

Table 3-13: Selected Basic Organic Chemicals and Concerned Air Pollutants

Sl. No	Name of the Basic Organic Chemical	Air Pollution
1	Chloromethanes	HCl and emissions from storage and handling
2	Trichloroethylene	Chlorine from tetra synthesis, HCl
3	Plasticisers	
4	Benzyl chloride, Benzyl alcohol, Benzaldehyde, Benzyl acetate	HCl
5	Cresol	
6	Benzoic acid	Toluene
7	Bromostyrol	Bromine
8	Nitrobenzene	Benzene, nitrobenzene and oxides of nitrogen
9	Dinirobenzene	Nitrobenzene
10	Nitrochlorobenzene	Chlorobenzene
11	Aniline	
12	Potassium salt of metanilic acid	HCl
13	m- Meta aminophenol	
14	Nitrotoluene	Alkaline and acidic wastewater, spent acid
15	Glycerine	
16	Acetic acid and acetic anhydride	Vent gases from venturi scrubber and column vent consisting of CO, methane, VOCs *etc.*
17	Fatty acid	
18	Ethyl acetate	
19	Ethyl acrylate	
20	Amine and amine derivatives	NH_3 (Ammonia), Nitrogen gas in small amounts
21	Detergent	
22	Soap	

Sl. No	Name of the Basic Organic Chemical	Air Pollution
23	Sodium alphaolefin sulphonate	SO_x

3.2.5.4 Emissions from halomethane plant

Process emissions from inert gas purge vent at the chloromethane manufacture include hydrogen chloride recycled to the hydrochlorination reactor from hydrogen chloride stripper and methyl chloride. Emission of 1.5×10^{-3} kg of methyl chloride per kg of total chloromethanes is anticipated. Build up of inert gases occurs in the condensers associated with methylene chloride and chloroform distillation. Emission result from storage and handling of methanol, methylene chloride, chloroform and crude carbon tetra chloride.

3.2.6 Solid waste generation

Table 3-14: Selected Basic Organic Chemicals and Concerned Solid Waste

Sl. No	Name of the Basic Organic Chemical	Solid waste
1	Chloromethanes	Heavy ends from distillation
2	Trichloroethylene	$CaCl_2$ slurry, distillation residue
3	Plasticisers	Neutralisation waste, sludge from alkali wash, filtration residue
4	Benzyl chloride, Benzyl alcohol, Benzaldehyde, Benzyl acetate	Distillation residue, filtration residue
5	Cresol	Gypsum cake, sodium sulfite, soda ash, sodium sulfate from decantation, distillation residue
6	Benzoic acid	Distillation and filtration residue
7	Nitrobenzene	Distillation residue
8	Nitrochlorobenzene	Distillation residue
9	Aniline	Distillation residue
10	Potassium salt of metanilic acid	Filtration residue (NBSK cake), Iron sludge
11	m- Meta aminophenol	Iron sludge, sulfite sludge, distillation residue
12	Nitrotoluene	Distillation residue
13	Glycerine	Distillation residue, filtration residue
14	Fatty acid	Distillation residue
15	Ethyl acrylate	Distillation residue

3.3 Dyes and Dye Intermediates

Dyestuff sector is one of the core chemical industries in India. It is also the second highest export segment in chemical industry. The Indian dyestuff industry is made up of about 1,000 small scale units and 50 large organised units, who produce around 1,30,000 tonnes of dyestuff. Maharashtra and Gujarat account for 90% of dye stuff production in India due to the availability of raw materials and dominance of textile industry in these regions. In India, the major users of dyes are textiles, paper, plastics, printing ink and foodstuffs. The textiles sector consumes around 80% of the total production due to high demand for polyester and cotton, globally. At present, India contributes about 6% of the share in the global market with a CAGR of more than 15% in the last decade. The organised players contribute about 65% of the total dye stuff production in the country. The dyestuff industry has recently seen movement towards consolidation and as a result, organised players are now poised to take a lead in the global market. Small units (around 1000) that exist today still compete in the segments, where price realization is lower and the competition severe. Large and organised players (around 50) are gearing up for global competitiveness leveraging technology, product innovation and brand building. Increased focus is being laid on environmental friendliness and at the same time the industry is ensuring greater customer focus through technical services and marketing capabilities, in order to face global competition.

Structure of the industry: The small scale units account for a majority of dyestuff production while large units dominate manufacturing of dyestuff intermediates. The installed capacity of the dyestuff and intermediate industry for selected group is estimated at about 55,000 MT per year.

The main products on which the small-scale manufacturers concentrate are,acid dyes, and direct dyes, while large companies mainly concentrate on vat, disperse and pigment dyes. Disperse and reactive dyes constitute the largest product segments in the country constituting nearly 45% of dyestuff consumption. In future, it is expected that both these segments will dominate the dyestuff market with Disperse dyes likely to have the largest share followed by reactive dyes on account of dominance of textile and synthetic fibres in dyestuff consumption. Vat dye segment is also expected to record a positive growth in future.

The impact of global meltdown on Indian dyestuff industry

In India, dyestuff industry supplies its majority of production to the textile industries. Enormous amount of dye stuff products from India are exported to textile industries in Europe, South East Asia and Taiwan. India presently manufactures all kinds of synthetic dyestuff and intermediates and has its strong hold in the natural dyestuff market. India is one of the major global producers of dyestuffs and dye intermediates, principally for reactive, acid, vat and direct dyes. India has approximately 6% share in the world production of dyestuff products

3.3.1 Classification of Dyes

Dye manufacturing industries can be classified based on following factors; (a) type of the dye production and (b) application of dyes by users. The composition of dye is important for the process adopted for production while the application aspects are useful for users.

A dye has an unsaturated (multiple bond) group attached to it. This when reduced loses colour when oxidised regains colour. For example, diazomethane and glyoxal are simplest coloured organic compounds. Both have unsaturated group. On reduction diazomethane gives methyl hydrazine (colourless) and glyoxal gives glycerol (colourless). This unsaturated group is known as chromophore and the substance having chromophores are known as chromogens.

The presence of many chromophores produce deeper colour. Some groups though not chromophores and yet when present in chromogen deepen its colour. These groups are known as auxochromes. The auxochromes are acidic (phenolic) or basic, the important being OH, NH_2, NHR and NR_2.

The radicals which bring about deepening of colour are known as bathochromic and those posing opposite effect are known as hypochromic group.

The presence or absence of various chromophores, auxochromes and bathochromics determines the acidic, basic and complexing nature of dye which in turn decides applicability of the dye.

Classification based on composition

Nitro dyes: They contain the group-NO OH or -$N0_2$. The most important dye of this class is naphthol yellow.

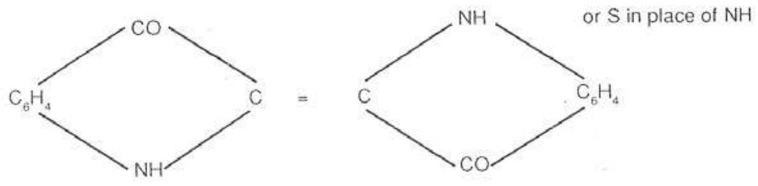
Nitroso dyes: They contain the group = NOH or -N - O. The important dye of this class is naphthlol green.

Azo dyes: The chromophoric group is azo group (-N--N-) and the auxochromic groups are-NH2, OH or NR2. This class includes large number of synthetic dyes. The essential substance is the primary amine which is diazotized and then coupled with either an auxochrome, an aromatic amine, in acid medium or with phenol in alkaline medium. Azo dyes are sub-classified as under:-

- Monoazodyes
  - Basic
  - Acidic
  - Ingrain
  - Mordant
- Diazodyes
  - Basic
  - Acidic
  - Developed
- Triazodyes
- Di and Triphenol methane dyes

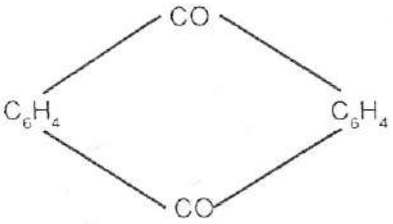
This is the parent hydrocarbon of a large number of dyes, which are; however, not prepared directly from triphenyl methane. Examples of this class of dyes are malachite green, pararosaniline, crystal violet, methyl violet *etc.*

Vat dyes: These dyes are represented by general structure as under:-



Indigo, tyrian purple and trioindigo are some examples of this type of dye.

Anthraquinonoid dyes: The general structure of the type of dye is as under



Alizarine is the first dye of this series. Other examples are alizarin blue, alizarin blue S, alizarin red S *etc.* Some of this group dyes are used as intermediates for preparation of other different dyes.

Quinoline dyes: The characteristic group in these dyes is several odd number of methane groups (= Ch-) linking quadrivalent and trivalent nitrogen atoms. The series of delcyanines dyes are the examples of this category.

Sulphur dyes: These are of unknown complex structures although prepared by heating aromatic substances such as amines, aminophenols with sodium polysulphide:

Classification based on application

Based on applications there are 15 groups of dyes.

Acid dyes: The common structural feature of this class of dyes is chromophoric structure with a sulphonic or analogous group which gives the dye an anionic character. Acid dyes are mainly used for dyeing wool, silk, nylon *etc.* These are applied from an acid dye bath.

Azo dyes: The term describes a system whereby a coupling component having affinity for cellulosic fibres is 'padded' on to cloth by passing it through 3 solution of the component and then through rollers to remove surplus solutions. The impregnated material is then brought into contact with a solution of a stabilized diazo component, where formation of an insoluble dye occurs.

Basic Dyes: The basic dyes are cationic dyes, often brilliant in shade and of very high tinctorial strength, but having inferior fastness properties on cotton, which requires to be tennin-mordanted before it can be dyed.

Direct Dyes: These dyes are used for dyeing animal or vegetable fibres directly from a solution of the dye in water. All dyes of this class are anionic dyes having affinity for cellulosic fibres. Certain direct dyes are extensively employed in dyeing of paper, leather, union materials, bast fibres and other substrates.

Disperse Dyes: This class of dyes is devoid of the common solublizing group, but they have slight solubility in water. This is used for dyeing of polyester fibres, the dyeing of which may require the presence of swelling agents and the use of pressure. The swelling agents are certain special types of chemicals used in the dyeing of synthetic fibres with disperse dyes.

Food Colours: Food dyes are of various structures, selected and tested for harmlessness and employed in colouring foods, candies, confections and cosmetics. Method of application is mainly from solution, dispersion on suspension in a mass.

Ingrain Dyes: These are water insoluble azo dyes and are so called because the dye is formed on the fibre itself. This includes both azoic systems and oxidation bases.

Metal complexes: These dyes are synthesised as metal complex on ti ,8 textile fibre *e.g.,* phthalonitrile and metal salts. The colour range depends on the metal salts used and these dyes give good fastness of colour on the fibre. As an example, copper phthalocyanine is a typical metal complex dye, which is most extensively used in dyeing of cotton fabrics.

Mordant Dyes: This class is in the group of special wool dyes, the dyeings from which are treated with aqueous bichromate in order to improve wet fastness. This treatment may be applied to the fabric before dyeing, during the dyeing process or afterwards.

Optical brightening, whitening agent: These dyes are mainly used to whiten textiles, plastics, paper, soap *etc.,* and to add brightness to delicate dyeing. Examples of dyes are derivatives of diaminostilbene, coumarin *etc.*

Pigment dyes: Pigments form insoluble compounds or cakes with salts of calcium, barium, chromium or phosphomolybdic acid. The dye molecules frequently contain-OH or -S03H groups. These are mainly used in paint industries and in the mass colouration of plastics.

Reactive dyes: These are defined as coloured compounds possessing a suitable group capable of forming a covalent bond between a carbon atom of the dye ion or molecule and an oxygen, nitrogen or sulphur atom of a hydroxy, an amino or a mercaptan group respectively of the substrate. It is suitable for dyeing wool and cotton.

Solvent Dyes: These dyes are mainly of azos, triarylmethane bases, or anthraquinones used to colour oils, waxes, varnishes, shoe, dressings, and gasoline, Solvent dyes can be used for dyeing synthetics with reduced problems in the disposal of spent liquors. In other words, the dyeing liquor will be completely used up and will not be present in the effluent.

Sulphur Dyes: Sulphur dyes are of indeterminate structure and are derived from the sulphurization at elevated temperatures of certain aromatic compounds. They are water insoluble but are rendered soluble for dyeing purposes by sulphide reduction. These dyes are mainly used for cotton dyeing.

Vat Dyes: These dyes which are insoluble in water but soluble in their reduced form have been classed as vat dyes. These dyes are suitably used for cotton and other cellulosic fibres. As the operation of dyeing is carried out in a strongly alkaline medium they are not suited for wool dyeing. Special methods have to be used for wool dyeing.

3.3.2 Manufacturing process

Manufacturing process generally adopted involves conversion of simple organic products like benzene, xylene, naphthalene, anthracene *etc.* into a vast number of complex chemical intermediate and dye through several steps of operation like

- Chemical conversion
- Sulphonation
- Neutralization
- Fusion
- Chlorination

- Nitration
- Reduction
- Amination
- Acetylation
- Hydrolysis
- Corboxylation, *etc.*

Each process requires different operations like charging, reflux, distillation, filtration, washing, drying, and grinding, *etc.*

Intermediates are reacted in several processes like hydrochlorination, sulfation, diazotization, coupling, condensation, phosgenation, thionation, *etc.*, in the manufacture of dyes. The process requires large number of chemical compounds but often in limited quantity. The raw material is fed into the reactor where reactions are carried out ordinarily at atmospheric pressure. Usually the reactions are exothermic for which adequate temperature control is maintained to avoid side reactions. Generally, batch process is followed for production of dyes.

Temperature control is accomplished primarily by addition of ice to the reaction tank. When the reaction is complete, dye particles settle out from the mixture. The liquid from reactor is then sent to a plate and frame filter press where the dye particles are separated from the mother liquor, which is discharged as wastewater. The filter cake is first washed with compressed air while still in the process. The moist cake is discharged into shallow trays, which are placed in circulating dryer. The moisture is removed in temperature between 50 and 120°C. The dried dye is ground and mixed with diluents such as salt to improve the colour and strength as shown in Fig 3-7.

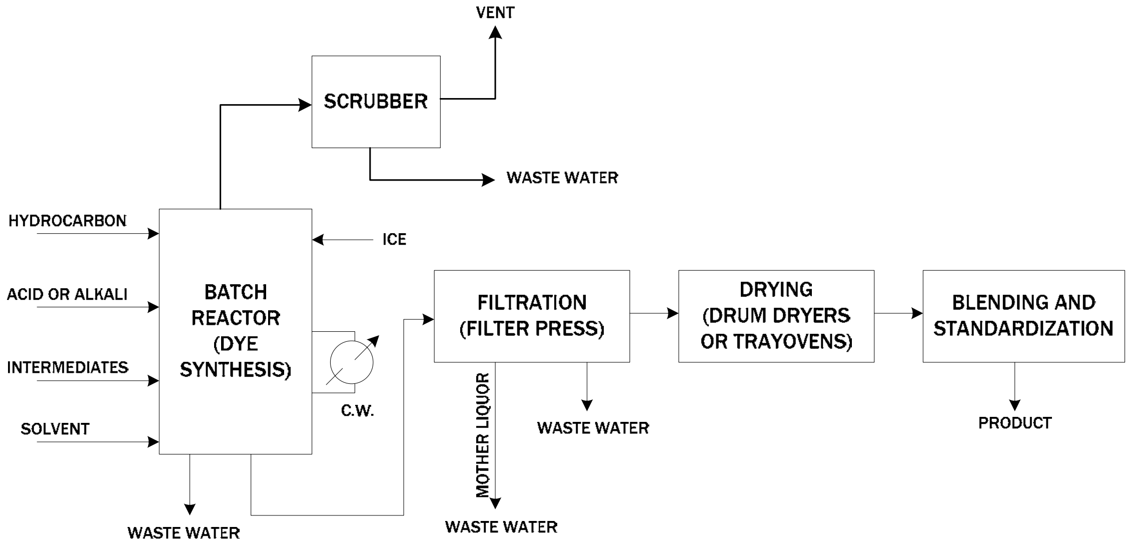


Figure 3-7: Dye Manufacturing Process

3.3.3 Available pollution control systems and their requirements

The pollution that accompanies this industry in its nature and extents, particularly, because of the non-biodegradable nature of the dyes as well as due to the presence of acid/alkali/toxic trace metals/carcinogenic aromatic amines in the effluents. In addition to effluent, gaseous emissions such as SO_2, NOx, NH_3 & HCl and solid wastes in the form of iron sludge, gypsum and sludge from treatment facilities are generated.

The available pollution control systems and the requirements are given in Table 3-15.

Table 3-15: Available Pollution Control Systems and the Requirements

Technologies/Current Practices	Requirements
Effluent treatment comprising primary (physico-chemical) and secondary (biological) systems are in practice. Some of the units have also provided tertiary treatment and incinerators for non-biodegradable waste.	Possibilities for adaptation of cleaner process options for reducing the water consumption and effluent generation; better management practices for segregation and reuse/ recycle of the treated effluent; effective utilisation of raw materials; improvement in efficiency of process; and recovery of by-products. The effluent generated from manufacturing of some of the dyes and intermediates such as H-acid is not biodegradable, which requires process change.
Gaseous emissions such as SOx, NOx, HCl and NH_3 are generally scrubbed.	Properly designed scrubber with recovery reuse of scrubbed liquid is required.
Gypsum, iron sludge and sludge from ETP are generated as solid waste. The gypsum and iron sludge can be used in the cement and pigment industries. The sludge is either disposed off on land/secured landfill or sent to other user industries.	Cleaner process technologies *e.g.,* catalytic hydrogenation, use of spent acid after nitration for acidification of fusion mass, which can eliminate generation of iron and gypsum sludge.

3.3.3.1 Water consumption and wastewater generation

The water usage in the industry is mainly for the following purposes:

- synthesis of the dyes and dye intermediates
- steam generation and cooling system
- washing and rinsing of reaction kettles, filter press, and floors *etc.*
- domestic and other miscellaneous activities

The water consumption pattern varies widely from one industry to another. In the same industry also, the rate of water consumption often changes due to frequent change in the feed material, synthesis reaction and desired products. The change of product pattern needs cleaning and washing, which consume substantial quantity of water.

Thus water requirement of a dye and dye intermediate industry depends on the following factors:

- type of dye produced
- number of products
- gross production
- pattern of working of factory *i.e.* continuous or in one shift only
- frequency of change in product pattern, *etc.*

In general, process water consumption is highest and next to it is the cooling and boiler make-up water requirement. The water needs for domestic purposes is the lowest.

The generation of wastewater follows the trend of consumption of water. In Table 3-16, comparative quantities of water consumption and wastewater generation are provided.

Table 3-16: Water Consumption and wastewater generation during production of various types of dye products

Sl .No	Type of Product	Range lit/kg of Product	
		Water consumption	Wastewater generation
1	Direct Dyes	2.5-667	1.0-644
2	Reactive Dyes	2.0-186	2.0-157
3	Basic Dyes	60-4200	50-200
4	Azo Dyes	90-400	8.0-213
5	Vat Dyes	1528-10345	1389-7980
6	Dye Intermediates	36-230	9.0-74
7	Naphthol dye	6.0-17	5.0-8.0
8	Pigments	93-923	7.0-785
9	Indigosol colours	529	429
10	Disperse Dyes	70	12-42.5
11	All varieties of Dyes/ Intermediates	13-2300	11-1146

The wastewater quantity varies according to the number of batches of products manufactured in a day, week or month, the duration of synthesis of the dye in the reactor vessel and the duration of the washing and rinsing operations.

The frequency of discharge may be intermittent in the small dye units, operating one or two batch per day, but in case of the medium and larger units, which operate a number of reactors simultaneously, wastewater discharge is continuous. The wastewater generation sources are as follows:

- process wastewater including left out mother liquor
- washing and rinsing wastes
- cooling water bleed and boiler blowdown
- sanitary and other miscellaneous wastewater.

Wastewater characteristics

The process of wastewater is mainly the mother liquor left over after the product is isolated and separated by filter press. This wastewater is of smaller volume and highly concentrated in terms of pollutants. The vessel washings also contain similar type of pollutants but with lower concentration.

It has been identified that the wastewater of the industries has the following characteristics:

- high levels of BOD and COD
- high acidity
- high TDS

- deep colour of different shades
- high levels of chlorides and sulphates
- presence of phenolic compounds
- presence of heavy metals *e.g.,* copper, cadmium, chromium, lead manganese, mercury, nickel and zinc
- presence of oil and grease

The dye industry wastewaters, if derived from naphthalene and anthracene bases are resistant to biodegradation. The colour removal is also not adequate by the conventional chemical and biological treatment.

In-plant control

It is essential to have proper in-plant control measures before going for wastewater treatment. Some of the relevant in-plant measures are summarised below:

(a) Reduction of waste

The volume of wastewater can be reduced by proper control of fresh water consumption. The cooling water blowdown may be reduced by raising the concentration factor. Timely maintenance of the units may be done to prevent leakage, spillage *etc.* Minimal usage of water for washing and rinsing may be practiced. The last wash water may be recycled for first washing. Application of counter current washing may also reduce wastewater generation. Dry cleaning of the floor is preferred when the floor washing is absolutely necessary. Treated wastewaters may be used for this purpose.

The pollution load can be reduced by recovery of chemicals and solvents as far as practicable. Spills, leakages, and overflows *etc.,* may not be allowed to join the wastewater stream.

(b) Segregation

Stormwaters need segregation to reduce the volume of wastewater. Similarly, the uncontaminated and less contaminated wastewater streams like cooling water blowdown, boiler blowdown, and condensate *etc.,* are to be segregated and should not be permitted to join the process wastewater stream. The highly contaminated and coloured mother liquors should be segregated and collected separately. These unforeseen strong wastes are to be collected in separate holding tanks and drawn into the wastewater treatment plant at a regulated rate.

(c) Process modification

The production process equipments should be modified so as to generate less waste. The raw materials used in the synthesis may be substituted by choice of more readily biodegradable chemicals.

3.3.3.2 Air pollution

In the dye industry, point-source generation of process emissions is from the reaction vessels. These emissions are scrubbed by water. The other emissions are of fugitive nature and should be controlled by proper modification of plant and maintenance of the equipment.

3.3.3.3 Solid waste

The solid wastes in the dye and dye intermediate industry generate from the following sources:

- Filter press from the process house.
- Physico-chemical wastewater treatment plant
- Biological wastewater treatment plant

3.3.4 Waste mininisation

Based on the manufacture of dyes and dye intermediates, certain waste minimisation measures are identified. These measures mainly address the following criteria:

- Effective utilization of raw-materials and improvement in processes efficiency
- Innovation in unit processes
- Innovative and more efficient unit operations
- Recycle of waste streams after sufficient purification
- Recovery of by-products and conversion to value added products with market potential
- Good manufacturing practices

Waste minimisation measures that can be taken in the manufacturing processes of the dyes and dye intermediates are presented in Table 3-17.

Table 3-17: Suggested Waste Minimisation Measures in the Manufacturing Processes

Class	Dye/Dye Intermediate	Waste Minimisation Measures
Reactive dyes	Reactive Red 141	▪ Spray drying of mono-azo dye, instead of salting out, to totally eliminate liquid effluent and load on ETP. ▪ Efficient dust collector on pulverizer vent to arrest loss of product dust. ▪ Effective washing of clarification sludge to make it free of retained product.
	Reactive Yellow 145	▪ Optimization of process to minimise formation of side products and thereby loss of material. ▪ Optimization of quantity of sulphuric acid used, to minimise generation of gypsum sludge and loss of retained liquid. ▪ Effective washing of clarification sludge to make it free of retained product.
Acid dye	Ink Blue	▪ Optimization of process to minimise formation of side products and thereby loss of material. ▪ Optimization of quantity of sulphuric acid used, to minimise generation of gypsum sludge and loss of retained liquid.
Pigments	Copper phthalocyanine α – Blue	▪ Optimization of parameters such as strength of sulphuric acid, temperature and quality of wash water, to maximize the yield. ▪ Effective washing of cake, to minimise quantity of

Class	Dye/Dye Intermediate	Waste Minimisation Measures
		wash water and thereby liquid effluent. ▪ Effective dust collectors to arrest fine dust of CPC going in the air.
	Copper phthalocyanine Green	▪ Efficient filtration to achieve washing with minimum wash water. ▪ Entrainment separator on gas vent, to stop loss of liquid particles. ▪ Efficient dust collectors to arrest loss of fine dust of CPC Green going in the air.
Vat dyes	Dark Blue BO	▪ Optimization of process to minimise side products. ▪ Use of ethyl cellusolve in place of naphthalene. ▪ Effective washing of cake to minimise quantity of wash water and retained liquids. ▪ Naphthalene trap on vent to arrest naphthalene vapours going out in atmosphere. ▪ Entrainment separator on vent line to stop carryover of liquid particles.
	Blue RSN	▪ Better process control to minimise side products. ▪ Effective washing to minimise wash water and retained material in cake. ▪ Entrainment separator on vent line to stop carryover of liquid particles. ▪ Dust collector on exhaust of dryer.
Meta complex	Copper phthalocyanine	▪ Process optimization for reducing the formation side products. ▪ Optimization of acid input and thereby minimisation of requirement of lime and generation of ETP sludge. ▪ Effective filtration to minimise wash water and liquid retained in cake.
Dye intermediates	Gamma acid	▪ Process optimization to improve yield of Gamma acid and reduce quantity of unreacted G-salt and isomeric products going in effluent. ▪ Reduction in quantities of alkali and acid used in alkali fusion and acidification and thereby reducing load of inorganics in effluent. ▪ There is a scope to reduce input of NH_3 solution
	Tobias acid	▪ Optimization of process to get maximum conversions of oxy-Tobias acid and intermediates to Tobias acid and minimisation of loss in effluent. ▪ Process control to ensure maximum conversion of ammonium salts to calcium salts so as to reduce formation of sodium salts going in liquid effluent. ▪ Effective washing of gypsum cake to minimise wash water and retained liquid in cake.
	6-chloro metanilic acid	▪ Sulphonation by liquid SO_3 will drastically reduce generation of gypsum sludge. ▪ Catalytic hydrogenation in place of iron- acid reduction, will totally eliminate generation of iron sludge. ▪ There is scope to reduce consumptions of caustic soda in neutralization and sulphuric acid in acidification.
	Beta naphthol	▪ Development of better process to eliminate formation of sulphone.

Class	Dye/Dye Intermediate	Waste Minimisation Measures
		▪ Distillation of Beta naphthol at higher vacuum and lower temperature. ▪ Proper layer separation to minimise loss of product and solvent. ▪ Effective washing of crude Beta naphthol with minimum wash water. ▪ There is a scope to reduce quantities of sulphuric acid and caustic soda.
	Resorcinol	▪ Process optimization to reduce formation of side products. ▪ Distillation at higher vacuum and lower temperature to minimise thermal degradation and formation of tar. ▪ Proper layer separation, to minimise loss of solvent and product in aqueous layer. ▪ There is a scope to reduce input of sulphuric acid and neutralizing alkali.
Anthraquinone derivatives	Anthraquinone-1-sulphonic acid ammonium salt	▪ Optimization of process to minimise formation of side products. ▪ Accurate layer separation to minimise loss of solvent benzene and product in aqueous effluent. ▪ Improving recovery of HgS to minimise its loss in effluent. ▪ Alternatively development of a process which does not use mercury as catalyst.
	Anthraquinone-1-sulphonic acid ammonium salt	▪ Entrainment separator to stop carryover of liquid particles with vent gases. ▪ Effective washing which minimises requirement of wash water. ▪ Optimization of present process to minimise formation of side products. ▪ Alternatively developing a process which does not use mercury as catalyst.

3.3.5 Recovery

The raw materials which can be recovered and reused or side products which can be recovered and sold, in the manufacture of the dyes and dye intermediates are listed in Table 3-18.

Table 3-18: Recoveries of Raw Materials/Side Products

S.No	Dye/Dye Intermediate		Recovery for recycle	Method of recovery	Recovery for sale	Method of recovery
1	Reactive dye	Reactive Red 141 and Reactive Yellow 145	Water	Water can be recovered and recycled by Reverse osmosis prior to spray drying	Aqueous HCl to dyes/dye intermediates industry	HCl gas liberated in cyanuration can be scrubbed by water in multiple scrubbers to get 30% HCl from the first scrubber.
2	Acid dye	Ink Blue	Monochlorobenzene,	Monochlorobenzene and aniline can be	Gypsum to cement	Gypsum generated, after liming and

S.No	Dye/Dye Intermediate		Recovery for recycle	Method of recovery	Recovery for sale	Method of recovery
			Aniline	recovered separately by fractional distillation of mother liquor of PRA, HCl.	manufacturers	acidification if washed effectively to minimise retained organics, can be sold to cement manufacturers
3	Pigments	Copper phthalo-cyanine alpha blue	Product from dust, wash water	Product lost as fine dust from pulveriser can be recovered by providing efficient dust collectors after centrifugal separator.	Spent sulphuric acid to dye intermediates industry	Spent sulphuric acid as wash of filter, can be utilized in dyes and dye intermediates industry, if it is made free of dye and copper.
		Copper phthalo-cyanine green	HCl	HCl liberated in chlorination and drowning can be scrubbed by water in Multiple scrubbers to get 30% HCl which can be recycled and used in other plants or ETP.	Aluminium hydroxide to pharmaceutical	Purification of aluminium hydroxide to make it free of colour and impurities can give product acceptable to pharmaceutical industry. About 1 T $Al(OH)_3$ can be recovered per tonne of product.
4	Disperse dye	Disperse Blue 165	Monochlorobenzene	Monochlorobenzene can be recovered by distillation of organic layer obtained by steam distribution	Copper from $Cu\text{-}NH_3$ complex to copper smelter	Possibility of recovering Cu from copper-ammonium complex needs to be explored.
		Dispergator FNA	CO_2 in other plants	CO_2 generated in liming, can be cleaned by entrainment separator, collected and sent to other plants, if there is a requirement	Gypsum to cement manufacturers	Gypsum sludge is generated on Liming and filtration. It can be sold to cement manufacturers, if it is washed effectively to minimise, retained organics.
5	Vat dye	Dark Blue BO	Naphthalene	Naphthalene which is vapourised in alkali fusion, can be condensed, recovered and recycled. Possibility of recovering naphthalene from wet cake needs to be explored	Dibenzanthranyl from wet cake to dye industry	Possibility of recovering Dibenzanthranyl from wet cake by extraction needs to be explored.

S.No	Dye/Dye Intermediate		Recovery for recycle	Method of recovery	Recovery for sale	Method of recovery
		Blue RSN	---	---	Ammonia solution to dyes/ dye intermediates industry	Ammonia generated in alkali fusion can be scrubbed by water in multiple scrubbers to get ammonia solution which may be sold to dyes/dye intermediate industry.
6	Meta complex	Copper phthalocyanine	Nitrobenzene	Nitrobenzene can be recovered by condensation of vapours from rotary vacuum dryer and further distillation to get purer nitrobenzene	Ammonia solution to dyes dye intermediates industry Gypsum to cement manufacturers	Ammonia generated in can be scrubbed by water in multiple scrubbers to get ammonia solution which may be sold to dyes/dye intermediates industry, Gypsum is generated in primary ETP. It can be sold to dyes/dye intermediates or organic industries.
7	Gamma acid		Ammonia solution	Ammonia liberated In the reactor, can be scrubbed by multiple scrubbers and ammonia solution can be recycled in the process	SO_2 gas / $NaHSO_3$ solution to dye inter- mediates industry	SO_2 is liberated in isolation step. It can be either recovered as SO_2 or scrubbed with NaOH to get $NaHSO_3$ solution in multiple scrubbers. It can be either used in plant or sold to other dyes/dye intermediates Manufacturers.
8	Tobias acid		Ammonia solution	Ammonia is liberated on alkalization. Ammonia solution can be obtained by scrubbing with water in multiple scrubbers, and it can be recycled in the process	SO_2 gas / $NaHSO_3$ solution to dye inter- mediates industry Gypsum to cement manufacturers	SO_2 gas is liberated in isolation step. It can be either recovered as SO_2 or scrubbed with NaOH in multiple scrubbers to get $NaHSO_3$ solution. It can be sold to other dyes/dye intermediates manufacturers.
9	Derivatives of metanilic acid	6-chloro metanilic acid	---	----	Gypsum to cement manufacturers. Iron oxide to pigment	Gypsum is generated in primary ETP. It can be sold to cement manufacturers; Iron

S.No	Dye/Dye Intermediate		Recovery for recycle	Method of recovery	Recovery for sale	Method of recovery
					manufacturers	sludge is generated per tonne of product on reduction and filtration. It can be sold to pigment manufacturers. It will fetch better price.
10	B naphthol		Naphthalene, sodium sulphate, SO_2, oxylene	Naphthalene can be obtained by steam distillation after sulphonation and can be recycled. Sodium sulphite solution obtained in alkali fusion and by washing crude B naphthol can be recycled in the process. SO_2 gas liberated in neutralization step can be utilized in acidification step, after separating entrained liquid by entrainment separator Q-Xylene obtained by distillation of organic layer after extraction and can be recycled.	Sulphone to dyes/dye intermediates industry	Sulphone may be recovered from tar by extraction, it can be sold to dyes/dye intermediates manufacturers.
11	Resorcinol		Butyl acetate	Butyl acetate can be recovered by solvent distillation, and Can be recycled.	Sodium sulphite, } To Sodium sulphate,} dyes/ Sulphuric acid } dye Sulphone } inter- } mediates	Sodium sulphite is generated in fusion. It can be recovered by filtration and effective washing to minimise retained organics. It can be sold to dyes dye intermediates manufacturers. Sodium sulphate is generated as Glauber salt on acidification. It can be recovered by filtration and effective washing. Sodium sulphate is generated in neutralization. It can

S.No	Dye/Dye Intermediate		Recovery for recycle	Method of recovery	Recovery for sale	Method of recovery
						be recovered by settling, filtration and washing.
12	Derivatives of anthraquin one	Anthraquin one- 1- sui phonic acid sodium salt	Anthraquinone, Benzene HgO from HgS	Anthraquinone is generated by dehydrolysis of BOB and it is sulphonated. Unreacted anthraquinone separates out on quenching.	Aluminium hydroxide to pharmaceutical industry	182 Kg of Al$(OH)_3$ per tonne of product is recovered by hydrolysis of Al $(OH)_3$ and filtration and effective washing of precipitated Al$(OH)_3$ This Al$(OH)_3$ sludge can be further purified by ion exchange and recrystallization, so that Al$(OH)_3$ can be sold to pharmaceutical industry.
		Anthraquin one- 1 sui phonic acid ammonium salt	Anthraquinone, HgO or Hg from amalgam	It can be filtered, washed and recycled for sulphonation. Process needs to be developed to recover HgO from the Kieselguhr sludge and it can be recycled.	SO_3/H2SO_4 to dye intermediates industry	A small amount of unreacted SO_3, liberated from oleum in acid preparation and sul phonation steps. It can be scrubbed by sulphuric acid in multiple scrubbers to recover concentrated sulphuric acid which can be sold to dyes, dye intermediates manufacturers.
				Purified sodium sulphate and Glauber salt can be dried to get anhydrous sodium sulphate and sold to dyes dye intermediates manufacturers. Sulphone generated by side reactions finds its way in tar. Possibility of recovering the same from tar and using it in dyes manufacture needs to be explored.		

3.4 Bulk Drugs and Intermediates

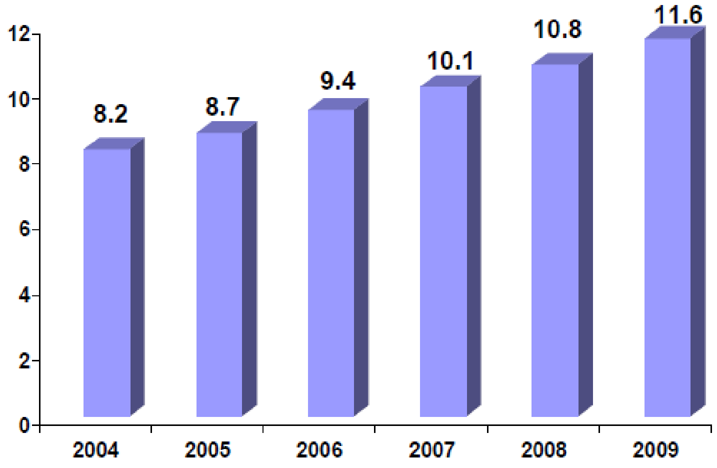
The Indian pharmaceutical sector has come a long way to become a prominent provider of healthcare products, meeting almost 95% of the country's pharmaceuticals needs. The industry today is in the front rank of India's science-based industries with wide ranging capabilities in the complex field of drug manufacture and technology. It ranks very high, third in the world, in terms of technology, quality and range of medicines manufactured. From simple headache pills to sophisticated antibiotics and complex cardiac compounds, almost every type of medicine is now made indigenously. Playing a key role in promoting and sustaining development in the vital field of medicine, Indian Pharma industry boasts of quality producers and many units approved by regulatory authorities.

Public sector undertaking [Public Sector Units (PSUs) like IDPL, HAL, *etc*], International companies associated with this sector have stimulated, assisted and spearheaded this dynamic development in the past 53 years and helped to put India on the pharmaceutical map of the world.

The Indian Pharmaceutical sector is highly fragmented with more than 20,000 registered units with severe price competition and government price control. It has expanded drastically in the last two decades. There are about 250 large units that control 70% of the market with market leader holding nearly 7% of the market share and about 8000 Small scale units together, which form the core of the pharmaceutical industry in India (including 5 Central PSUs). These units produce the complete range of pharmaceutical formulations, *i.e.*, medicines ready for consumption by patients and about greater than 500 bulk drugs and their intermediates, *i.e.*, chemicals having therapeutic value and used for production of pharmaceutical formulations. Following the de-licensing of the pharmaceutical industry, industrial licensing for most of the drugs and pharmaceutical products has been done away with. Manufacturers are free to produce any drug duly approved by the Drug Control Authority. Technologically strong and totally self-reliant, the pharmaceutical industry in India has low costs of production, low R&D costs, innovative scientific manpower, strength of national laboratories and an increasing balance of trade.

The total Indian production constitutes about 13% of the world market in value terms and, 8% in volume terms. The per capita consumption of drugs in India, stands at US$3, is amongst the lowest in the world, as compared to Japan US$412, Germany US$222 and USA US$191.

India’s US$ 9.4 billion pharmaceutical industry is growing at the rate of 14 % per year. It is one of the largest and most advanced among the developing countries. The Indian pharmaceutical industry reached a market size of US$ 11.6 billion by 2009.



Source: Epsicom

Figure 3-8: Market Size of Indian Pharmaceutical Industry

A beginning has been made with the signing of General Agreement on Tariffs and Trade in January 2005 with which India began recognising global patents. Soon after, the Indian pharmacy market became a sought after destination for foreign players. Foreign direct investment into the country’s pharmacy industry touched US$ 172 million during 2005-06 having grown at a CAGR of 62.6 % during the period beginning 2002-06. The sector recorded strong growth in the second quarter ended September 2006, driven by launch of new generic drugs with 180 days exclusivity period in the US market. The top ten pharmacy companies reported an impressive 57% growth in consolidated net profit at US$ 314.3 million, as against US$ 200.7 million in the same quarter of the previous year, while consolidated net sales were up 51% at US$ 1.7 billion. There are 74 U.S. FDA-approved manufacturing facilities in India, more than in any other country outside the U.S, and in 2005, almost 20 % of all Abbreviated New Drug Applications (ANDA) to the FDA were filed by Indian companies.

The focus of the Indian pharma companies are also shifting from process improvisation to drug discovery and R&D. The Indian companies are setting up their own R&D setups and are also collaborating with the research laboratories like CDRI, IICT, *etc*.

3.4.1 Manufacturing process of intermediates and bulk drugs

A large number of pharmaceuticals are manufactured by organic synthesis. This involves several steps like oxidation, reduction, nitration, sulphonation, halogenation, amination, aminolysis, Friedel Craft's acytilation, alkylation, esterification, crystalisation, hydrogenation, precipitation *etc.* Products produced by organic synthesis are like chloramphenicol, sulpha-drugs, quinolines, dexamethasone, antidiobatic, antihelmintic, antifilarial, antileprotic, anti-malarial, anti-T.B., anti-pyretic, analgesics, vitamins *etc.* A wide range of chemicals are used in different processes for production and purification of various drugs.

Overview of bulk drug manufacturing process

The pharmaceutical industry includes the manufacture, extraction, processing, purification and packing of chemical materials to be used as medicines for humans and also animals. Pharmaceutical manufacturing is divided into two major stages: the production of active ingredient or drug (primary processing or manufacturing) and secondary processing, the conversion of the active drugs into products suitable for administration.

3.4.2 Raw material inputs and pollutant outputs

Pharmaceutical batch processes use numerous raw materials and generate wastes and emissions. In general, the waste and emissions generated depend on raw materials and equipment used, as well as the manufacturing process employed. In designing bulk manufacturing processes, consideration is given to the availability of the starting materials and their toxicity, as well as the wastes (*e.g.*, mother liquors, filter residues, and other by-products) and the emissions generated.

When bulk manufacturing reactions are complete, the solvents are physically separated from the resulting product. Due to purity concerns, solvents often are not reused in a pharmaceutical process. They may be sold for non-pharmaceutical uses, used for fuel blending operations, recycled, or destroyed through incineration.

Table 3-19 describes the raw materials and associated waste streams and some of the more common technologies used to control these wastes.

Table 3-19: Raw Materials and Associated Waste Streams

Process	**Inputs (examples of some commonly used chemicals provided)**	**Air emissions**	**Wastewater**	**Residual wastes**
Chemical Synthesis *-Reaction*	Solvents, catalysts, reactants, *e.g.,* benzene, chloroform,methylene chloride, toluene, methanol, ethylene glycol,methyl isobuty1 ketone (MiBK),xylenes, hydrochloric acid, *etc.*	VOC emissions from reactor vents, man ways, material loading and unloading, acid gases (halogen acids, sulfur dioxide , nitrous oxides); fugitive emissions, from pumps, sample collections, valves, and tanks	Process wastewater with spent solvents, catalysts, reactants pump seal water, wet scrubber wastewater ;equipment cleaning wastewater; wastewater maybe high in BOD,COD TSS with pH of 1-11.	Reaction residues and reactor bottom wastes
-separation	Separation and extraction solvents, *e.g.,* methanol, toluene, hexanes *etc.*	VOC emissions from filtering systems which aren't contained; and fugitive emissions from valves, tanks and centrifuges	Equipment cleaning wash water, spills, leaks ,spent separation solvents	
-Purification	Purification solvents *e.g.* methanol, toluene, acetone, hexanes, *etc.*	Solvent vapours from purification tanks; fugitive emissions	Equipment cleaning wash waters, spills, leaks, spent purification solvents	
-Drying	Finished active drug(s) or intermediates	VOC emissions from manual loading and unloading of dryers	Equipment cleaning wash waters, spills, leaks	
Natural Product Extraction	Plants, roots, animal tissues, extraction solvents, *e.g.* ammonia, chloroform, phenol, toluene, *etc.*	Solvent vapours & VOC's from extraction chemicals	Equipment cleaning wash waters, spent solvents (ammonia); natural product extraction wastewater have low BOD, COD, TSS and pH of 6-8.	Spent raw materials (plants, roots *etc.*)
Fermentation	Inoculum, sugars, starches, nutrients, phosphates, fermentation solvents, *e.g.* ethanol, amyl alcohol, methanol. MiBK, acetone, *etc.*	Odoriferous gases, extraction solvent vapours, particulates	Spent fermentor broth, fermentation wastewater containing sugars, starches, nutrients, *etc.*; wastewater tends to have high BOD, COD, TSS and have pH of 4-8.	Waste filter cake, fermentation residues
Formulation	Active drug, binders (starches), sugar, syrups, *etc.*	Tablet dusts, other particulates	Equipment cleaning wash waters (spent solvents), spills, leaks; wash waters typically contain low levels of BOD, COD, TSS and have pH of 6-8.	Particulates, waste packaging, rejected tablets, capsules *etc.*

Source: Development Document for Proposed Effluent Limitations Guidelines and Standards for the Pharmaceutical Manufacturing Point Source Category, US EPA, Washington, DC., February 1995.

3.4.2.1 Wastewater

Pharmaceutical manufacturers use water for process operations, as well as for other non-process purposes. However, the use and discharge practices and the characteristics of the wastewater will vary depending on the operations conducted at the facility. Additionally, in some cases, water may be formed as part of a chemical reaction.

Process water includes all water that comes into direct contact with or results from the use of any raw material or production of an intermediate/finished product/byproduct/waste. Process wastewater includes water that was used or formed during the reaction, water used to clean process equipment and floors, and pump seal water. Non-process wastewater includes noncontact cooling water (*e.g.*, used in heat exchangers), noncontact ancillary water (*e.g.*, boiler blowdown, bottle washing), sanitary wastewater, and wastewater from other sources (*e.g.*, stormwater runoff).

Pharmaceutical manufacturers generate process wastewater containing a variety of conventional parameters (*e.g.*, BOD, TSS, and pH) and other chemical constituents. The top ten chemicals discharged by the pharmaceutical industry are given below. Of these compounds, two are “priority pollutants”. The top four compounds are oxygenated organic solvents (*e.g.*, methanol, ethanol, acetone, and isopropanol).

- Methanol
- Ethanol
- Acetone
- Isopropanol
- Acetic acid
- Methylene chloride
- Formic acid
- Ammonium hydroxide
- N1N-Dimethylacetamide
- Toluene

Most process wastewater receives necessary treatment, either in-plant at the process unit prior to combining with the wastewaters from the facilities with other facility wastewater or prior to discharge to a permitted outfall. Use of neutralization, equalization, activated sludge, primary clarification, multimedia filtration, steam stripping, secondary clarification, granular activated carbon, and oxidation have all increased, while the use of aerated lagoons, chlorination, waste stabilization ponds, and trickling filters have decreased slightly.

More than half of the surveyed facilities provide pH adjustment or neutralization to adjust the pH prior to discharge. Additionally, because wastewater treatment can be sensitive to spikes of high flow or high constituent concentration, many treatment systems include equalization. Advanced biological treatment is used to treat biochemical oxygen demand (BOD5), chemical oxygen demand (COD), total suspended solids (TSS), as well as various organic constituents. Biological systems can be divided into two basic types: aerobic (treatment takes place in the presence of oxygen) and anaerobic (treatment takes places in the absence of oxygen). Very few pharmaceutical facilities (only two) use anaerobic treatment. However, more than 30% use aerobic systems such as activated sludge, aerated lagoons, trickling filter, and rotating biological contactors (RBC).

Wastewater generation

Water consumption in pharmaceutical industry depends on process of manufacture, the nature of products, raw materials used and purification process of the final product. Data collected from various industries are compiled in an attempt to arrive at water uses pattern and generation of effluents from the industrial units.

Wastewater treatment system

Before selection of a particular treatment system for effluents of pharmaceutical industries the following aspects are required to be considered:

- Good housekeeping practices
- Segregation of certain wastewater streams
- Process and equipment modifications
- Recovery of by-products and recycle possibilities

Various combinations of unit processes are involved in effective treatment of pharmaceutical industry effluent. The schematic flow diagram, suitable for wastewater treatment of bulk drug manufacturing unit is presented in Figure 3-9

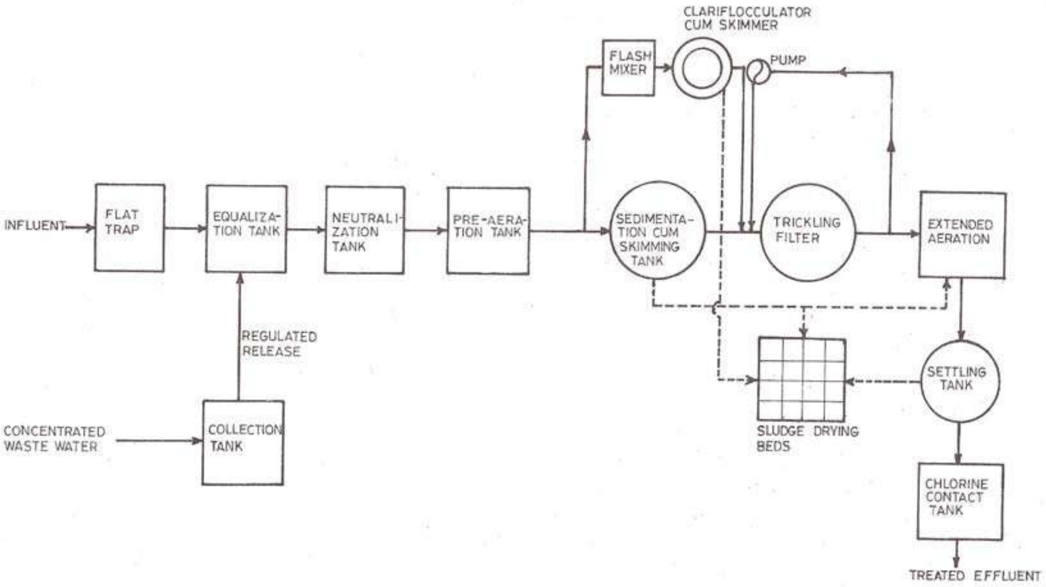


Figure 3-9: Schematic flow diagram for the treatment of effluent from bulk drug units

Conventional activated sludge

Conventional activated sludge is commonly practiced in pharmaceutical manufacturing industry. This requires lesser space compared to oxidation ditch or aerobic pond and easily operates with a high efficiency of BOD removal of more than 90%. The dynamic behaviour of the process is complicated by the presence of mixed population of microbes, varying physical and chemical characteristics of organic loads, fluctuation of influent flow and limiting substrate concentration. The presence of nickel in effluent has toxic effects on nitrifying bacteria in the activated sludge process. This system needs high rate of aeration and sludge recirculation.

Extended aeration

Extended aeration treatment system has all the advantages of conventional activated sludge as described earlier. In addition, it takes care of complete sludge stabilisation and remaining BOD in the sludge as well as in the wastewater. But the disadvantages are it can handle low organic load and unable to tackle shock loads of BOD fluctuations and toxic compounds. It requires an aeration time of 35 to 40 hours. But the system is very suitable for treating effluent from a pharmaceutical formulation unit and bulk drug manufacturing unit. Since this unit will be in the down stream of the trickling filter, major portion of the shock loads of pollutants will be absorbed in the trickling filter.

Tertiary treatment

Desired effluent quality is the basis for the selection of any treatment scheme. In most cases, pharmaceutical industry effluents are not suitable for land disposal for farming due to the presence of high concentration of dissolved salts. Tertiary treatments are required to kill virus and bacteria and to remove other impurities like colour, bad smell *etc.* Chlorination and sand filtration may generally be practiced for tertiary treatment.

3.4.2.2 Air emissions and control systems

Both gaseous organic and inorganic compounds, as well as particulates, may be emitted during pharmaceutical manufacturing and formulation. Some of the volatile organic compounds (VOC) and inorganic gases that are emitted are classified as hazardous air pollutants (HAPs) under the Clean Air Act.

The type and amount of emissions generated are dependent on the operations conducted by the facility, as well as how the product is manufactured or formulated. "Each (pharmaceutical) plant is unique, differing from other plants in size, types of products manufactured, amounts and types of VOC used, and air pollution control problems encountered".

As previously described, the industry manufactures most bulk pharmaceutical substances and intermediates in campaigns via batch processes. Following the completion of one campaign, another bulk substance or intermediate is typically made using the same equipment (*e.g.*, reactors, filters, dryers). The reactants and solvents used in manufacturing the next bulk substance or intermediate may vary greatly from the ones previously used. While some reactions may require the use of halogenated solvents, the next reaction may use another solvent or no solvent at all.

This wide variation in bulk manufacturing makes predicting typical or annual average emissions difficult. This is because the emission generated is predicated on what bulk substance or intermediate is manufactured and over what length of time, and which equipment and raw materials are used. Some bulk substances and intermediates are made frequently, while others may be made only once every two to three years over a one to two week period. This has often prevented the calculation of typical emission rates for each operation. However, an approximate ranking of emission sources has been established by EPA and is presented below in order of decreasing magnitude.

- Dryers
- Reactors
- Distillation units

- Storage and transfer of materials
- Filtration
- Extraction
- Centrifugation
- Crystallization

Dryers are one of the largest sources of VOC emissions in bulk manufacturing. In addition to the loss of solvent during drying, manual loading and unloading of dryers can release solvent vapours into ambient air, especially when tray dryers are used. VOCs are also generated from reaction and separation steps via reactor vents and man ways. Centrifuges may be a source of VOC emissions, especially in top loading types, where solids are manually scooped out.

Typical controls for these emission sources, excluding storage and transfer operations, include condensers, scrubbers, carbon absorbers and, on occasion incinerators. "Storage and transfer emissions can be controlled by vapour return lines, vent condensers, conservation vents, vent scrubbers, pressure tanks and carbon absorbers. Floating roofs may be feasible controls for large vertical storage tanks".

Air pollution control equipment

More than one type of air control equipment may be used at any one time in any one facility. The description of the various equipments used in the industry is provided below.

Condensers: Condensers are widely used in the pharmaceutical industry to recover solvents from process operations (a process condenser) and as air pollution control devices to remove VOCs from vented gases. Process condensers differ from condensers used as air pollution control devices as the primary purpose of a process condenser is to recover material as an integral part of a unit operation. The process condenser is the first condenser located after the process equipment and supports a vapour-to-liquid phase change for the vapours produced in the process equipment. Examples of process condensers include distillation condensers, reflux condensers, process condensers in line before the vacuum source, and process condensers used in stripping or flashing operations. The primary purpose of a condenser used as an air pollution control device is to remove VOCs prior to venting.

Condensation is the process of converting a gas or vapour to liquid. In this method, gas streams from vents containing VOCs are cooled to below their saturation temperatures, converting the gas into a VOC liquid. This removes some VOCs from the gas, but some remains. The amount of VOCs remaining in the gas depends on the temperature and vapour-liquid equilibrium of the VOC. Lowering the temperature of the condenser generally lowers the content of VOC in the gas stream.

In the most common type, surface condensers, the coolant does not directly contact condensable vapours, rather heat is transferred across a surface (usually a tube wall) separating vapour and coolant. In this way the coolant is not contaminated with condensed VOC and may be directly reused. The type of coolant used depends on the degree of cooling needed for a particular situation. Coolants in common use are water, chilled water, brine, and glycol.

Scrubbers: Scrubbers or gas absorbers are used to remove one or more constituents from a gas stream by treatment with a liquid. "Absorption is important in the pharmaceutical industry because many VOCs and other chemicals being used are soluble in water or aqueous solutions. Therefore, water, caustic or acidic scrubbers can be applied to a variety of air pollution problems".

When using a scrubber as an air pollution control device, the solubility of the constituents in the gas stream in the absorbing liquid must be determined. "The rate of transfer of the soluble constituents from the gas to the liquid phase is determined by diffusional processes occurring on each side of the gas liquid interface".

The main types of scrubbers used are packed tower, plate or tray tower, venturi scrubber, and spray tower. Each type of scrubber is designed to provide intimate contact between the scrubbing liquid and the gaseous constituents so that mass transfer between phases is promoted. The degree of control achieved is dependent on the residence time of the gas and liquids, the interfacial area, and the physical and thermodynamic properties of the VOC species involved.

Combustion or Incineration: Another method used for controlling VOC emissions is combustion or incineration. "In general, factors that influence the efficiency of combustion are: (1) temperature, (2) degree of mixing, (3) residence time in the combustion chamber, and (4) type of VOC combusted. Since more waste streams contain dilute VOC concentrations, they require that supplemental fuel maintain the necessary combustion temperatures". Although, combustion systems can achieve high removal efficiencies, these systems are typically more expensive to install, operate, and maintain, and have secondary emissions associated with their operation. Additionally, a scrubber may be required to control inorganic gases produced as by-products of combustion.

"Equipment used to control waste gases by combustion can be divided into three categories: direct combustion or flaring (not often used by the pharmaceutical industry), thermal oxidation, and catalytic oxidation. A direct combustor or flare is a device in which air and all the combustible waste gases react at the burner. In contrast, in thermal oxidation, the combustible waste gases pass over or around a burner flame into a residence chamber where oxidation of the waste gases is completed. Catalytic oxidation is very similar to thermal oxidation. The main difference is that after passing through the flame area, the gases pass over a catalyst bed which promotes oxidation at a lower temperature than that of thermal oxidation". Efficiency rates of catalytic oxidizers in destroying VOCs can reach close to 98%.

Adsorption: Adsorption is another method for removing VOCs from gas streams. This method filters out the volatiles by passing them through a packed column of activated carbon, silicates, aluminas, aluminosilicates, or any other surface which is porous and has a microcrystalline structure. As the gas stream passes through the column, the VOCs adsorb to the surface of the media. The adsorption material in the column eventually becomes saturated, and must be either regenerated or disposed. Most sorbents may be regenerated repeatedly by passing hot gas or steam through the bed. VOCs will desorb into the gas or steam. The high VOC concentration in the gas or steam can then be removed through condensation. Adsorption can be about 98% efficient in removing VOCs in the waste gas stream.

3.4.2.3 Solid waste

Both non-hazardous and hazardous wastes are generated during all three stages of pharmaceutical manufacturing. These wastes can include off-spec or obsolete raw materials or products, spent solvents, reaction residues, used filter media, still bottoms, used chemical reagents, dusts from filtration or air pollution control equipment, raw material packaging wastes, laboratory wastes, spills, as well as wastes generated during packaging of the formulated product.

Filter cakes and spent raw materials (plants, roots, animal tissues, *etc.*) from fermentation and natural product extraction are two of the largest sources of residual wastes in the pharmaceutical industry. Other wastes include reaction residues and filtrates from chemical synthesis processes. These wastes may be stripped of any solvents which remain in them, and then disposed as either hazardous or non-hazardous wastes. Typically, solid wastes are shipped off-site for disposal or incineration.

A number of practices are implemented by the industry to reduce waste generation and material losses as listed in Table 3-20. Typical practices include process optimization, production scheduling, materials tracking and inventory control, special material handling and storage procedures, preventive maintenance programs, and waste stream segregation.

Table 3-20: Current Practices and Requirements

Technologies/Current Practices	Requirements
▪ Wastewater treatment ▪ Collection of all the streams and providing collective treatment (end-of-pipe treatment) as follows: ▪ Collection tanks - For separation of carbon black (usually used for the colour removal of the final product). ▪ Oil & Grease trap - conventional separator ▪ Equalisation tank ▪ Neutralisation ▪ Primary clarification ▪ Biological treatment (mostly activated sludge process and lagoons) ▪ Secondary clarifier	▪ Wastewater treatment ▪ In-plant pollution control measures ▪ Process optimisation/modifications to avoid untreatable pollutants generation ▪ Segregation of effluent streams and characterisation for separate treatment as necessary is shown on next page. ▪ Salt recovery from high TDS (inorganic) containing streams through forced evapouration system. ▪ Efficient solvent recovery systems.
▪ Air Pollution Control Systems ▪ Scrubbers for point source emissions ▪ Cyclone to control emission ▪ Suitable stack height for appropriate dispersion	▪ Air Pollution Control Systems ▪ Properly designed chlorine storage facility with automatic control equipment ▪ Collection of fugitive emissions from the processing sections and loading/unloading sections through hoods & ducts and providing control equipment such as absorption/ adsorption systems ▪ Multi-cyclones or bag filters for control of emissions from boilers ▪ Continuous monitoring equipment/ sensors to be provided
▪ Solid/ hazardous waste management ▪ Empty drums are sold to third party for reuse. ▪ Process residues are stored in drums ▪ ETP primary sludge is sent sludge drying beds ▪ Oil & grease is collected & burnt in boilers	▪ Solid/hazardous waste management ▪ The process residues and other hazardous wastes generated in the industry should be stored/treated/ disposed as per the Hazardous Waste Management & Handling Rules , 1989 ▪ Proper incineration of organic residues, instead of burning in boiler, which leads to air pollution problem

Technologies/Current Practices	Requirements
	▪ Detoxification of empty drums/bags etc, before selling and to maintain good manifest system.

Solid wastes management

The present disposal practice mainly consists of hauling solid wastes to off-premises land disposal. Little attempt has been made to salvage solid wastes for reuse or making by-products. Reclamation possibilities include biological treatment of extracted botanical dregs to produce useful by-products and regeneration and reuse of filter materials. The reported solid waste recycling consists of selling mycelium and biological sludge as high protein animal or plant feed supplements. Toxic solid wastes from processes are to be incinerated. Radioactive wastes generated from research activities are to be sealed into special containers and disposed of in some designated area.

Strategy for hazardous waste management

The strategy for management of hazardous wastes generated from manufacturing of bulk drugs is shown in Figure 3-10.

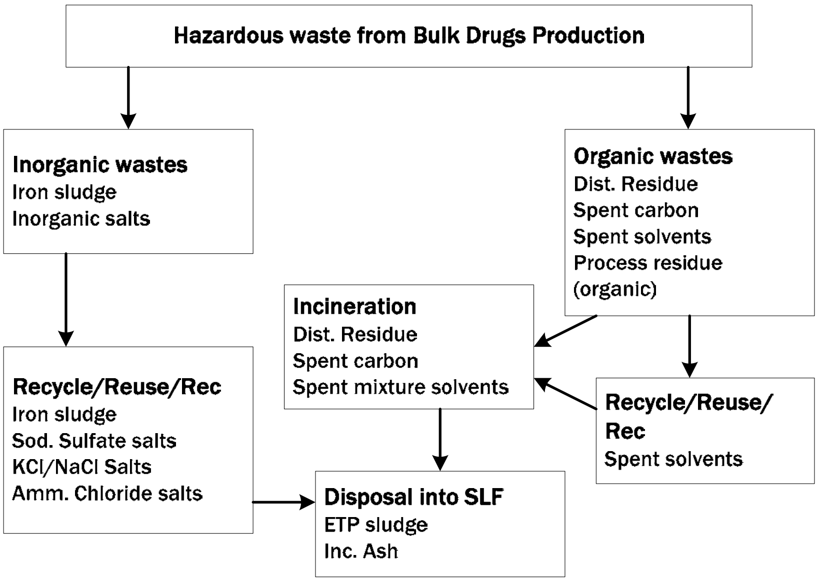


Figure 3-10: Strategy for Management of Hazardous Wastes

3.5 Fermentation

Most steroids, antibiotics, and certain food additives (such as vitamins) are commonly known pharmaceuticals which are produced by fermentation. In fermentation, microorganisms (*e.g.*, bacteria, yeast or fungi) are typically inoculated in a liquid broth supplemented with nutrients that are acclimated to an environment (*e.g.*, temperature, pH, oxygen), conducive to rapid growth). These microorganisms produce the desired product (*e.g.*, antibiotic, steroid, vitamin, *etc.*) as a by-product of normal metabolism. Fermentation involves three main steps: 1) inoculum and seed preparation, 2) fermentation, and 3) product recovery. Figure 3-11 shows a simplified diagram of a fermentation process and the wastes produced in this process.

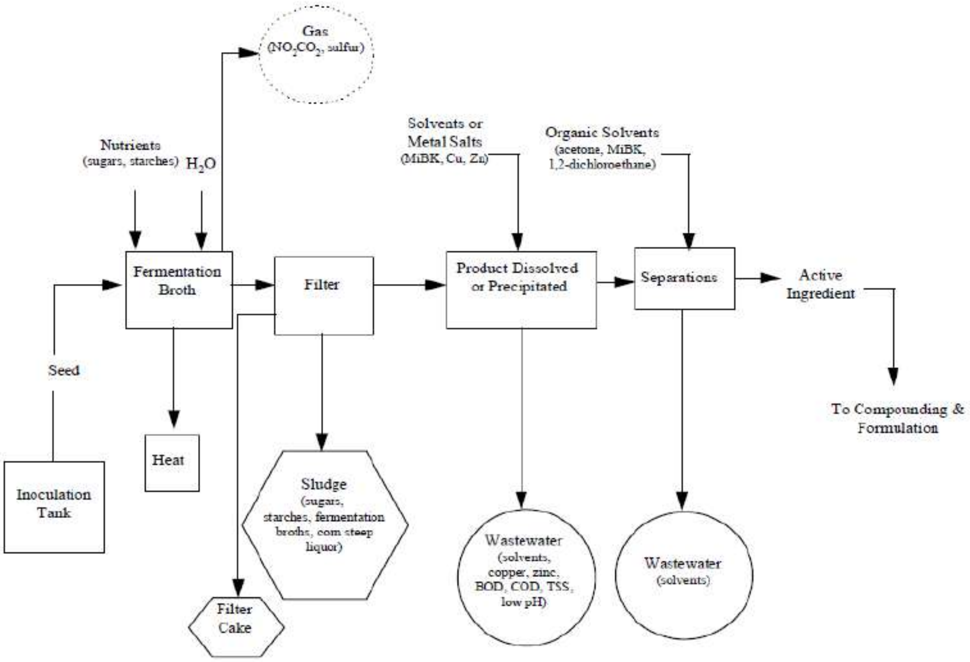


Figure 3-11: Simplified Process Flow Diagram for the Fermentation Process

Source: Adapted from Economic Impact and Regulatory Flexibility Analysis of Proposed Effluent Guidelines for the Pharmaceutical Manufacturing Industry, 1995.

3.5.1 Seed preparation

The fermentation process begins with the introduction of microbial strain to a primary seed fermentation, which is commonly performed using shaking-flask culture techniques at the laboratory scale. Once grown, the suspension is then transferred to further seed stages, which may be additional flask fermentations, stirred tanks or both. The purpose of this “seed-train” is to generate enough inoculum for the production fermentor (typically 1-10% of the production tank volume). Generally, special seed tanks are used for the fermentor inoculum which is miniature versions (1-10% of size) of the production fermentor. If a seed tank becomes contaminated, it is emptied, sterilized, and reinoculated.

3.5.2 Fermentation

Once the fermentor inoculum is ready, it is charged into a sterilized fermentor. During fermentation, the fermentor is usually agitated and aerated. The pH, temperature, and dissolved oxygen content of the fermentation broth may be monitored during fermentation. Fermentation may last from hours to weeks, depending on the process. A fermentor “broth” is produced, which is then filtered or centrifuged to separate out the solids.

3.5.3 Product recovery

Filtration removes any larger residues from the broth, but it does not isolate the active ingredient from the residues. This must be done by product recovery processes. Product recovery can be achieved through three different methods: solvent extraction, direct precipitation and ion exchange, or adsorption. Sometimes, the active material is contained within the cells of the microorganism. Cell wall breakage by heat or ultrasound, for example, may be required to recover the material.

In solvent extraction the active ingredient is removed from the aqueous broth by contacting it with an organic solvent, in which the product is more soluble than it is in water. Removal of the active agent from the solvent can be achieved by crystallization.

The direct precipitation method of product recovery involves precipitation of the active ingredient, as a metal salt from the broth using, for example, copper (Cu) and/or zinc (Zn) as precipitating agents. The actual choice of the precipitating agent depends on the properties of the desired active ingredient. The broth is then filtered and the product is recovered from the solid residues.

Additionally, ion exchange or adsorption may be used for product recovery. Ion exchange resin (or alternatively, activated carbon) is contacted with the broth and the product adsorbs onto the resin. The product is recovered from the resin by using a solvent or by washing the resin with an acidic or basic solution. It is then crystallized.

3.6 Synthetic rubbers

India occupies fourth position in respect of consumption of natural and synthetic rubber. Although, rubber product manufacture started in India, in the year 1920, the industry has been mostly inward oriented, catering to the needs of the vast domestic market. But in the recent past the country has been transforming itself into a major rubber product exporter.

The following are the specific points regarding the Indian rubber industry:

- The rubber products manufacturing industry in India had been mostly inward oriented, catering to the domestic market.
- In recent years India has entered the global market, exporting both raw natural rubber as well as rubber products.
- With its large population base, India is emerging as a large market for rubber products and with the opening up of the economy, import of rubber products has also been increasing in recent years.
- The rubber product mix in India is based mostly on dry forms of rubber, dictated by the requirements of the domestic market.
- The natural rubber/synthetic rubber consumption ratio in the country is presently 75:25.
- While the Indian tyre companies have been performing well, multinational tyre manufacturers are establishing production facilities in India.
- Manufacture of non-tyre products particularly high-value technical goods needs further investments

3.6.1 Manufacturing Process of synthetic rubbers

Rubber product manufacturing is as diverse as the number of rubber products produced. Even with this diversity, there are several basic, common processes. This profile focuses on the basic processes of mixing, milling, extruding, calendering, building, vulcanizing, and finishing, as shown in Figure 3-12.

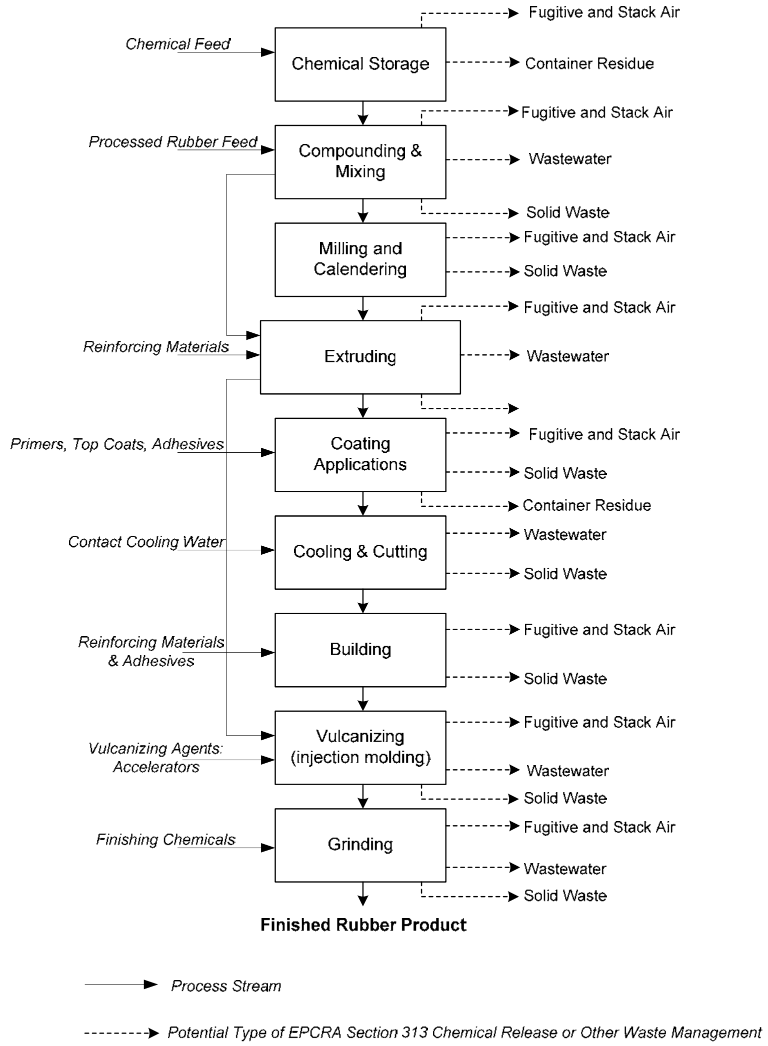


Figure 3-12: Manufacturing Process of Synthetic Rubbers

Source: Emergency Planning and Community Right-To-Know Act (EPCRA) Section 313 Reporting Guidance for Rubber and Plastics Manufacturing, May 2000.

Mixing

The rubber product manufacturing process begins with the production of a rubber mix from polymers (*i.e.*, raw and/or synthetic rubber), carbon black (the primary filler used in making a rubber mixture), oils, and miscellaneous chemicals. The miscellaneous chemicals include processing aids, vulcanizing agents, activators, accelerators, age resistors, fillers, softeners, and specialty materials. The following is a list of these miscellaneous chemicals and the functions they perform:

- Processing Aids modify the rubber during the mixing or processing steps, or aid in a specific manner during the extrusion, calendering, or molding operations.
- Vulcanizing Agents create cross links between polymer chains.

- Activators, in combination with vulcanizing agents, reduce the curing time by increasing the rate of vulcanization.
- Accelerators form chemical complexes with activators and thus aid in maximizing the benefits from the acceleration system by increasing vulcanization rates and improving the final product's properties.
- Age resistors slow down the deterioration of the rubber products that occurs through reactions with materials that may cause rubber failure (*e.g.*, oxygen, ozone, light, heat, radiation).
- Fillers reinforce or modify the physical properties of the rubber, impart certain processing properties, and reduce costs by decreasing the quantity of more expensive materials needed for the rubber matrix.
- Softeners aid in mixing, promote greater elasticity, produce tack, or extend (replace) a portion of the rubber hydrocarbon (without a loss in physical properties).
- Specialty materials include retarders, colorants, blowing agents, dusting agents, odorants, *etc.* Specialty materials are used for specific purposes, and are not required in the majority of rubber compounds.
- Rubber mixes differ depending upon the desired characteristics of the product being manufactured. The process of rubber mixing includes the following steps - mixing, milling (or other means of sheeting), anti-tack coating, and cooling. The appropriate ingredients are weighed and loaded into an internal mixer known as a Banbury mixer, which then combines these ingredients. The area where the chemicals are weighed and added to the Banbury is called the compounding area. The polymers and miscellaneous chemicals are manually introduced into the mixer hopper, while carbon black and oils are often injected directly into the mixing chamber from bulk storage systems. The mixer creates a homogeneous mass of rubber using two rotors that shear materials against the walls of the machine's body. The rubber is then cooled as this mechanical action also adds considerable heat to the rubber.

Milling

The mixed rubber mass is discharged to a mill or other piece of equipment that forms it into a long strip or sheet. The hot, tacky rubber then passes through a water-based "antitack" solution that prevents the rubber sheets from sticking together as they cool to ambient temperature. The rubber sheets are placed directly onto a long conveyor belt that, through the application of cool air or cool water, lowers the temperature of the rubber sheets.

After cooling, the sheets of rubber are sent through another mill. These mills "warm up" the rubber for further processing on extruders and calenders. Some extruders can be "cold fed" rubber sheets, making this milling step unnecessary.

Extruding

Extruders transform the rubber into various shapes or profiles by forcing it through dies via a rotating screw. Extruding heats the rubber, which remains hot until it enters water bath or spray conveyor where it cools.

Calendering

Calenders receive hot strips of rubber from mills and squeeze them into reinforcing fibers or cloth-like fiber matrices, thus forming thin sheets of rubber-coated materials. Calenders are also used to produce nonreinforced, thickness-controlled sheets of rubber.

Building

Extruded and calendered rubber components are combined (layered, built-up) with wire, polyester, aramid, and other reinforcing materials to produce various rubber products. Adhesives, called cements, are sometimes used to enhance the bonding of the various product layers. This assembling, reinforcing, precuring, and bonding process is called building.

Vulcanizing

All rubber products undergo vulcanization (curing). This process occurs in heated compression molds, steam-heated pressure vessels (autoclaves), hot air and microwave ovens, or various molten and fluidized bed units. During the curing process, the polymer chains in the rubber matrix cross-link to form a final product of durable, elastic, thermoset rubber. Increasing the number of cross-links in the rubber matrix gives rubber its elastic quality. One way to visualise this is to think of a bundle of wiggling snakes in constant motion. If the bundle is pulled at both ends and the snakes are not entangled, then the bundle comes apart. The more entangled the snakes are (like the rubber matrix after vulcanization), the greater the tendency for the bundle to bounce back to its original shape.

Finishing: Finishing operations are used to prepare the products for delivery to the end user. Finishing operations might include balancing, grinding, printing, washing, wiping, and buffing.

3.6.2 Emulsion styrene-butadiene (SBR) copolymers production

Two types of polymerization reactions are used to produce styrene-butadiene copolymers, the emulsion type and the solution type. VOC emissions will be there from the manufacture of copolymers of styrene and butadiene made by emulsion polymerization processes. The emulsion products can be sold in either a granular solid form, known as crumb, or in a liquid form, known as latex. Copolymers of styrene and butadiene can be made with properties ranging from those of a rubbery material to those of a very resilient plastic. Copolymers containing less than 45 weight percent styrene are known as SBR. As the styrene content is increased over 45 weight percent, the product becomes increasingly more plastic.

Emulsion crumb process

As shown in Figure3-13, fresh styrene and butadiene are piped separately to the manufacturing plant from the storage area. Polymerization of styrene and butadiene proceeds continuously through a train of reactors, with a residence time in each reactor of approximately l hour. The reaction product formed in the emulsion phase of the reaction mixture is a milky white emulsion called latex. The overall polymerization reaction ordinarily is not carried out beyond a 60% conversion of monomers to polymer, because the reaction rate falls off considerably beyond this point and product quality begins to deteriorate. Because recovery of the unreacted monomers and their subsequent purification are essential to economical operation, unreacted butadiene and styrene from the emulsion crumb polymerization process normally are recovered. The latex emulsion is introduced to flash tanks where, using vacuum flashing, the unreacted butadiene is removed. The butadiene is compressed, condensed, and then pumped back to the tank from storage area for subsequent reuse. The condenser tail gases and noncondensables pass through a butadiene adsorber/desorber unit, where more butadiene is recovered.

Some non-condensables and VOC vapours pass to the atmosphere or, at some plants, to a flare system. The latex stream from the butadiene recovery area is then sent to the styrene recovery process, usually taking place in perforated plate steam stripping columns. From the styrene stripper, the latex is stored in blend tanks. From this point in the manufacturing process, latex is processed continuously. The latex is pumped from the blend tanks to coagulation vessels, where dilute sulfuric acid (H_2SO_4 of pH 4 to 4.5) and sodium chloride solution are added. The acid and brine mixture causes the emulsion to break, releasing the styrene-butadiene copolymer as crumb product. The coagulation vessels are open to the atmosphere.

Leaving the coagulation process, the crumb and brine acid slurry is separated by screens into solid and liquid. The crumb product is processed in rotary presses that squeeze out most of the entrained water. The liquid (brine/acid) from the screening area and the rotary presses is cycled to the coagulation area for reuse.

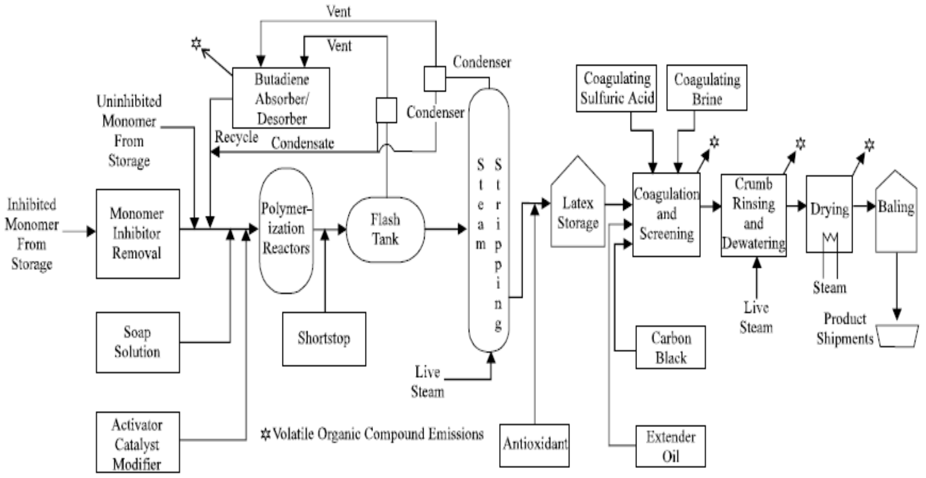


Figure 3-13: Typical process for crumb production by emulsion polymerization

Emulsion latex process

Emulsion polymerization can also be used to produce latex products. These latex products have a wider range of properties and use than do the crumb products, but the plants are usually much smaller. Latex production, shown in Figure 3-14, follows the same basic processing steps as emulsion crumb polymerization, with the exception of final product processing. As in emulsion crumb polymerization, the monomers are piped to the processing plant from the storage area. The polymerization reaction is taken to near completion (98 to 99 percent conversion), and the recovery of unreacted monomers is therefore uneconomical. Process economy is directed towards maximum conversion of the monomers in one process trip. Because most emulsion latex polymerization is done in a batch process, the number of reactors used for latex production is usually smaller than for crumb production. The latex is sent to a blowdown tank where, under vacuum, any unreacted butadiene and some unreacted styrene are removed from the latex. If the unreacted styrene content of the latex has not been reduced sufficiently to meet product specifications in the blowdown step, the latex is introduced to a series of steam stripping steps to reduce the content further. Any steam and styrene vapour from these stripping steps is taken overhead and is sent to a water-cooled condenser. Any uncondensables leaving the condenser are vented to the atmosphere.

After discharge from the blowdown tank or the styrene stripper, the latex is stored in process tanks. Stripped latex is passed through a series of screen filters to remove unwanted solids and is stored in blending tanks, where antioxidants are added and mixed. Finally, latex is pumped from the blending tanks to be packaged into drums or to be bulk loaded into railcars or tank trucks.

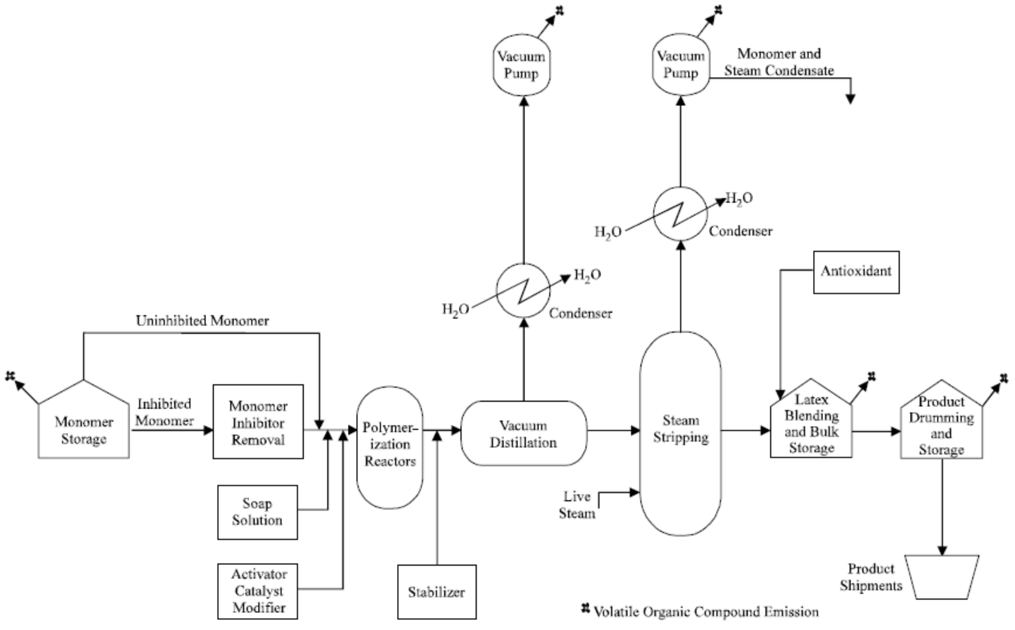


Figure 3-14: Typical process for latex production by emulsion polymerization

3.6.3 Raw material inputs and pollution outputs in the production line

In rubber products industry, the primary environmental concerns are fugitive emissions, solid wastes, wastewater, and hazardous wastes, as shown in Figure 3-15. Each of these is discussed below.

Wastewater

Wastewater from cooling, heating, vulcanizing, and cleaning operations is an environmental concern at many facilities. Contaminants can be added to wastewater in direct contact cooling applications such as extruder cooling conveyors and from direct contact steam used in vulcanizing operations. The residual in adhesive-dispensing containers and contaminated adhesives can also be sources of contaminated wastewater.

Zinc is of particular concern as a constituent of stormwater for the facilities involved in manufacturing and processing rubber products. Inadequate housekeeping is considered to be the primary source of zinc. Inefficient, overloaded, or malfunctioning dust collectors and baghouses are another source of zinc.

Solid waste

Solid wastes are also an issue at rubber products manufacturing facilities. Surface grinding activities that generate dust and rubber particles are typically controlled by a primary cyclone and a secondary baghouse or electrostatic precipitator. This baghouse-captured PM (*e.g.*, chemicals, ground rubber) from compounding areas, Banburys, and grinders is a source of solid waste. Used lubricating, hydraulic, and process oils are also prevalent at most manufacturing facilities.

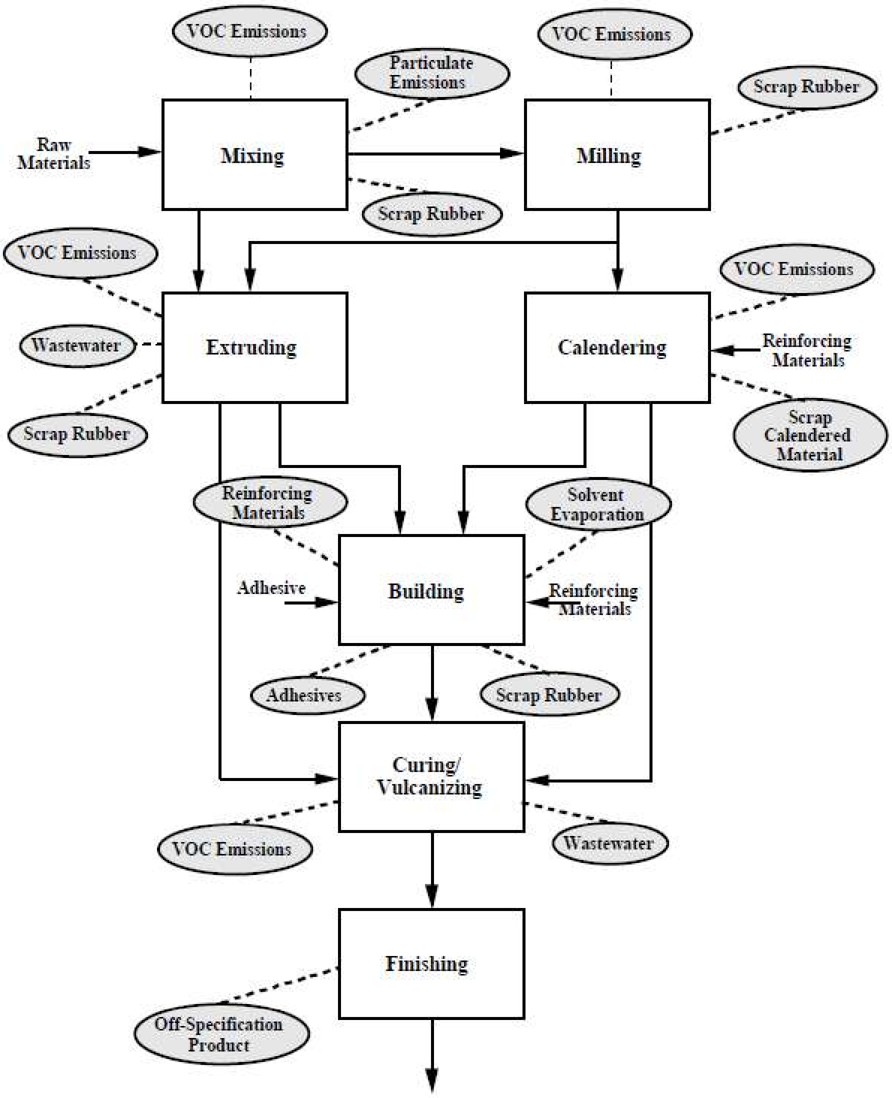


Figure 3-15: Rubber Products Manufacturing Process Pollution Outputs

Scorched rubber from mixing, milling, calendering, and extruding is a major solid waste source within rubber products manufacturing facilities, as is waste rubber produced during rubber molding operations. A rubber is scorched when chemical reactions begin to take place in the rubber as it is being heated. A scorched rubber is no longer processable. Waste rubber can be classified into three categories: (1) uncured rubber waste; (2) cured rubber waste; and (3) off-specification products. Currently, much of the uncured rubber waste is recycled at the facility. Cured rubber waste is either recycled at the facility or sold to other companies that use it to make products such as mud flaps and playground mats. Off-specification products can be sold to other companies that make products from shredded or scrap rubber or it can be disposed of. Much of the off-spec, uncured rubber is sold, reprocessed, or recycled.

3.6.4 Pollution prevention opportunities

The best way to reduce pollution is to prevent it in the first place. This can be done in many ways such as reducing material inputs, reengineering processes to reuse by-products, improving management practices, and using substitutes for toxic chemicals. Some smaller facilities are able to get below regulatory thresholds just by reducing pollutant releases through aggressive pollution prevention policies.

Pollution outputs from the rubber products industry occur at many stages of the manufacturing process. Most facilities are reducing these outputs by using the many reasonable and effective pollution prevention options that exist.

Chemicals

The compounding and mixing area of a rubber products manufacturing facility, where dry chemicals are weighed, put into small containers, and loaded into the rubber mixer, is generally a minor source of particulate emissions. Some mixing facilities have practically eliminated particulate emissions by purchasing their chemicals in small preweighed, sealed polyethylene bags. The sealed bags are put directly into the Banbury mixer and the bag itself becomes part of the rubber matrix, thus eliminating this formerly dusty operation. For facilities not purchasing their chemicals in preweighed bags, a variety of other pollution prevention options exist. The following pollution prevention methods have been used by various facilities:

- Careful Transportation Mechanisms - Receiving chemicals in closed docks in sealed containers or in bulk rail or truck shipments with a minimal history of spills. Storing chemical piles inside the facility to ensure that any fugitive emissions can be contained within the facility.
- Sealed Containers - Providing sealed containers for all open materials. Sealed containers should have air space between the chemical and the container cover to minimise "puffing" losses when the container is opened. Similarly, placing secondary containment mechanisms around all storage containers provides further protection from spills and leaks.
- Automatic Dispensing - Utilizing automatic dispensing and weighing equipment whenever possible. Automatic dispensing minimises waste due to spills from manual dispensing and provides quality control.
- Reduced Toxic Chemical Usage - Reducing the use of toxic chemicals via reformulation. Rubber manufacturers continually research opportunities for pollution prevention through product reformulation.
- However, rubber manufacturers must adhere to stringent product performance requirements. Therefore, pollution prevention opportunities must be balanced with product specifications.
- Computer Inventories - Providing computer inventory control methods to minimise the amount of stock purchased.
- Spills and Sweeping Protocols - Providing protocols for cleaning up spills and sweeping to ensure the proper segregation of waste.

Spent solvents

Spent solvents known to contribute to ozone depletion is not a problem in rubber products manufacturing facilities. A major initiative by the rubber products industry to eliminate ozone-depleting chemicals in 1994 and early 1995 resulted in many innovative spent solvent pollution prevention activities. Among the accomplishments were replacing solvent cleaning applications with high pressure water systems, using caustic cleaning solutions, and substituting old solvents with cleaner, citrus-based solvents. Many mold release compounds, coatings, and adhesives that formerly used ozone-depleting chemicals as carriers were reformulated to eliminate the offending chemicals. In some cases, process changes directly eliminated the chemicals of concern. Most rubber products are now free from having been manufactured with ozone-depleting chemicals.

Disposal

A significant issue in the rubber products industry is the disposal of waste rubber. To prevent the improper disposal of scrap rubber, facilities can segregate and recycle rubber wastes. Properly segregating waste streams may be as simple as placing a screen over part of the molding equipment, so that waste rubber stock produced during preforming operations can be segregated from the oily wastewaters and recycled back into the process. Other segregation processes may include separating cured from uncured rubber, and recycling the uncured portion back into the process.

Reclaiming and recycling cured, off-specification rubber is also a waste minimisation option. Reprocessing rubber involves taking used rubber products and processing them in a manner such that they can be incorporated into virgin rubber compounds.

Scrap rubber that cannot be recycled within the manufacturing process is being used in the following manner:

- Adding it to coal and wood waste fuels for firing process boilers;
- Making it into sheets and various shapes to use as athletic area surfaces and other floor coverings;
- Making it into sheet gasket material; and
- Making it into loading dock bumpers.

An important factor that limits recycling post-consumer and post-production scrap into products is the increased performance requirements of the materials. Automobile components are continuously being designed for greater endurance (*e.g.*, automobiles capable of 150,000 miles without maintenance or a tune-up). Such performance standards require manufacturers to use high-purity chemicals and quality, precision manufacturing processes. These rubber products, whether they are tires, belts, hoses, motor mounts, gaskets, or seals, turn out to be highly engineered entities with strict quality standards. Introducing used, off-specification, or unknown quality ingredients into the dynamically stressed, high-performance rubber product can be a problem. As a result, recycling of the post-consumer and postproduction waste applies to materials used in less demanding applications.

3.7 Summary of Applicable National Regulations

3.7.1 General description of major statutes

A compilation of legal instruments which are applicable to the synthetic organic chemicals industry is annexed as **Annexure II**.

3.7.2 General standards for discharge of environmental pollutants

General standards are applicable wherever industry-specific standards are not mentioned or notified. General standards for discharge of environmental pollutants as per CPCB are given in **Annexure III**.

3.7.3 Industry-specific requirements

Table 3-21: Environmental Standards for Organic Chemicals Industries

	Parameter	**Concentration not to exceed mg/l Except pH**
Compulsory	▪ pH	▪ 6.5-8.5
	▪ BOD (3 days at 27°C	▪ 100
	▪ COD	▪ No limits
	▪ Oil and grease	▪ 10
	▪ Bioassay Test	▪ Minimum 90% survival after 96 hours with fish at 10% effleunts
Additional	▪ Nitrate (as N)	▪ 10
	▪ Arsenic	▪ 0.2
	▪ Chromium	▪
	▪ - Hexavalent	▪ 0.1
	▪ -Total	▪ 1.0
	▪ Lead	▪ 0.1
	▪ Cyanide as CN	▪ 0.1
	▪ Zinc	▪ 5.0
	▪ Mercury	▪ 0.01
	▪ Copper	▪ 2.0
	▪ Nickel	▪ 2.0
	▪ Phenolics as C_6H_5OH	▪ 5.0
	▪ Sulphide	▪ 2.0

Note:

1. Industry covered under this group are: Haloalphatics, Plasticizers, Aromatics (Alcohols, Phenols, Esters, Acids and Salts, Aldehydes and Ketones), Substituted Aromatics, Aliphatics (Alcohols, Esters, Acids,Aldehydes,Ketones,Amines and Amide and Detergents but not applicable to formulating units of detergents)

2. No limit for COD is prescribed but it should be monitored. If the COD in a treated effluent is persistently greater than 250 mg/l, such industrial units are required to identify chemicals causing the same. In case these are found to toxic as defined in Hazardous Chemicals Rules, 1989 in Part-I of Schedule-I, the State Boards in such cases shall direct the industries to install tertiary treatment *system stipulating time limit. Otherwise, COD may be stipulated. This may be done on case-to-case basis*

Source: EPA Notification

3.7.4 Proposed Standards

3.7.4.1 CREP action points for Dyes and Dye Intermediates

Wastewater

- Industry Associations will conduct feasibility study for adoptions of cleaner technologies for H-Acid manufacture (Catalytic hydrogenation and others) within one year.
- Industries will submit a proposal for recovery and purification.
- Dye intermediate industries will install salt recovery systems in case of sodium sulphate from dyestuff and reuse recovered salt in the process.
- An action plan for installation /up gradation of incineration systems as per CPCB guidelines to handle concentrated wastewater and reuse of treated weak wastewater will be submitted within six months.
- Industry Associations will encourage waste exchange for proper use of weak acids.
- Wherever possible waste generated from one industry will be utilized by others (e.g use of effluent generated from Vinly Sulphone plant in H- Acid plant).
- Industries will regularly monitor ground water quality. This will be initiated immediately.
- H-Acid industries will examine the feasibility to increases product yield form 1.09 to 1.86 for reducting iron sludge, within six months.
- In case of dyestuff, wherever possible, industries will use spray drying instead of salting to minimise load on Effluent Treatment Plants.
- Industries will submit proposal on adoption of waste minimisation practices.
- Existing standards will be reviewed in consultation with industries.

Air Pollution Management

- Industries will minimise loss of volatile organics (solvent recovery of lead either individually or collectively.
- Scrubbing systems for SOx and NOx emission will be upgraded.

Solid Management

- Proper on site storage facilities and final disposal of solid waste on secured landfill will be ensured immediately.

Better Management Practices

- Improvement of house keeping such as concreting of floors, sealing of breaches/leakages in the system, replacement of corrosive pipelines, *etc.* to prevent spillages, leakages, fugitive emissions.

3.7.4.2 CREP action points for Pharmaceuticals

Wastewater

- Segregation of waste streams: Waste streams should be segregated into high COD waste toxic waste, low COD waste, inorganic waste etc, for the purpose of providing appropriate treatment.
- Detoxification and treatment of high COD waste streams: High COD streams should be detoxified and treated in XTP or thermally destroyed in incinerator.
- Management of solid waste: Proper facilities should be provided for handing and storage of hazardous waste. For final disposal of hazardous waste, recycling and reuse should be given priority, either within the premises or outside with proper manifest system. In case of incinerable waste, property designed incinerator should be installed within the premises or outside as a common facility. The non-incinerable hazardous waste should be disposed of in properly designed secure landfill either within the industry's premises or in a common facility.
- Minimum scale of production to afford cost of pollution control: For new industries which are not connected with CETP & TSDF and which do not have the economics to install treatment facilities may not be considered for granting consent to establishment. Industry association shall submit proposal to SPCB/CPCB.
- Long term strategies for reduction in waste: Consent for establishment and consent for operation under the Water Act will be based on pollution load and concentration of pollutants. Each industry will submit pollution load, concentration of final discharge along with water balance to SPCB/CPCB for formulation of strategy.
- Control of air pollution: Industry will take up in priority the control of hazardous air pollutants (such as benzene carbon tetrachloride 1-4 diocane, methanol, toluene, methyl chloride *etc*) and odorous compounds (mercaptan & hydrogen sulphide).
- Self – regulation by Industry through regular monitoring and environmental auditing: Industries on their will carry out monitoring environmental parameters, audit it at regular interval and submit the same to SPCB.
- Organizational restructuring and accreditation of Environmental Manager of Industry:
  - Environment management cell will be created for each industry reporting to CEO directly.
  - There should be a certification system for the environmental managers at individual level and common facility level.
- Optimizing the inventory of hazardous chemicals: The Information shall be submitted to SPCB regularly along with rational action plan to be submitted to SPCB.

4.
OPERATIONAL ASPECTS OF EIA

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

Consistency with other requirements

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

4.1 Coverage of the Synthetic Organic Chemicals Industry under the Purview of Notification

All the new synthetic organic chemicals industrial projects (dyes & dye intermediates; bulk drugs and intermediates excluding drug formulations; synthetic rubbers, basic organic chemicals, other synthetic chemicals and chemical intermediates) including expansion and modernization require prior environmental clearance. Based on pollution potential, these projects are classified into Category A and Category B *i.e.*

- Category A: all the projects located outside the notified industrial area/estate
- Category B: all the projects located in the notified industrial area/estate.

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

The sequence of steps in the process of prior environmental clearance for Category A projects and the Category B projects are shown in Figure 4.1 and Figure 4.2 respectively. The timelines indicated against each stage are the maximum permissible time lines set in the Notification for said task. In case the said task is not cleared/objected by the concerned Authority, within the specified time, said task is deemed to be cleared, in accordance to the proposal submitted by the proponent. Each stage in the process of prior environmental clearance for the synthetic organic chemicals industry is discussed in subsequent sections.

In case of Expansion or Modernization of the developmental Activity:

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

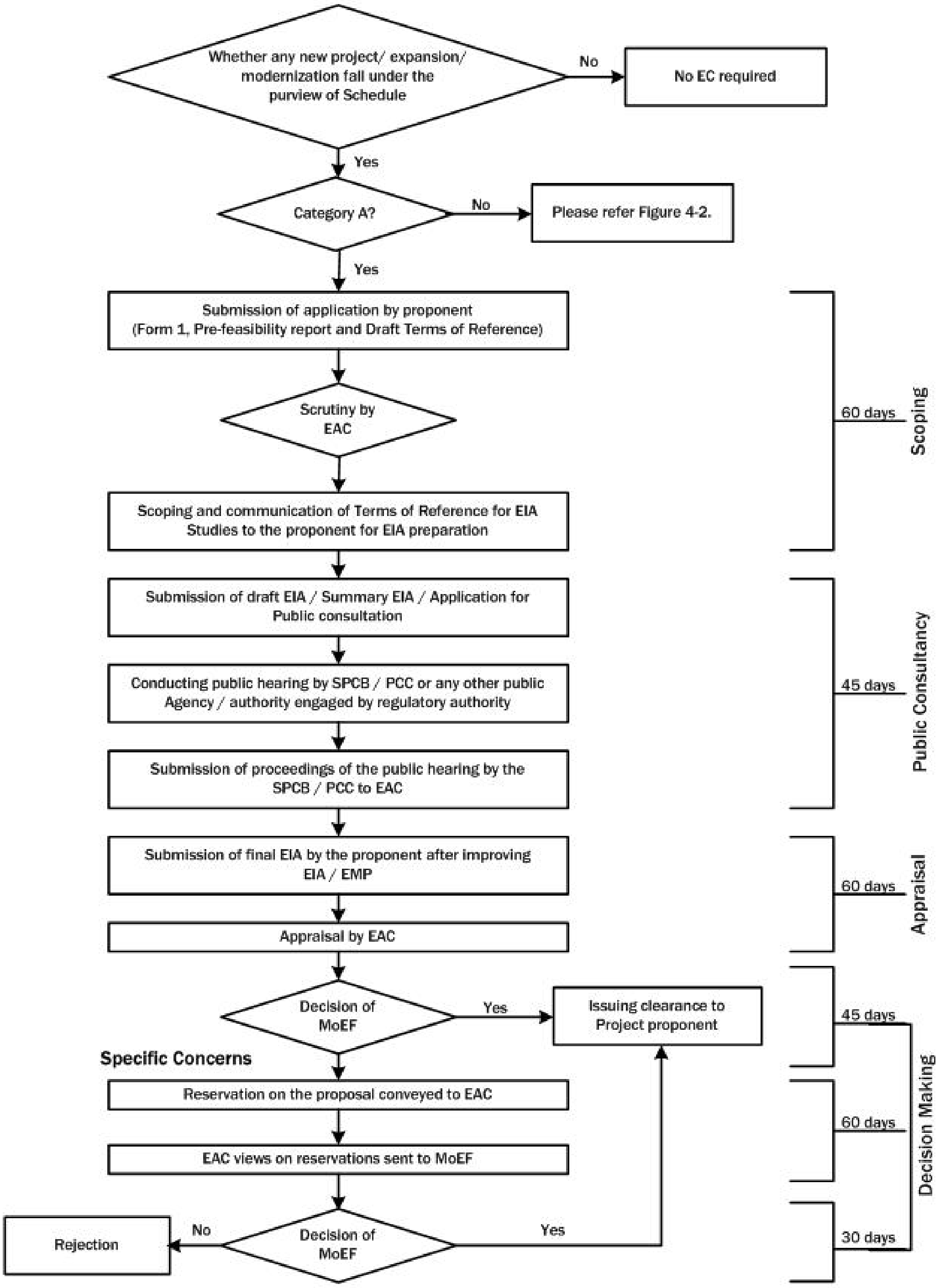


Figure 4-1: Prior Environmental Clearance Process for Activities Falling Under Category A

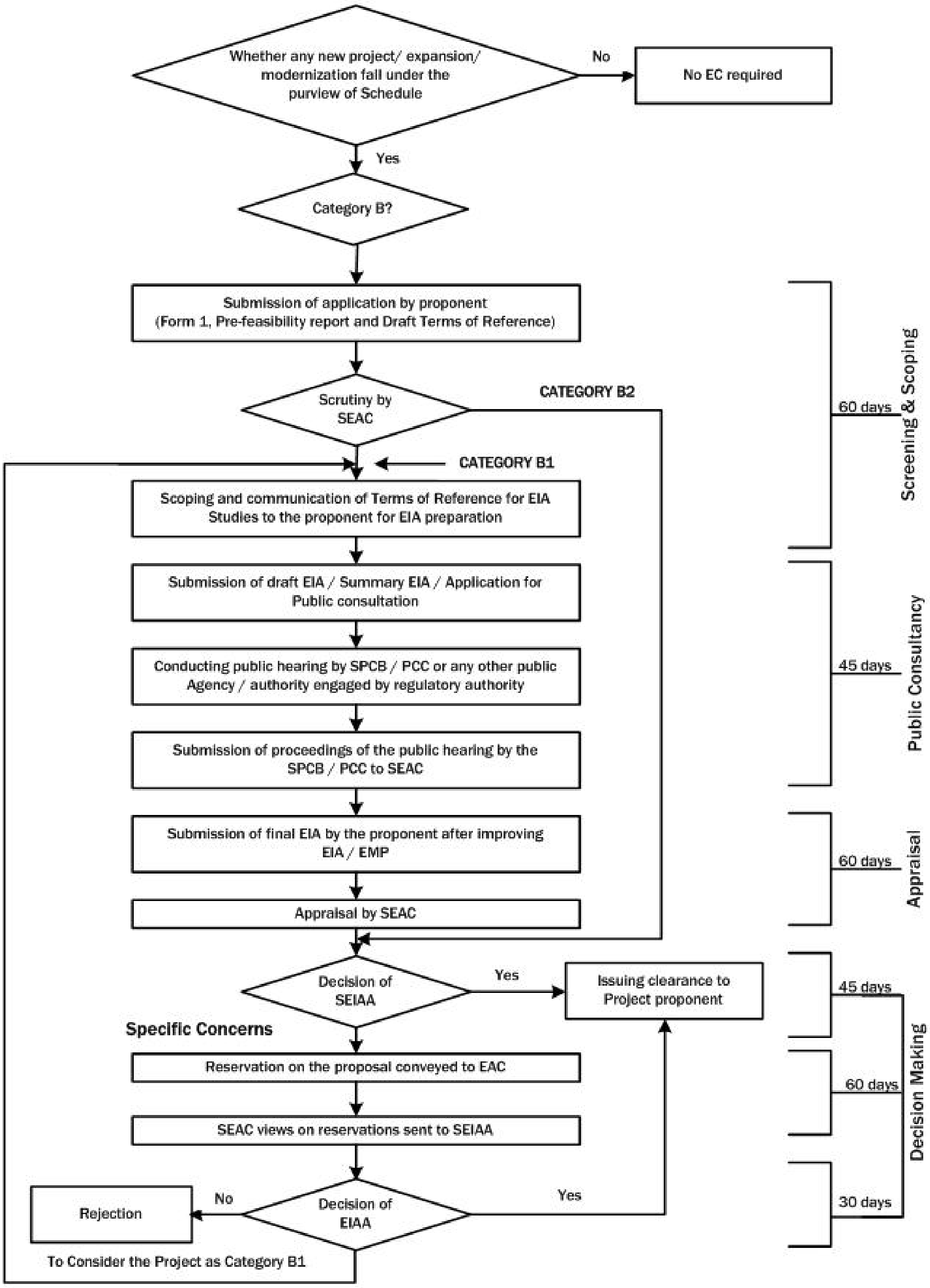


Figure 4-2: Prior Environmental Clearance Process for Activities Falling Under Category B

4.2 Screening

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

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

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

4.2.1 Applicable conditions for Category B projects

Generic condition:

- Any synthetic organic chemicals project, located in a notified industrial area/estate (usually falling under Category B) will be treated as Category A, if located in whole or in part within 10 km from the boundary of:
  - Protected areas notified under the Wild Life (Protection) Act, 1972
  - Critically polluted areas as notified by the CPCB from time to time
  - Eco-sensitive areas as notified under Section 3 of the E(P) Act, 1986, such as Mahabaleshwar Panchgani, Matheran, Panchmarhi, Dahanu, Doon valley and
  - Inter-State boundaries and international boundaries. - provided that the requirement regarding distance of 10 km of the inter-state boundaries can be reduced or completely done away with by an agreement between the respective States/UTs sharing the common boundary in case the activity does not fall within 10 km of the areas mentioned above
- If any of the conditions listed in above general condition applies, then a Category B project will be treated as Category A
- The SEIAA shall base its decision on the recommendations of a State/UT level EAC for the purpose of prior environmental clearance.
- In absence of a duly constituted SEIAA or SEAC, a Category B project shall be appraised at the Central level *i.e* at the MoEF
- The EAC at the State/UT level shall screen the projects or activities in Category B. SEAC shall meet at least once every month
- If any Category B synthetic organic chemicals project/activity, after proposed expansion of capacity/production or fuel change, falls under the purview of Category A in terms of production capacity, then clearance is required from the Central Government.

Specific Condition:

- If any Industrial Estate / Complex / Export Processing Zones / Special Economic Zones / Biotech parks / Leather Complex with homogeneous type of industries such leather / skin / hide / processing industry or those industrial estates with pre-defined set of activities (not necessarily homogeneous obtains prior environmental clearance, individual industries including proposed industrial housing within such estates / complexes will not be required to take prior environmental clearance, so long as the terms and conditions for the industrial estate / complex are complied with (such estates/ complexes must have a clearly identified management with the legal responsibility of ensuring adherence to the terms and conditions of prior environmental clearance, who may be held responsible for violation of the same throughout the life of the complex / estate.)

4.2.2 Criteria for classification of Category B1 and B2 projects

The classification of Category B projects or activities into B1 or B2 (except the project or activities listed in item 8(b) in the schedule to the EIA Notification, 2006) will be determined based on whether or not the project or activity requires further environmental studies for preparation of an EIA for its appraisal prior to the grant of prior environmental clearance. The necessity of which will be decided, depending upon the nature and location specificity of the project, by SEAC after scrutiny of the applications seeking prior environmental clearance for Category B projects or activities.

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

4.2.3 Application for prior environmental clearance

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

4.2.4 Siting guidelines

These are the guidelines, stakeholders may consider while siting the developmental projects, to minimise the associated possible environmental impacts. In some situations, adhering to these guidelines is difficult and unwarranted. Therefore, these guidelines may be kept in the background, as far as possible, while taking the decisions.

Areas preferably be avoided

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

- Ecologically and/or otherwise sensitive areas: Preferably 5 km; depending on the geo-climatic conditions the requisite distance may be decided appropriately by the agency.
- Coastal areas: Preferably ½ km away from high tide line (HTL).
- Flood plain of the riverine system: Preferably ½ km away from flood plain or modified flood plain affected by dam in the upstream or flood control systems.
- Transport/Communication System: Preferably ½ km. away from highway and railway line.
- Major settlements (3,00,000 population): Distance from major settlements is difficult to maintain because of urban sprawl. At the time of siting of the industry, if the notified limit of any major settlement is found to be within 50 km from the project boundary, the spatial direction of growth of the settlement for at least a decade must be assessed. Subsequently, the industry may be sited at least 25 km from the projected growth boundary of the settlement.
- Critically polluted areas are identified by MoEF from time-to-time. Current list of critically polluted areas is given in **Annexure V**.

Note:

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

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

General siting factors

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

- No forest land shall be converted into non-forest activity for the sustenance of the industry (Ref: Forest Conversation Act, 1980).
- No prime agricultural land shall be converted into industrial site.
- Land acquired shall be sufficiently large to provide space for appropriate green cover including green belt, around the battery limit of the industry.

- Layout of the industry that may come up in the area must conform to the landscape of the area, without affecting the scenic features of that place.
- Associated township of the industry may be created at a space having physiographic barrier between the industry and the township.

4.3 Scoping for EIA Studies

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

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

- Project proponent shall submit the application to the concerned authority. The application (Form 1 as given in annexure IV) shall be attached with pre-feasibility report and proposed ToR for EIA Studies. The proposed sequence to arrive at the draft ToR is discussed below:
    - Pre-feasibility report summarizes the project details and also the likely environmental concerns based on secondary information, which will be availed for filling Form 1.
    - From the pre-feasibility report and the Form 1, valued environmental components (VECs) may be identified for a given project (the receiving environment/social components, which are likely to get affected due to the project operations/activities).
    - Once the project details from the pre-feasibility report & Form 1; and VECs are identified, a matrix establishing the interactions which can lead to the effects/impacts could be developed (Qualitative analysis).
    - For each identified possible effect in the matrix, significance analysis could be conducted to identify the impacts, which need be studied further (quantitative analysis) in subsequent EIA studies. All such points find a mention in the part of the draft ToR to be proposed by the project proponent.-.The draft ToR shall include applicable baseline parameters (refer annexure VIII) and impact prediction tools (refer annexure IX) proposed to be applied.
    - The information to be provided in pre-feasibility report, guidelines for filling Form 1 and guidelines for developing draft ToR is summarized in subsequent sections.
    - Authority consults the respective EAC/SEAC to reply to the proponent. The EAC/SEAC concerned reviews the application form, pre-feasibility report and proposed draft ToR by the proponent and make necessary additions/deletions to make it a comprehensive ToR that suits the statutory requirements for conducting the EIA studies.
- The concerned EAC/SEAC may constitute a sub-committee for a site visit, if considered necessary. The sub-committee will act up on receiving a written approval from the chairperson of EAC/SEAC concerned. Project proponent will facilitate such site visits of the sub-committees.

- EAC/SEAC shall provide an opportunity to the project proponent for presentation and discussions on the proposed project and related issues as well as the proposed ToR for EIA studies. If the State Government desires to present its views on any specific project in the scoping stage, it can depute an officer for the same at the scoping stage to EAC, as an invitee but not as a member of EAC. However, non-appearance of the project proponent before EAC/SEAC at any stage will not be a ground for rejection of the application for the prior environmental clearance.
- If a new or expansion project is proposed in a problem area as identified by the CPCB, then the Ministry may invite representative SEIAA to the EAC to present their views, if any at the stage of scoping, to the EAC.
- The final set of ToR for EIA studies shall be conveyed to the proponent by the EAC/ SEAC within sixty days of the receipt of Form 1 and pre-feasibility report. If the finalized ToR for EIA studies is not conveyed to the proponent within sixty days of the receipt of Form 1, the ToR suggested by the proponent shall be deemed as the final and will be approved for EIA studies.
- Final ToR for EIA studies shall be displayed on websites of the MoEF/SEIAA.
- Applications for prior environmental clearance may be rejected by the concerned Authority based on the recommendations by the concerned EAC/SEAC at the scoping stage itself. In case of such rejection, the decision together with reasons for the same shall be communicated to the proponent in writing within sixty days of the receipt of the application.
- The final EIA report and other relevant documents submitted by the applicant shall be scrutinized by the concerned Authority strictly with reference to the approved ToR for EIA studies.

4.3.1 Pre-feasibility report

The pre-feasibility report should include, but not limited to highlight the proposed project information, keeping in view the environmental sensitivities of the selected site, raw material, technology options and its availability. Information required in pre-feasibility report varies from case to case even in the same sector depending upon the local environmental setting within which the plant is located/proposed. However, the information which may be furnished in the pre-feasibility report may include as under:

I. Executive summary

II. Project details: Description of the project including in particular;

- a description of the main characteristics of the production processes, for instance, nature and quantity of materials used,
- an estimate, by type and quantity, of expected residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation, *etc.*) resulting from the operation of the proposed project.
- a description of the physical characteristics of the whole project and the land-use requirements during the construction and operational phases

III. Selection of site based on least possible impacts

- An outline of the main alternatives studied by the developer and an indication of the main reasons for this choice, taking into account the environmental effects.

IV. Anticipated impacts based on project operations on receiving environment

- A description of the aspects of the environment likely to be significantly affected by the proposed project, including, in particular, population, fauna, flora, soil, water, air, climatic factors, material assets, including the architectural and archaeological heritage, landscape and the inter-relationship between the above factors.
- A description of the likely significant effects of the proposed project on the environment resulting from:
  - existence of the project,
  - use of natural resources
  - emission of pollutants, the creation of nuisances and the elimination of waste
  - project proponent's description of the forecast methods used to assess the effects on environment

V. Proposed broad mitigation measures which could effectively be internalized as project components to have environmental and social acceptance of the proposed site

- A description of key measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment

VI. An indication of any difficulties (technical deficiencies or lack of know-how) encountered by the developer in compiling the required information

Details of the above listed points which may be covered in pre-feasibility report are listed in **Annexure VI**.

4.3.2 Guidance for providing information in Form 1

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

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

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

4.3.3 Identification of appropriate valued environmental components

VECs are components of natural resources and human world that are considered valuable and are likely to be affected by the project activities. Value may be attributed for economic, social, environmental, aesthetic or ethical reasons. VECs represent the investigative focal point for further EIA process. The indirect and/or cumulative effects can be concerned with indirect, additive or even synergistic effects due to other projects or activities or even induced developments on the same environmental components as would be considered direct effects. But such impacts tend to involve larger scale VECs such as within entire region, river basins or watersheds; and, broad social and economic VECs such as quality of life and the provincial economy. Once VECs are identified then appropriate indicators are selected for impact assessments on the respective VECs.

4.3.4 Methods for identification of impacts

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

- Nature of the impact(s)
- Availability and quality of data
- Availability of resources (time, finance and staff)

The method chosen should not be complex, but should aim at presenting the results in a way that can be easily understood by the developer, decision maker and the public. A comparative analysis of major impact identification methods is given in Table 4-1

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

	Description	Advantages	Disadvantages
Checklists	▪ Annotate the environmental features that need to be addressed when identifying the impacts of activities in the project	▪ Simple to understand and use ▪ Good for site selection and priority setting ▪ Simple ranking and weighting	▪ Do not distinguish between direct and indirect impacts ▪ Do not link action and impact ▪ The process of incorporating values can be controversial
Matrices	▪ Identify the interaction between project activities (along one axis) and environmental characteristics (along other axis) using a grid like table ▪ Entries are made in the cells	▪ Link action to impact ▪ Good method for displaying EIA results	▪ Difficult to distinguish direct and indirect impacts ▪ Significant potential for double-counting

	Description	Advantages	Disadvantages
	which highlights impact severity in the form of symbols or numbers or descriptive comments		of impacts
Networks	▪ Illustrate cause effect relationship of project activities and environmental characteristics ▪ Useful in identifying secondary impacts ▪ Useful for establishing impact hypothesis and other structured science based approaches to EIA	▪ Link action to impact ▪ Useful in simplified form for checking for second order impacts ▪ Handles direct and indirect impacts	▪ Can become very complex if used beyond simplified version
Overlays	▪ Map the impacts spatially and display them pictorially ▪ Useful for comparing site and planning alternatives for routing linear developments ▪ Can address cumulative effects ▪ Information incentive	▪ Easy to understand ▪ Good to display method ▪ Good siting tool	▪ Address only direct impacts ▪ Do not address impact duration or probability
GIS	▪ Maps the impacts spatially and display them pictorially ▪ Useful for comparing site and planning alternatives for routing linear developments ▪ Can address cumulative effects ▪ Information incentive	▪ Easy to understand ▪ Good to display method ▪ Good siting tool ▪ Excellent for impact identification and analysis	▪ Do not address impact duration or probability ▪ Heavy reliance on knowledge and data ▪ Often complex and expensive
Expert System	▪ Assist diagnosis, problem solving and decision making ▪ Needs inputs from user by answering systematically developed questions to identify impacts and determine their mitigability and significance ▪ Information intensive, high investment methods of analysis	▪ Excellent for impact identification and analysis ▪ Good for experimenting	▪ Heavy reliance on knowledge and data ▪ Often complex and expensive

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

While the impact matrix is each project-specific, Table 4-2 may facilitate the stakeholders in identifying a set of components and phase-specific project activities for determination of likely impacts. However, the location-specific concerns may vary from case to case; therefore, the components even without likely impacts are also retained in the matrix for the location-specific reference.

Table 4-2: Matrix of Impacts

			PHASE I					PHASE II							PHASE III		
			Pre Construction					Construction/ Establishment							Operation and Maintenance		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
ENVIRONMENT	Component	Project Activities / Parameter/ factor	Detailed Topographic Survey	Land Acquirement	Site Clearing	Burning of wastes, refuse and cleared vegetation	Site Preparation / Change in Topography	Civil works such as earth moving and building of structures including temporary structures	Heavy Equipment operations	Disposal of construction wastes	Generation of sewerage	Influx of construction workers	Deforestation	Transportation of material	Raw materials handling and storage, access, parking, and loading/ unloading arrangements	Chemical reactions of unit processes and unit operations - Cracking process, Dryers, Reactors, Distillation units operation, Product separation and refinement	Waste management –liquid and solid waste
Physical	**Soil**	Erosion Risks											*				
		Contamination						*		*					*	*	*
		Soil Quality						*							*	*	*
	Resources	Fuels/ Electricity												*	*	*	
		Raw materials						*							*		
		Land especially undeveloped or agricultural land								*					*		*
	Water	Interpretation or Alteration of River Beds					*										
		Alteration of Hydraulic Regime											*				
		Alteration of surface run-off and interflow					*	*									*
		Alteration of aquifers					*	*									*
		Water quality						*			*				*	*	*
		Temperature															
	Air	Air quality				*		*	*					*		*	
		Noise						*	*					*	*	*	*

			PHASE I					PHASE II							PHASE III		
			Pre Construction					Construction/ Establishment							Operation and Maintenance		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		Climate				*							*		*	*	
Biological	**Terrestrial Flora**	Effect on grass & flowers			*		*			*			*		*	*	
		Effect on trees & shrubs			*		*						*		*	*	*
		Effect on farmland			*		*			*						*	*
		Endangered species			*		*						*		*	*	*
	Aquatic Biota	Habitat removal			*		*								*	*	*
		Contamination of habitats			*		*										*
		Reduction of aquatic biota			*		*								*	*	*
	Terrestrial Fauna	Fragmentation of terrestrial habitats			*		*						*			*	*
		Disturbance of habitats by noise or vibration			*		*									*	*
		Reduction of Biodiversity			*		*						*		*	*	*
Social	**Economy**	Creation of new economic activities	*									*			*	*	*
		Commercial value of properties										*			*	*	
		Conflict due to negotiation and/ compensation payments													*	*	*
		Generation of temporary and permanent jobs										*			*	*	*
		Effect on crops			*			*			*				*	*	*
		Reduction of farmland productivity		*											*	*	*
		Income for the state and private sector													*	*	*
		Savings for consumers & private consumers														*	
		Savings in foreign currency for the state														*	

			PHASE I					PHASE II							PHASE III		
			Pre Construction					Construction/ Establishment							Operation and Maintenance		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Education	Training in new technologies	*													*	
		Training in new skills to workers	*												*	*	
	Public Order	Political Conflicts		*											*	*	*
		Unrest, Demonstrations & Social conflicts		*											*	*	*
	Infrastructure and Services	Conflicts with projects of urban, commercial or Industrial development	*					*							*	*	*
	Security and Safety	Increase in Crime								*					*	*	*
		Accidents caused by							*								
	Health					*									*	*	
	Cultural	Land use			*		*								*	*	*
		Recreation													*	*	*
		Aesthetics and human interest								*			*		*	*	*
		Cultural status													*	*	*

Note:

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

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

4.3.5 Testing the Significance of Impacts

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

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

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

4.3.6 Terms of reference for EIA studies

ToR for EIA studies in respect of the synthetic organic chemicals industry may include, but not limited to the following:

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

Project description

2. Justification for selecting the proposed product and unit size.
3. Land requirement for the project including its break up for various purposes, its availability and optimization.
4. Details of proposed layout clearly demarcating various units within the plant.
5. Product spectrum (Proposed products along with production Capacity) and processes
6. Complete process flow diagram describing each unit, its processes and operations, along with material (material balance).
7. Details on raw materials, source and storage with in the premises.

8. Details on solvent balance, measures for solvent recovery
9. Details on requirement of energy and water along with its source and authorization from the concerned department.
10. Details on water balance including quantity of effluent generated, recycled & reused. Efforts to minimise effluent discharge and to maintain quality of receiving water body.
11. Segregation of waste stream, characterization and quality with specific treatment
12. Details of end of the pipe effluent treatment plant, inlet and treated water quality with specific efficiency of each treatment unit in reduction in respect of all concerned/regulated environmental parameters.
13. Details on volatile organic compounds from the plant operations and occupational safety and health protection measures
14. Details on channelised emissions and control equipment for each of the source.
15. Control technologies for combustion emissions
16. Details on composition, generation and utilization of waste from the plant.
17. Management plan for solid/hazardous waste including storage, utilization and safe disposal. CPCB guidelines in respect of specific treatment, such as solar evaporation, incineration, *etc*., need to be followed.
18. Details of proposed source-specific pollution control schemes and equipments to meet the national standards.
19. Details regarding infrastructure facilities such as sanitation, fuel storage, restroom, *etc.,* to the workers during construction and operation phase.
20. In case of expansion of existing industries, remediation measures adopted to restore the environmental quality if the groundwater, soil, crop, air, *etc*., are affected and a detailed compliance to the prior environmental clearance/consent conditions.
21. Any litigation pending against the project and /or any direction /order passed by any Court of Law against the project, if so, details thereof.

Description of the environment

22. The study area shall be up to a distance of 10 km from the boundary of the proposed project site.
23. Location of the project site and nearest habitats with distances from the project site to be demarcated on a toposheet (1: 50000 scale).
24. Landuse based on satellite imagery including location specific sensitivities such as national parks / wildlife sanctuary, villages, industries, *etc.,* for the study area.
25. Demography details of all the villages falling within the study area.
26. Topography details of the project area.
27. The baseline data to be collected from the study area w.r.t. different components of environment viz. air, noise, water, land, and biology and socio-economic (please refer Section 4.4.2 for guidance for assessment of baseline components and identify attributes of concern). Actual monitoring of baseline environmental components shall be strictly according to the parameters prescribed in the ToR after considering the proposed coverage of parameters by the proponent in draft ToR and shall commence after finalization of ToR by the competent Authority.

28. Geological features and geo-hydrological status of the study area.
29. Details of groundwater and surface water quality of nearby water sources and other surface drains. Water quality parameters may include pH*, BOD* (3 days at 27 ^{o}C), COD*, toxicity factor*, Nitrate* (as N), Arsenic*, Chromium*, Hexavalent*, Total Lead*, Cyanide as CN*, Zinc*, Mercury*, Copper*, Nickel*, Phenolics* as C_6H_5OH, Sulphide, *etc*. (* - as applicable)
30. Details on existing ambient air quality and expected, stack and fugitive emissions for PM10*, PM2.5*, SO_2*, NOx*, VOC*, mercaptans*, solvents*, NH_3*, chlorine*, HCl*, HBr*, H_2S*, HF*, other process-specific pollutants*, *etc*., and evaluation of the adequacy of the proposed pollution control devices to meet standards for point sources and to meet AAQ standards. (* - as applicable)
31. The air quality contours may be plotted on a location map showing the location of project site, habitation nearby, sensitive receptors, if any and wind roses.
32. Details on noise levels at sensitive/commercial receptors.
33. Site-specific micro-meteorological data including mixing height.
34. One season site-specific data excluding monsoon season.
35. Proposed baseline monitoring network for the consideration and approval of the Competent Authority.
36. Ecological status (terrestrial and aquatic) of the study area such as habitat type and quality, species, diversity, rarity, fragmentation, ecological linkage, age, abundance, *etc.*
37. If any incompatible landuse attributes fall within the study area, proponent shall describe the sensitivity (distance, area and significance) and propose the additional points based on significance for review and acceptance by the EAC/SEAC. Incompatible land use attributes include:
    - Public water supply areas from rivers/surface water bodies, from ground water
    - Scenic areas/tourism areas/hill resorts
    - Religious places, pilgrim centers that attract over 10 lakh pilgrims a year
    - Protected tribal settlements (notified tribal areas where industrial activity is not permitted)
    - Monuments of national significance, World Heritage Sites
    - Cyclone, Tsunami prone areas (based on last 25 years);
    - Airport areas
    - Any other feature as specified by the State or local government and other features as locally applicable, including prime agricultural lands, pastures, migratory corridors, *etc.*
38. If ecologically sensitive attributes fall within the study area, proponent shall describe the sensitivity (distance, area and significance) and propose additional points based on significance for review and acceptance by the EAC/ SEAC. Ecological sensitive attributes include:
    - National parks
    - Wild life sanctuaries Game reserve
    - Tiger reserve/elephant reserve/turtle nesting ground
    - Mangrove area
    - Wetlands
    - Reserved and protected forests

- Any other closed/protected area under the Wild Life (Protection) Act, 1972, any other area locally applicable
- Any other eco-sensitive areas

39. If the location falls in Valley, specific issues connected to the natural resources management shall be studied and presented.

40. If the location falls in CRZ area: A CRZ map duly authenticated by one of the authorized agencies demarcating LTL, HTL, CRZ area, location of the project and associate facilities w.r.t. CRZ, coastal features such as mangroves, if any.

    - Provide the CRZ map in 1:10000 scale in general cases and in 1:5000 scales for specific observations.
    - Proposed site for disposal of dredged material and environmental quality at the point of disposal/impact areas.
    - Fisheries study should be done w.r.t. Benthos and Marine organic material and coastal fisheries.

Anticipated environmental impacts and mitigation measures

41. Anticipated generic environmental impacts due to this project are indicated in Table 4-2, which may be evaluated for significance and based on corresponding likely impacts VECs may be identified. Baseline studies may be conducted for all the concerned VECs and likely impacts will have to be assessed for their magnitude in order to identify mitigation measures (please refer Chapter 4 of the manual for guidance).

42. Tools as given in Section 4.4.3 may be referred for the appropriate assessment of environmental impacts and same may be submitted in draft ToR for consideration and approval by EAC/SEAC.

43. While identifying the likely impacts, also include the following for analysis of significance and required mitigation measures:

    - impacts due to transportation of raw materials and end products on the surrounding environment
    - impacts on surface water, soil and groundwater
    - impacts due to air pollution
    - impacts due to odour pollution
    - impacts due to noise
    - impacts due to fugitive emissions including VOCs / HAPs
    - impact on health of workers due to proposed project activities

44. Proposed odour control measures

45. Action plan for the greenbelt development – species, width of plantations, planning schedule, *etc.*, in accordance to CPCB published guidelines.

46. In case of likely impact from the proposed project on the surrounding reserve forests, Plan for the conservation of wild fauna in consultation with the State Forest Department.

47. For identifying the mitigation measures, please refer Chapter III for source control and treatment. Besides typical mitigation measures which may also be considered are discussed in Table 4-5.

Analysis of alternative resources and technologies

48. Comparison of alternate sites considered and the reasons for selecting the proposed site. Conformity of the site with prescribed guidelines in terms of CRZ, river, highways, railways, *etc.*
49. Details on improved technologies.
50. Details on proposed recovery options.

Environmental monitoring program

51. Monitoring programme for pollution control at source.
52. Monitoring pollutants at receiving environment for the appropriate notified parameters – air quality, groundwater, surface water, gas quality, *etc.* during operational phase of the project.
53. Specific programme to monitor safety and health protection of workers.
54. Proposed plan to estimate and monitor fugitive emissions including VOCs from all the sources and appropriated control measures.
55. Stack and fugitive emissions may be monitored for SPM, PM10, PM2.5, SO_2, NOx, HC, CO, VOC and evaluation of the adequacy of the proposed pollution control devices to meet gaseous emissions.
56. Monitoring of carbon foot print
57. Appropriate monitoring network has to be designed and proposed, to assess the possible residual impacts on VECs.
58. Details of in-house monitoring capabilities and the recognized agencies if proposed for conducting monitoring.

Additional studies

59. Details on risk assessment and damage control during different phases of the project and proposed safeguard measures.
60. Details on socio-economic development activities such as commercial property values, generation of jobs, education, social conflicts, cultural status, accidents, *etc.*
61. Proposed plan to handle the socio-economic influence on the local community. The plan should include quantitative dimension as far as possible.
62. Details on compensation package for the people affected by the project, considering the socio-economic status of the area, homestead oustees, land oustees, and landless labourers.
63. Points identified in the public hearing and commitment of the project proponent to the same. Detailed action plan addressing the issues raised, and the details of necessary allocation of funds.
64. Details on plan for corporate social responsibility including the villages, population spread, SC/ST/backward communities, upgradation of existing schools, establishing new schools with facilities (such as laboratories, toilets, *etc.*), link roads, community halls, primary health facilities, health camps, *etc.*

Environmental management plan

65. Administrative and technical organizational structure to ensure proposed post-project monitoring programme for approved mitigation measures.
66. EMP devised to mitigate the adverse impacts of the project should be provided along with item-wise cost of its implementation (capital and recurring costs).
67. Allocation of resources and responsibilities for plan implementation.
68. Details of the emergency preparedness plan and on-site and off-site disaster management plan.

Note:

Above points shall be adequately addressed in the EIA report at corresponding chapters, in addition to the contents given in the reporting structure (Table: 4-6).

4.4 Environmental Impact Assessment

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

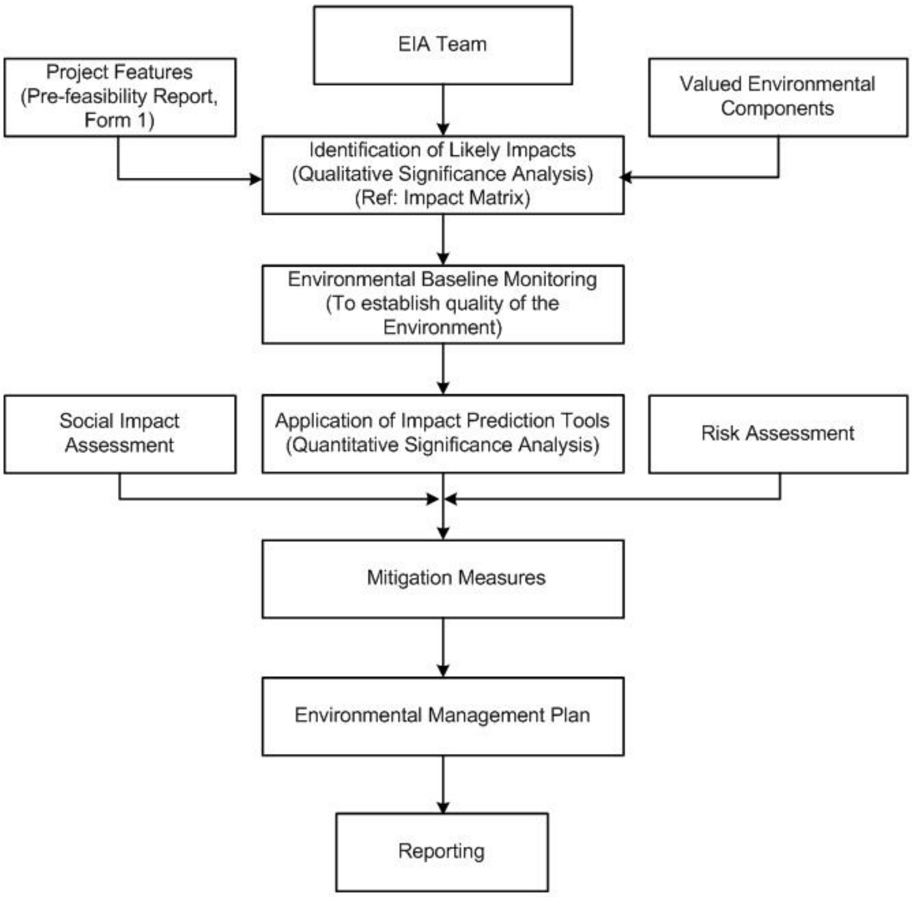


Figure 4-3: Approach for EIA Study

4.4.1 EIA team

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

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

- Environmental management specialist/Regulator
- Air and noise quality
- Toxicology/Occupational health
- Geology/geo-hydrology
- Ecologist
- Transportation specialist
- Safety and risk specialist
- Chemical engineer
- Social scientist, *etc.*

4.4.2 Baseline quality of the environment

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

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

4.4.2.1 Objectives of EBM in EIA context

The term ‘baseline’ refers to conditions existing before development. EBM studies are carried out to:

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

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

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

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

4.4.2.2 Environmental monitoring network design

Monitoring refers to the collection of data through a series of repetitive measurements of environmental parameters (or, more generally, to a process of systematic observation). Design of the environmental quality monitoring programme depends up on the monitoring objectives specified for the selected area of interest. Types of monitoring and network design considerations are discussed in **Annexure VII**.

4.4.2.3 Baseline data generation

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

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

Environmental Component	Environmental Indicators
Climatic variables	▪ Rainfall patterns – mean, mode, seasonality ▪ Temperature patterns ▪ Extreme events ▪ Climate change projections ▪ Prevailing wind - direction, speed, anomalies ▪ Relative humidity ▪ Stability conditions and mixing height, *etc.*
Topography	▪ Slope form ▪ Landform and terrain analysis ▪ Specific landform types, *etc.*
Drainage	▪ Surface hydrology ▪ Natural drainage pattern and network ▪ Rainfall runoff relationships ▪ Hydrogeology ▪ Groundwater characteristics – springs, *etc.*
Soil	▪ Type and characteristics ▪ Porosity and permeability ▪ Sub-soil permeability ▪ Run-off rate ▪ Infiltration capacity ▪ Effective depth (inches/centimeters) ▪ Inherent fertility ▪ Suitability for method of sewage disposal, *etc.*
Geology	▪ Underlying rock type, texture

Environmental Component	Environmental Indicators
	▪ Surgical material ▪ Geologic structures (faults, shear zones, *etc.*) ▪ Geologic resources (minerals, *etc.*)
Water	▪ Raw water availability ▪ Water quality ▪ Surface water (rivers, lakes, ponds, gullies) – quality, water depths, flooding areas, *etc.* ▪ Ground water – water table, local aquifer storage capacity, specific yield, specific retention, water level depths and fluctuations, *etc.* ▪ Coastal ▪ Floodplains ▪ Wastewater discharges ▪ Thermal discharges ▪ Waste discharges, *etc.*
Air	▪ Ambient ▪ Respirable ▪ Airshed importance ▪ Odour levels, *etc.*
Noise	▪ Identifying sources of noise ▪ Noise due to traffic/transportation of vehicles ▪ Noise due to heavy equipment operations ▪ Duration and variations in noise over time, *etc.*
Coastal dynamics and morphology	▪ Wave patterns ▪ Currents ▪ Shoreline morphology – near shore, foreshore ▪ Sediment – characteristics and transport, *etc.*
Biological	▪ Species composition of flora and fauna ▪ Flora – type, density, exploitation, *etc.* ▪ Fauna – distribution, abundance, rarity, migratory, species diversity, habitat requirements, habitat resilience, economic significance, commercial value, *etc.* ▪ Fisheries – migratory species, species with commercial/ recreational value, *etc.*
Landuse	▪ Landuse pattern, *etc.*

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

Infrastructure requirements for EBM

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

Defining data statistics/analyses requirements

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

Use of secondary data

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

To facilitate stakeholders, IL&FS Ecosmart LTD., has made an attempt to compile the list of information required for EIA studies and sources of secondary data, which are given in **Annexure IXA** and **Annexure IXB**.

4.4.3 Impact prediction tools

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

Choice of models/methods for impact predictions in respect to air, noise, water, land, biological and socio-economic environment are tabulated in **Annexure X**.

4.4.4 Significance of the impacts

Evaluating the significance of environmental effects is perhaps the most critical component of impact analysis. The interpretation of significance bears directly on the subsequent EIA process and also during prior environmental clearance on project approvals and condition setting. At an early stage, it also enters into screening and scoping decisions on what level of assessment is required and which impacts and issues will be addressed.

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

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

i. Step 1: Are the environmental effects adverse?

Criteria for determining if effects are "adverse" include:

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

ii. Step 2: Are the adverse environmental effects significant?

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

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

iii. Step 3: Are the significant adverse environmental effects likely?

Criteria for determining 'likelihood' include:

- probability of occurrence, and
- scientific uncertainty

4.5 Social Impact Assessment

Social Impact Assessment (SIA) is an instrument used to analyze social issues and solicit stakeholder views for the design of projects. SIA helps in making the project responsive to social development concerns, including options that enhance benefits for poor and vulnerable people while mitigating risk and adverse impacts. It analyzes distributional impacts of intended project benefits on different stakeholder groups, and identifies differences in assets and capabilities to access the project benefits.

The scope and depth of SIA should be determined by the complexity and importance of issues studied, taking into account the skills and resources available. SIA should include studies related to involuntary resettlement, compulsory land acquisition, impact of imported workforces, job losses among local people, damage to sites of cultural, historic or scientific interest, impact on minority or vulnerable groups, child or bonded labour, use of armed security guards. However, SIA may primarily include the following:

Description of the socio-economic, cultural and institutional profile

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

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

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

Legislative and regulatory considerations

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

Key social issues

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

Data collection and methodology

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

- Build on existing data;
- Clarify the units of analysis for social assessment: intra-household, household level, as well as communities/settlements and other relevant social aggregations on which data is available or will be collected for analysis;

- Choose appropriate data collection and analytical tools and methods, employing mixed methods wherever possible; mixed methods include a mix of quantitative and qualitative methods.

Strategy to achieve social development outcomes

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

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

Implications for analysis of alternatives

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

If SIA and consultation processes indicate that alternative approaches may have better development outcomes, such alternatives should be described and considered, along with the likely budgetary and administrative effects these changes might have.

Recommendations for project design and implementation arrangements

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

Developing a monitoring plan

Through SIA process, a framework for monitoring and evaluation should be developed. To the extent possible, this should be done in consultation with key stakeholders, especially beneficiaries and affected people.

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

- a set of monitoring indicators to track the progress achieved. The benchmarks and indicators should be limited in number, and should combine both quantitative and qualitative types of data. The indicators should include outputs to be achieved by the social development strategy should include indicators to monitor the process of stakeholder participation, implementation and institutional reform
- indicators to monitor social risk and social development outcomes; and indicators to monitor impacts of the project's social development strategy. It is important to suggest mechanisms through which lessons learnt from monitoring and stakeholder feedback can result in changes to improve the operation of the project. Indicators should be of such a nature that results and impacts can be disaggregated by gender and other relevant social groups;
- define transparent evaluation procedures. Depending on context, these may include a combination of methods, such as participant observation, key informant interviews, focus group discussions, census and socio-economic surveys, gender analysis, Participatory Rural Appraisal (PRA), Participatory Poverty Assessment (PPA) methodologies, and other tools. Such procedures should be tailored to the special conditions of the project and to the different groups living in the project area; Estimate resource and budget requirements for monitoring and evaluation activities, and a description of other inputs (such as institutional strengthening and capacity building) needs to be carried out.

4.6 Risk Assessment

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

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

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

- Identification of safety areas
- Identification of hazard sources
- Generation of accidental release scenarios for escape of hazardous materials from the facility
- Identification of vulnerable units with recourse to hazard indices

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

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

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

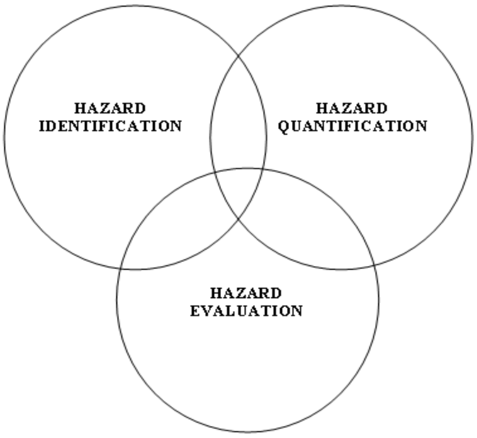


Figure 4-4: Risk Assessment – Conceptual Framework

Methods of risk prediction should cover all the design intentions and operating parameters to quantify risk in terms of probability of occurrence of hazardous events and magnitude of its consequence. Table 4-4 shows the predictive models for risk assessment.

Table 4-4: Choice of Models for Impact Predictions: Risk Assessment

Name	Application	Remarks
EFFECT	Consequence Analysis for Visualization of accidental chemical release scenarios & its consequence	Heat load, press wave & toxic release exposure neutral gas dispersion
WHAZAN	Consequence Analysis for Visualization of accidental chemical release scenarios & its consequence	

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

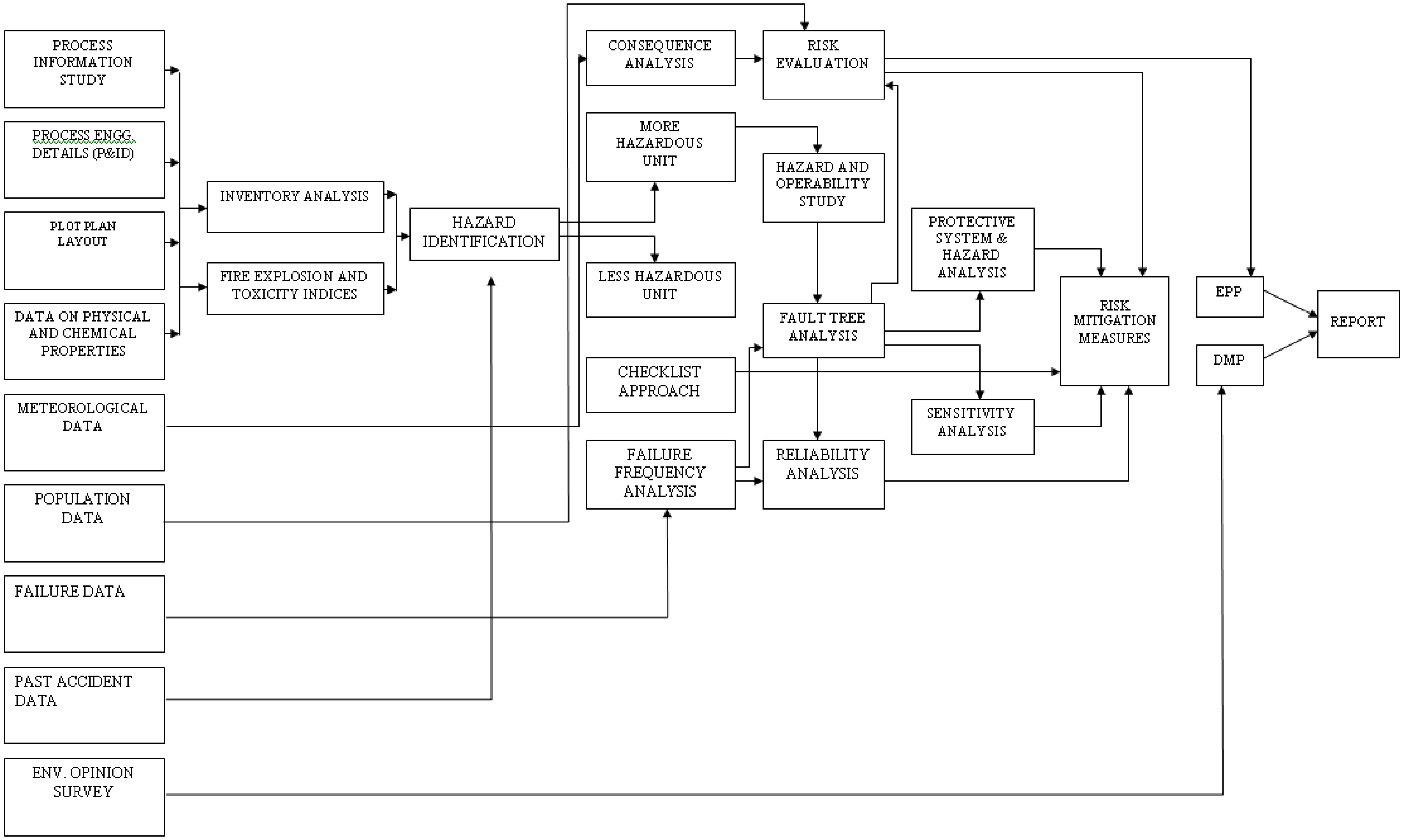


Figure 4-5: Comprehensive Risk Assessment - At a Glance

4.6.1 Storage and handling of hazardous materials

Both hazardous and non-hazardous materials generated within the manufacturing units in the project facility shall be temporarily accommodated in designated storage units within the project facility built/made in line with the safety, health and environmental standards.

Size of these temporary units would depend on the quantity and type of hazardous waste materials like asbestos, PCB, oils, fuels, *etc*., with appropriate storage capacities placed in the project facility in compliance with the Hazardous Waste Management and Handling Rules. In case of radioactive wastes, storage and handling should be based on Rules for Management of Radioactive Waste under AERB. Also, if gas cylinders must be stored in the facility, rules applicable for gas cylinders under the Explosives Act shall be followed. Later, these materials must be disposed off at a centralized disposal facility with utmost care following safety norms. Each unit in the facility should be have fire hydrant system to handle fire hazards.

4.6.2 Hazard identification

Hazard is the characteristic of any system or process which has the potential for accident. Identification of hazards, in presence of any hazardous waste generating units within the project facility is of primary significance in the analysis, quantification and cost-effective control of accidents involving chemicals and process.

Hence, all components of a system/unit need to be thoroughly examined to assess their potential for initiating or propagating an unplanned event/sequence of events, which can be termed as an accident.

Typical methods for hazard identification employed are:

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

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

4.6.3 Hazard assessment and evaluation

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

Frequent causes of accidents

- Fire and explosion: explosives, flammable material
- Being struck by falling objects
- Caught in/compressed
- Snapping of cables, ropes, chains, slings
- Handling heavy objects
- Electricity (electrocution)
- Poor illumination
- Falls from height inside industrial units or on the ground
- Struck by moving objects
- Slipping on wet surfaces
- Sharp objects
- Oxygen deficiency in confined spaces
- Lack of personal protective equipment (PPE), housekeeping practices, safety signs
- Hackles, hooks, chains
- Cranes, winches, hoisting and hauling equipment;

Hazardous substances and wastes

- Heavy and toxic metals (lead, mercury, cadmium, copper, zinc, *etc*.)
- Organometallic substances (tributyltin, *etc*.)
- Lack of hazard communication (storage, labelling, material safety data sheets)
- Batteries, fire-fighting liquids
- PCBs and PVC (combustion products)
- Welding fumes
- Volatile organic compounds (solvents)
- Inhalation in confined and enclosed spaces
- Physical hazards
- Noise
- Extreme temperatures
- Vibration
- Radiation (UV, radioactive materials)

Physical hazards

- Noise
- Extreme temperatures
- Vibration
- Radiation (UV, radioactive materials)

Mechanical hazards

- Trucks and transport vehicles
- Scaffolding, fixed and portable ladders
- Impact by tools, sharp-edged tools
- Power-driven hand tools, saws, grinders and abrasive cutting wheels
- Failure of machinery and equipment
- Poor maintenance of machinery and equipment
- Lack of safety guards in machines
- Structural failure

Biological hazards

- Toxic marine organisms (If the project facility is located in Coastal Regions)
- Risk of communicable diseases transmitted by pests, vermin, rodents, insects and other animals that may infest the project facility.
- Animal bites
- Vectors of infectious diseases (TB, malaria, dengue fever, hepatitis, respiratory infections, others)

Ergonomic and psychosocial hazards

- Repetitive strain injuries, awkward postures, repetitive and monotonous work, excessive workload
- Long working hours, shift work, night work, temporary employment
- Mental stress, human relations (aggressive behaviour, alcohol and drug abuse, violence)
- Poverty, low wages, minimum age, lack of education and social environment

General concerns

- Lack of safety and health training
- Poor work organization
- Inadequate housing and sanitation
- Inadequate accident prevention and inspection
- Inadequate emergency, first-aid and rescue facilities
- Lack of medical facilities and social protection

4.6.4 Disaster management plan

A disaster is a catastrophic situation in which suddenly, people are plunged into helplessness and suffering and, as a result, need protection, clothing, shelter, medical & social care and other necessities of life.

The Disaster Management Plan (DMP) is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operations in this same order of priorities. For effective implementation of DMP, it should be widely circulated and a personnel training is to be provided through rehearsals/drills.

To tackle the consequences of a major emergency inside the plant or immediate vicinity of the plant, a DMP has to be formulated and this planned emergency document is called DMP.

The objective of the DMP is to make use of the combined resources of the plant and the outside services to achieve the following:

- Effective rescue and medical treatment of casualties
- Safeguard other people
- Minimize damage to property and the environment
- Initially contain and ultimately bring the incident under control
- Identify any dead
- Provide for the needs of relatives
- Provide authoritative information to the news media
- Secure the safe rehabilitation of affected area

- Preserve relevant records and equipment for the subsequent inquiry into the cause and circumstances of the emergency

In effect, it is to optimize operational efficiency to rescue rehabilitation and render medical help and to restore normalcy.

The DMP should include emergency preparedness plan, emergency response team, emergency communication, emergency responsibilities, emergency facilities, and emergency actions

4.6.4.1 Emergency preparedness plan

Incidents, accidents and contingency preparedness should be accounted during construction and operation process. This shall be a part of EMS. Emergency Preparedness Plan (EPP) should be prepared following the National Environmental Emergency Plan and OSHA guidelines. According to these guidelines, an environmental emergency plan would essentially provide the following information:

- Assignment of duties and responsibilities among the authorities, participating agencies, response team, their coordinators and/or those responsible for the pollution incident
- Relationship with other emergency plans
- A reporting system that ensures rapid notification in the event of a pollution incident
- The establishment of a focal point for coordination and directions connected to the implementation of the plan
- Response operations should always cover these four phases:
  - Discovery and alarm
  - Evaluation, notification and plan invocation
  - Containment and counter measures
  - Cleanup and disposal
- Identification of expertise and response resources available for assistance for the implementation of plan
- Directions on the necessary emergency provisions applicable to the handling, treatment or disposal of certain pollutants
- Link to the local community for assistance, if necessary
- Support measures, such as procedures for providing public information, carrying out surveillance, issuing post-incident reports, review and updating of the plan, and periodic exercising of the plan.

4.6.4.2 Emergency response

Various units within the project facility are always subjected to accidents and incidents of many a kind. Therefore, a survey of potential incidents and accidents is to be carried out. Based on this, a plan for response to incidents, injuries and emergencies should be prepared. Response to emergencies should ensure that:

- The exposure of workers should be limited as much as possible during the operation

- Contaminated areas should be cleaned and, if necessary disinfected
- Limited impact on the environment at the extent possible.

Written procedures for different types of emergencies should be prepared and the entire workforce should be trained in emergency response. All relevant emergency response equipment should also be readily available.

With regard to dangerous spills, associated cleanup and firefighting operations should be carried out by specially allocated and trained personnel.

4.6.4.3 Response team

It is important to setup an Emergency Organization. A senior executive who has control over the affairs of the plant would be heading the Emergency Organization. He would be designated at Site Controller. Manager (Safety) would be designated as the Incident Controller. In case of stores, utilities, open areas, which are not under control of the Production Heads, Senior Executive responsible for maintenance of utilities would be designated as Incident Controller. All the Incident Controllers would be reporting to the Site Controller.

Each Incident Controller organizes a team responsible for controlling the incidence with the personnel under his control. Shift in charge would be the reporting officer, who would bring the incidence to the notice of the Incidence Controller and Site Controller.

Emergency Coordinators would be appointed who would undertake the responsibilities like firefighting, rescue, rehabilitation, transport and provide essential & support services. For this purposes, Security In charge, Personnel Department, Essential services personnel would be engaged. All these personnel would be designated as key personnel.

In each shift, electrical supervisor, electrical fitters, pump house in charge, and other maintenance staff would be drafted for emergency operations. In the event of power or communication system failure, some of staff members in the office/facility would be drafted and their services would be utilized as messengers for quick passing of communications. All these personnel would be declared as essential personnel.

4.6.4.4 Response to injuries

Based on a survey of possible injuries, a procedure for response to injuries or exposure to hazardous substances should be established. All staff should have minimum training to such response and the procedure ought to include the following:

- Immediate first aid, such as eye splashing, cleansing of wounds and skin, and bandaging
- Immediate reporting to a responsible designated person
- If possible, retention of the item and details of its source for identification of possible hazards
- Rapid additional medical care from medical personnel
- Medical surveillance
- Recording of the incident

- Investigation, determination and implementation of remedial action

It is vital that incident reporting should be straightforward so that reporting is actually carried out.

4.6.4.5 Emergency communication

Whoever notices an emergency situation such as fire, growth of fire, leakage, *etc.* would inform his immediate superior and Emergency Control Center. The person on duty in the Emergency Control Center, would appraise the Site Controller. Site Controller verifies the situation from the Incident Controller of that area or the Shift In charge and takes a decision about an impending On-site Emergency. This would be communicated to all the Incident Controllers, Emergency Coordinators. Simultaneously, the emergency warning system would be activated on the instructions of the Site Controller.

4.6.4.6 Emergency responsibilities

Responsibilities of the following key personnel should be defined:

- Site controller
- Incident controller
- Emergency coordinator - rescue, fire fighting
- Emergency coordinator-medical, mutual aid, rehabilitation, transport and communication
- Emergency coordinator - essential services
- Employers responsibility

4.6.4.7 Emergency facilities

- Emergency Control Center – with access to important personnel, telephone, fax, telex facility, safe contained breathing apparatus, hand tools, emergency shut down procedures, duties and contact details of key personnel and government agencies, emergency equipments, *etc.*
- Assembly Point – with minimum facilities for safety and rescue
- Emergency Power Supply – connected with diesel generator, flame proof emergency lamps, *etc.*
- Fire Fighting Facilities – first aid fire fighting equipments, fire alarms, *etc.*
- Location of wind Stock – located at appropriate location to indicate the direction of wind for emergency escape
- Emergency Medical Facilities – Stretchers, gas masks, general first aid, emergency control room, breathing apparatus, other emergency medical equipment, ambulance

4.6.4.8 Emergency actions

- Emergency warning
- Evacuation of personnel
- All clear signal
- Public information and warning

- Coordination with local authorities
- Mutual aid
- Mock drills

4.7 Mitigation Measures

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

4.7.1 Important considerations for mitigation methods

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

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

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

- avoiding sensitive areas such as eco-sensitive area *e.g.,* fish spawning areas, dense mangrove areas or areas known to contain rare or endangered species
- adjusting work schedules to minimise disturbance
- engineered structures such as berms and noise attenuation barriers
- pollution control devices, such as scrubbers and electrostatic precipitators
- changes in fuel feed, manufacturing, process, technology use, or waste management practices, *etc.*

4.7.2 Hierarchy of elements of mitigation plan

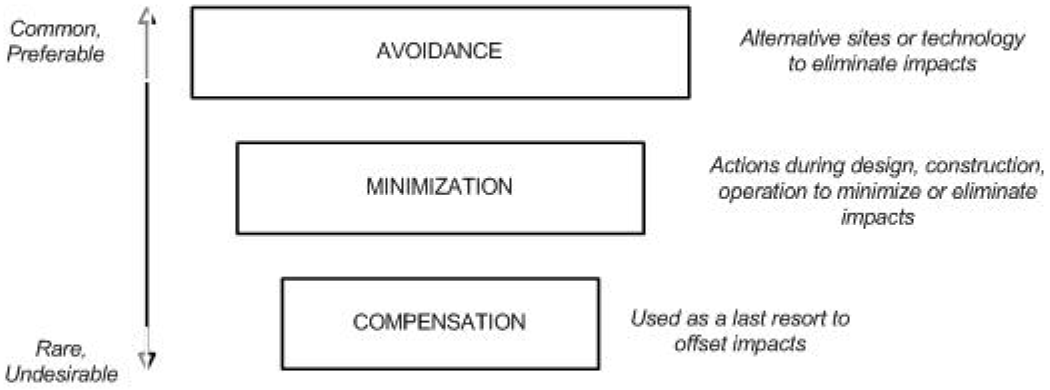


Figure 4-6: Elements of Mitigation

A good EIA practice requires technical understanding of relevant issues and the measures that work in such given circumstances: The priority of selection of mitigation measures should be in the order:

Step One: Impact avoidance

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

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

Step Two: Impact minimisation

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

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

Step Three: Impact compensation

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

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

Important compensation elements

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

In-kind compensation

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

4.7.3 Typical mitigation measures

Choice of location for the developmental activity plays an important role in preventing the adverse impacts on surrounding environment. Detailed guidelines on siting of industries are provided in Section 4.2. However, if the developmental activity produces any more adverse impacts, mitigation measures should be taken.

Previous sub-sections of the Section 4.7 could be precisely summarized into following:

- Impacts from a developmental project could have many dimensions. As most of the direct impacts are caused by releases from developmental projects, often control at source is the best opportunity to either eliminate or mitigate the impacts, in case these are cost-effective. In other words, the best way to mitigate the impacts is to prevent them from occurring. Choice of raw materials/technologies/processes which produce least impact would be one of the options to achieve it.
- After exploring cost-effective feasible alternatives to control impacts at source, various interventions to minimise the adverse impacts may be considered. These interventions, primarily aim at reducing the residual impacts on the valued environmental components of the receiving environment to the acceptable concentrations.
- Degree of control at source and external interventions differs from situation-to - situation and is largely governed by techno-economic feasibility. While the regulatory bodies stress for further source control (due to high reliability), the project proponents bargain for other interventions which may be relatively cost-effective than further control at source (in any case, project authority is required to meet the industry-specific standards by adopting the best practicable technologies. However, if the location demands further control at source, then the proponents are required to adopt further advanced control technologies, *i.e.* towards best available control technologies). After having discussions with the project proponent, EAC/SEAC

reaches to an agreed level of source control + other interventions (together called as mitigation measures in the given context) that achieve the targeted protection levels for the VECs in the receiving environment. These levels will become the principal clearance conditions.

- Chapter 3 of this TGM offers elaborate information on cleaner technologies, waste minimisation opportunities, and control technologies for various kinds of polluting parameters that emanate from this developmental activity. This information may be used to draw appropriate control measures applicable at source.

The choice of interventions for mitigation of impacts may also be numerous and depend on various factors. Mitigation measures based on location-specific suitability and some other factors are discussed in sub-sections 4.7.1 and 4.7.2. A few typical measures which may also be explored for mitigation of impacts are listed in Table 4-5.

Table 4-5: Typical Mitigation Measures

Impacts	Typical Mitigation Measures
Soil	▪ Windscreens, maintenance, and installation of ground cover ▪ Installation of drainage ditches ▪ Runoff and retention ponds ▪ Minimise disturbances and scarification of the surface ▪ Usage of appropriate monitoring and control facilities for construction equipments deployed ▪ Methods to reuse earth material generated during excavation
Resources – fuel/construction material, *etc.*	▪ Availing the resources which could be replenished by natural systems, *etc.*
Deforestation	▪ Plant or create similar areas ▪ Initiate a tree planning program in other areas ▪ Donate land to conservationalist groups
Water pollution (Ground water/ Surface water)	▪ Conjunctive use of ground/surface water, to prevent flooding/water logging/depletion of water resources. Included are land use pattern, land filling, lagoon/reservoir/garland canal construction, and rainwater harvesting and pumping rate. ▪ Stormwater drainage system to collect surface runoff ▪ Minimise flow variation from the mean flow ▪ Storing of oil wastes in lagoons should be minimised in order to avoid possible contamination of the ground water system. ▪ All effluents containing acid/alkali/organic/toxic wastes should be properly treated. ▪ Monitoring of ground waters ▪ Use of biodegradable or otherwise readily treatable additives ▪ Neutralization and sedimentation of wastewaters, where applicable ▪ Dewatering of sludges and appropriate disposal of solids ▪ In case of oil waste, oil separation before treatment and discharge into the environment ▪ By controlling discharge of sanitary sewage and industrial waste into the environment ▪ By avoiding the activities that increases erosion or that contributes nutrients to water (thus stimulating alga growth) ▪ For wastes containing high TDS, treatment methods include removal of liquid and disposal of residue by controlled landfilling to avoid any possible leaching of the fills

Impacts	Typical Mitigation Measures
	▪ All surface runoffs around mines or quarries should be collected treated and disposed. ▪ Treated wastewater (such as sewage, industrial wastes, or stored surface runoffs) can be used as cooling water makeup. ▪ Wastewater carrying radioactive elements should be treated separately by means of de-watering procedures, and solids or brine should be disposed of with special care. ▪ Develop spill prevention plans in case of chemical discharges and spills ▪ Develop traps and containment system and chemically treat discharges on site
Air Pollution	▪ Periodic checking of vehicles and construction machinery to ensure compliance to emission standards ▪ Attenuation of pollution/protection of receptor through green belts/green cover ▪ Dilution of odourant (dilution can change the nature as well as strength of an odour), odour counteraction or neutralise (certain pairs of odours in appropriate concentrations may neutralise each other), odour masking or blanketing (certain weaker malodours may be suppressed by a considerably stronger good odour). ▪ Regular monitoring of air polluting concentrations
Dust pollution	▪ Adopt sprinkling of water ▪ Wetting of roadways to reduce traffic dust and re-entrained particles ▪ Control vehicle speed on sight ▪ Ensure priodical washing of construction equipment and transport vehicles to prevent accumulated dust ▪ Ensure that vehicles should be covered during transportation ▪ Installation of windscreens to breakup the wind flow ▪ Burning of refuse on days when meteorological conditions provide for good mixing and dispersion ▪ Providing dust collection equipment at all possible points ▪ Maintaining dust levels within permissible limits ▪ Provision for masks when dust level exceeds
Noise pollution	▪ Use of suitable muffler systems/enclosures/sound-proof glass panelling on heavy equipment/pumps/blowers ▪ Pumps and blowers may be mounted on rubber pads or any other noise absorbing materials ▪ Limiting certain activities ▪ Proper scheduling of high noise generating activities to minimise noise impacts ▪ Usage of well maintained construction equipment meeting the regulatory standards ▪ Placement of equipments emitting high noise in an orientation that directs the noise away from sensitive receptors ▪ Periodic maintenance of equipments/repalcing whenever necessary/lubrication of rotating parts, *etc.* ▪ By using damping, absorption, dissipation, and deflection methods ▪ By using common techniques such as constructing sound enclosures, applying mufflers, mounting noise sources on isolators, and/or using materials with damping properties ▪ Performance specifications for noise represent a way to insure the procured item is controlled ▪ Use of ear protective devices.

Impacts	Typical Mitigation Measures
	▪ In case of steady noise levels above 85-dB (A), initiation of hearing conservation measures ▪ Implementation of greenbelt for noise attentuation may be taken up
Biological	▪ Installation of systems to discourage nesting or perching of birds in dangerous environments ▪ Increased employee awareness to sensitive areas
Social	▪ Health and safety measures for workers ▪ Development of traffic plan that minimises road use by workers ▪ Upgrade of roads and intersections ▪ Provide sufficient counselling and time to the affected population for relocation ▪ Discuss and finalize alternate arrangements and associated infrastructure in places of religious importance ▪ Exploration of alternative approach routes in consultation with local community and other stakeholders ▪ Provision of alternate jobs in unskilled and skilled categories
Marine	▪ Water quality monitoring program ▪ Limit construction activities to day time to provide recuperation time at night and reduce turbidity ▪ Prevention of spillage of diesel, oil, lubes, *etc.* ▪ Usage of appropriate system to barges/workboats for collection of liquid/solid waste generated onboard ▪ Avoid discharge of construction/dredging waste (lose silt) into sea. It may be disposed at the identified disposal point. ▪ Ensure usage of suitable/proper equipment for dredging in order to minimise the turbidity and suspensions at the dredging site. ▪ Checking with the complainace conditions before discharging wastes into the sea water ▪ Have a post-dregding monitoring programme in place ▪ Take up periodic maintenance dredging including inspectionof sub-sea conditions, *etc.*
Occupational health and safety	▪ Provision of worker camps with proper santiation and medical facilities, as well as making the worker camps self- sufficient with resources like water supply, power supply, etc ▪ Arrangement of periodic health check-ups for early detection and control of communicatble diseases. ▪ Arrangement to dispose off the wastes at approved disposal sites. ▪ Provide preventive measures for potentital fire hazards with requisite fire detection, fire-fighting facilities and adequate water storage
Construction	▪ Have a Transport Management Plan in place in order to prevent/minimise the disturbance on surrounding habitats ▪ Initiate traffic density studies
Solid/Hazardous waste	▪ Proper handling of excavated soil ▪ Proper plan to collect and dispose off the solid waste generated onsite. ▪ Identify an authorized waste handler for segregation of construction and hazardous waste and its removal on a regular basis to minimise odour, pest and litter impacts ▪ Prohibit burning of refuse onsite.

4.8 Environmental Management Plan

A typical EMP shall be composed of the following:

1. summary of the potential impacts of the proposal
2. description of recommended mitigation measures
3. description of monitoring programme to ensure compliance with relevant standards and residual impacts
4. allocation of resources and responsibilities for plan implementation
5. implementation schedule and reporting procedures
6. contingency plan when impacts are greater than expected

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

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

Description of monitoring programme to ensure compliance with relevant standards and residual impacts: Environmental monitoring refers to compliance monitoring and residual impact monitoring. Compliance monitoring refers to meeting the industry-specific statutory compliance requirements (Ref. Applicable National regulations as detailed in Chapter 3).

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

Allocation of resources and responsibilities for plan implementation: These should be specified for both the initial investment and recurring expenses for implementing all measures contained in the EMP, integrated into the total project costs, and factored into loan negotiation.

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

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

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

Contingency Plan when the impacts are greater than expected: There shall be a contingency plan for attending the situations where the monitoring results shows residual impacts are higher than expected. It is an imperative requirement for all the project Authorities to plan additional programmes to deal with the situation, after duly intimating the concerned local regulatory bodies.

4.9 Reporting

Structure of the EIA report (Appendix III of the EIA Notification), applicable for synthetic organic chemicals industry is given in the Table 4.6. Each task prescribed in ToR shall be incorporated appropriately in the contents in addition to the contents described in the table.

Table 4-6: Structure of EIA Report

S.No	EIA Structure	Contents
1.	Introduction	▪ Purpose of the report ▪ Identification of project & project proponent ▪ Brief description of nature, size, location of the project and its importance to the country, region ▪ Scope of the study – details of regulatory scoping carried out (As per Terms of Reference)
2.	Project Description	Condensed description of those aspects of the project (based on project feasibility study), likely to cause environmental effects. Details should be provided to give clear picture of the following: ▪ Type of project ▪ Need for the project ▪ Location (maps showing general location, specific location, project boundary & project site layout) ▪ Size or magnitude of operation (incl. Associated activities required by or for the project) ▪ Proposed schedule for approval and implementation ▪ Technology and process description ▪ Project description including drawings showing project layout, components of project *etc.* Schematic representations of the feasibility drawings which give information important for EIA purpose ▪ Description of mitigation measures incorporated into the project to meet environmental standards, environmental operating conditions, or other EIA requirements (as required by the scope) ▪ Assessment of new & untested technology for the risk of technological failure
3.	Description of the Environment	▪ Study area, period, components & methodology ▪ Establishment of baseline for VECs, as identified in the scope ▪ Base maps of all environmental components
4.	Anticipated Environmental Impacts &	▪ Details of Investigated Environmental impacts due to project location, possible accidents, project design, project construction, regular operations, final decommissioning or rehabilitation of a completed project

S.No	EIA Structure	Contents
	Mitigation Measures	▪ Measures for minimizing and / or offsetting adverse impacts identified ▪ Irreversible and irretrievable commitments of environmental components ▪ Assessment of significance of impacts (Criteria for determining significance, Assigning significance) ▪ Mitigation measures
5.	Analysis of Alternatives (Technology & Site)	▪ Incase, the scoping exercise results in need for alternatives: ▪ Description of each alternative ▪ Summary of adverse impacts of each alternative ▪ Mitigation measures proposed for each alternative and selection of alternative
6.	Environmental Monitoring Program	▪ Technical aspects of monitoring the effectiveness of mitigation measures (incl. measurement methodologies, frequency, location, data analysis, reporting schedules, emergency procedures, detailed budget & procurement schedules)
7.	Additional Studies	▪ Public consultation ▪ Risk assessment ▪ Social impact assessment, R&R action plans
8.	Project Benefits	▪ Improvements in physical infrastructure ▪ Improvements in social infrastructure ▪ Employment potential –skilled; semi-skilled and unskilled ▪ Other tangible benefits
9.	Environmental Cost Benefit Analysis	▪ If recommended at the scoping stage
10.	EMP	▪ Description of the administrative aspects that ensures proper implementation of mitigative measures and their effectiveness monitored, after approval of the EIA
11.	Summary & Conclusion (This will constitute the summary of the EIA Report)	▪ Overall justification for implementation of the project ▪ Explanation of how, adverse effects have been mitigated
12.	Disclosure of Consultants engaged	▪ Names of the Consultants engaged with their brief resume and nature of Consultancy rendered

4.10 Public Consultation

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

- Public consultation is not a decision taking process, but is a process to collect views of the people having plausible stake. If the SPCB/Public agency conducting public hearing is not convinced with the plausible stake, then such expressed views need not be considered.
- Public consultation involves two components, one is public hearing, and other one is inviting written responses/objections through Internet/by post, *etc.*, by placing the summary of EIA report on the web site.
- All Category A and Category B1 projects require public hearing except the following:

  - Once prior environmental clearance is granted to an industrial estates/SEZs/EPZs *etc.*, for a given composition (type and capacity) of industries, then individual units will not require public hearing
  - Expansion of roads and highways, which do not involve any further acquisition of land.
  - Maintenance dredging provided the dredged material shall be disposed within port limits
  - All building/construction projects/area development projects/townships
  - All Category B2 projects
  - All projects concerning national defense and security or involving other strategic considerations as determined by the Central Government

- Public hearing shall be carried out at the site or in its close proximity, district-wise, for ascertaining concerns of local affected people.

- Project proponent shall make a request through a simple letter to the Member–Secretary of the SPCB/UTPCC to arrange public hearing.

- Project proponent shall enclose with the letter of request, at least 10 hard copies and 10 soft copies of the draft EIA report including the summary EIA report in English and in official language of the State/local language prepared as per the approved scope of work, to the concerned Authority.

- Simultaneously, project proponent shall arrange to send, one hard copy and one soft copy, of the above draft EIA report along with the summary EIA report to the following Authorities within whose jurisdiction the project will be located:

  - District magistrate/District Collector/Deputy Commissioner (s)
  - Zilla parishad and municipal corporation or panchayats union
  - District industries office
  - Urban local bodies (ULBs)/PRIs concerned/development authorities
  - Concerned regional office of the MoEF/SPCB

- Above mentioned Authorities except regional office of MoEF shall arrange to widely publicize the draft EIA report within their respective jurisdictions requesting the interested persons to send their comments to the concerned regulatory Authorities. They shall also make draft EIA report for inspection electronically or otherwise to the public during normal office hours till the public hearing is over.

- Concerned regulatory Authority (MoEF/SEIAA/UTEIA) shall display the summary of EIA report on its website and also make full draft EIA report available for reference at a notified place during normal office hours at their head office.

- SPCB or UTPCC concerned shall also make similar arrangements for giving publicity about the project within the State/UT and make available the summary of draft EIA report for inspection in select offices, public libraries or any other suitable location, *etc.* They shall also additionally make available a copy of the draft EIA report to the above five authorities/offices as mentioned above.

- The Member–Secretary of the concerned SPCB or UTPCC shall finalize the date, time and exact venue for the conduct of public hearing within seven days of the date of the receipt of the draft EIA report from the project proponent and advertise the same in one major National Daily and one Regional vernacular Daily/official State language.

- A minimum notice period of 30 (thirty) days shall be provided to the public for furnishing their responses.

- No postponement of the date, time, venue of the public hearing shall be undertaken, unless some untoward emergency situation occurs. Only in case of emergencies and up on recommendation of the concerned District Magistrate/District Collector/Deputy Commissioner, the postponement shall be notified to the public through the same National and Regional vernacular dailies and also prominently displayed at all the identified offices by the concerned SPCB/ UTPCC
- In the above exceptional circumstances fresh date, time and venue for the public consultation shall be decided by the Member–Secretary of the concerned SPCB/ UTPCC only in consultation with the District Magistrate/District Collector/Deputy Commissioner and notified afresh as per the procedure.
- The District Magistrate/District Collector/Deputy Commissioner or his or her representative not below the rank of an Additional District Magistrate assisted by a representative of SPCB or UTPCC, shall supervise and preside over the entire public hearing process.
- The SPCB/UTPCC shall arrange to video film the entire proceedings. A copy of the videotape or a CD shall be enclosed with the public hearing proceedings while forwarding it to the Regulatory Authority concerned.
- The attendance of all those who are present at the venue shall be noted and annexed with the final proceedings
- There shall be *no quorum* required for attendance for starting the proceedings
- Persons present at the venue shall be granted the opportunity to seek information or clarifications on the project from the proponent. The summary of the public hearing proceedings accurately reflecting all the views and concerns expressed shall be recorded by the representative of the SPCB/UTPCC and read over to the audience at the end of the proceedings explaining the contents in the local/vernacular language and the agreed minutes shall be signed by the District Magistrate/District Collector/Deputy Commissioner or his or her representative on the same day and forwarded to the SPCB/UTPCC concerned.
- A statement of the issues raised by the public and the comments of the proponent shall also be prepared in the local language or the official State language, as the case may be and in English and annexed to the proceedings.
- The proceedings of the public hearing shall be conspicuously displayed at the office of the Panchayats within whose jurisdiction the project is located, office of the concerned Zilla Parishad, District Magistrate/District Collector/Deputy Commissioner, and the SPCB or UTPCC. The SPCB/ UTPCC shall also display the proceedings on its website for general information. Comments, if any, on the proceedings, may be sent directly to the concerned regulatory authorities and the Applicant concerned.
- The public hearing shall be completed within a period of 45 (forty five) days from date of receipt of the request letter from the Applicant. Therefore the SPCB or UTPCC concerned shall send the public hearing proceedings to the concerned regulatory authority within eight (8) days of the completion of the public hearing. Simultaneously, a copy will also be provided to the project proponent. The proponent may also directly forward a copy of the approved public hearing proceedings to the regulatory authority concerned along with the final EIA report or supplementary report to the draft EIA report prepared after the public hearing and public consultations incorporating the concerns expressed in the public hearing along with action plan and financial allocation, item-wise, to address those concerns.

- Upon receipt of the same, the Authority will place executive summary of the report on the website to invite responses from other concerned persons having a plausible stake in the environmental aspects of the project or activity.
- If SPCB/UTPCC is unable to conduct public hearing in the prescribed time, the Central Government incase of Category A projects and State Government or UT administration in case of Category B projects at the request of the SEIAA may engage any other agency or Authority for conducting the public hearing process within a further period of 45 days. The respective governments shall pay the appropriate fee to the public agency for conducting public hearing.
- A public agency means a non-profit making institution/ body such as technical/academic institutions, government bodies not subordinate to the concerned Authority.
- If SPCB/Public Agency authorized for conducting public hearing informs the Authority, stating that it is not possible to conduct the public hearing in a manner, which will enable the views of the concerned local persons to be freely expressed, then Authority may consider such report to take a decision that in such particular case, public consultation may not have the component of public hearing.
- Often restricting the public hearing to the specific district may not serve the entire purpose, therefore, NGOs who are local and registered under the Societies Act in the adjacent districts may also be allowed to participate in public hearing, if they so desire.
- Confidential information including non-disclosable or legally privileged information involving intellectual property right, source specified in the application shall not be placed on the website.
- The Authority shall make available on a written request from any concerned person the draft EIA report for inspection at a notified place during normal office hours till the date of the public hearing.
- While mandatory requirements will have to be adhered to, utmost attention shall be given to the issues raised in the public hearing for determining the modifications needed in the project proposal and the EMP to address such issues.
- Final EIA report after making needed amendments, as aforesaid, shall be submitted by the applicant to the concerned Authority for prior environmental clearance. Alternatively, a supplementary report to draft EIA and EMP addressing all concerns expressed during the public consultation may be submitted.

4.11 Appraisal

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

- The appraisal shall be made by EAC to the Central Government or SEAC to SEIAA.
- Project proponent either personally or through consultant can make a presentation to EAC/SEAC for the purpose of appraising the features of the project proposal and also to clarify the issues raised by the members of the EAC/SEAC.
- On completion of these proceedings, concerned EAC/SEAC shall make categorical recommendations to the respective Authority, either for grant of prior environmental

clearance on stipulated terms & conditions, if any, or rejection of the application with reasons.

- In case EAC/SEAC needs to visit the site or obtain further information before being able to make categorical recommendations, EAC/SEAC may inform the project proponent accordingly. In such an event, it should be ensured that the process of prior environmental clearance is not unduly delayed to go beyond the prescribed timeframe.
- Up on the scrutiny of the final report, if EAC/SEAC opines that ToR for EIA studies finalized at the scoping stage are covered by the proponent, then the project proponent may be asked to provide such information. If such information is declined by the project proponent or is unlikely to be provided early enough so as to complete the environmental appraisal within prescribed time of 60 days, the EAC/SEAC may recommend for rejection of the proposal with the same reason.
- Appraisal shall be strictly in terms of ToR for EIA studies finalized at the scoping stage and the concerns expressed during public consultation.
- This process of appraisal shall be completed within 60 days from the receipt of the updated EIA report and EMP reports, after completing public consultation.
- The EIA report will be typically examined for following:
  - Project site description supported by topographic maps & photographs – detailed description of topography, land use and activities at the proposed project site and its surroundings (buffer zone) supported by photographic evidence.
  - Clarity in description of drainage pattern, location of eco-sensitive areas, vegetation characteristics, wildlife status - highlighting significant environmental attributes such as feeding, breeding and nesting grounds of wildlife species, migratory corridor, wetland, erosion and neighboring issues.
  - Description of the project site – how well the interfaces between the project related activities and the environment have been identified for the entire project cycle *i.e* construction, operation and decommissioning at the end of the project life.
  - How complete and authentic are the baseline data pertaining to flora and fauna and socio-economic aspects?
  - Citing of proper references, with regard to the source(s) of baseline data as well as the name of the investigators/investigating agency responsible for collecting the primary data.
  - How consistent are the various values of environmental parameters with respect to each other?
  - Is a reasonable assessment of the environmental and social impact made for the identified environmental issues including project affected people?
  - To what extent the proposed environmental plan will mitigate the environmental impact and at what estimated cost, shown separately for construction, operation and closure stages and also separately in terms of capital and recurring expenses along with details of agencies that will be responsible for the implementation of environmental plan/ conservation plan.
  - How well the concerns expressed/highlighted during the public hearing have been addressed and incorporated in the EMP giving item wise financial provisions and commitments (in quantified terms)?

- How far the proposed environmental monitoring plan will effectively evaluate the performance of EMP? Are details for environmental monitoring plan provided in the same manner as the EMP?
- Identification of hazard and quantification of risk assessment and whether appropriate mitigation plan has been included in the EMP?
- Does the proposal include a well formulated time bound green belt development plan for mitigating environmental problems such as fugitive emission of dust, gaseous pollutants, noise, odour, *etc.*
- Does EIA make a serious attempt to guide the project proponent for minimizing the requirement of natural resources including land, water energy and other non renewable resources?
- How well has the EIA statement been organized and presented so that the issues, their impact and environmental management strategies emerge clearly from it and how well organized was the power point presentation made before the expert committee?
- Is the information presented in the EIA adequately and appropriately supported by maps, imageries and photographs highlighting site features and environmental attributes?

4.12 Decision Making

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

Approval / Rejection / Reconsideration

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

shall make the application liable for rejection, and cancellation of prior environmental clearance granted on that basis. Rejection of an application or cancellation of a prior environmental clearance already granted, on such ground, shall be decided by the regulatory authority, after giving a personal hearing to the applicant, and following the principles of natural justice.

If approved

- MoEF or concerned SEIAA will issue a prior environmental clearance for the project.
- The project proponent should make sure that the award of prior environmental clearance is properly publicized in at least two local newspapers of the district or state where the proposed project is located. For instance, the executive summary of the prior environmental clearance may be published in the newspaper along with the information about the location (website/office where it is displayed for public) where the detailed prior environmental clearance is made available. The MoEF and SEIAA/UTEIAA, as the case may be, shall also place the prior environmental clearance in the public domain on Government Portal. Further copies of the prior environmental clearance shall be endorsed to the Heads of local bodies, Panchayats and Municipal bodies in addition to the relevant offices of the Government.
- The prior environmental clearance will be valid from the start date to actual commencement of the production of the developmental activity.
- Usual validity period will be 5 years from the date of issuing environmental clearance, unless specified by EAC/SEAC.
- A prior environmental clearance issued to a project proponent can be transferred to another legal person entitled to undertake the project, upon application by the transferor to the concerned Authority or submission of no-objection of the transferor by the transferee to the concerned Authority for the concurrence. In this case, EAC/SEAC concurrence is not required, but approval from the concerned authority is required to avail the same project configurations, validity period transferred to the new legally entitled person to undertake the project.

4.13 Post-clearance Monitoring Protocol

The MoEF, Government of India will monitor and take appropriate action under the EP Act, 1986.

- In respect 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 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 proponents website permanently.
- In respect of Category B projects, irrespective of its clearance by MoEF/SEIAA, the project proponent shall prominently advertise in the newspapers indicating that the project has been accorded environment clearance and the details of MoEF website where it is displayed.
- The MoEF and the SEIAAs/UTEIAAs, as the case may be, shall also place the environmental clearance in the public domain on Government Portal.
- Copies of the environmental clearance shall be submitted by the project proponents to the Heads of the local bodies, Panchayats and Municipal bodies in addition to the

relevant offices of the Government who in turn have to display the same for 30 days from the date of receipt.

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

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

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

5.
STAKEHOLDERS' ROLES AND RESPONSIBILITIES

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

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

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

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

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

Stage	MoEF/ SEIAA	EAC/ SEAC	Project Proponent	EIA Consultant	SPCB/ Public Agency	Public and Interest Group
	summary of EIA report in the website Conveys objections to the project proponent for update, if any		EMP accordingly		the Authority and the project proponent as well	Internet in response to the summary placed in the website
Appraisal and Clearance	Receives updated EIA Takes advice of EAC/ SEAC, approves EIA and attaches the terms and conditions	Critically examines the reports, presentation of the proponent and appraises MoEF/ SEIAA (recommendations are forwarded to MoEF/ SEIAA)	Submits updated EIA, EMP reports to MoEF/SEIAA. Presents the overall EIA and EMP including public concerns to EAC/SEAC	Provides technical advise to the project proponent and if necessary presents the proposed measures for mitigation of likely impacts (terms and conditions of clearance)		
Post-clearance Monitoring			Implements environmental protection measures prescribed and submits periodic monitoring results	Conducts periodic monitoring	Incorporates the clearance conditions into appropriate consent conditions and ensures implementation	

Table 5-2: Organization-specific Functions

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

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

5.1 SEIAA

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

A. Constitution

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

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

B. Composition

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

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

C. Decision-making process

- The decision of the Authority shall be arrived through consensus.
- If there is no consensus, the Authority may either ask SEAC for reconsideration or may reject the approval.
- All decisions of the SEIAA shall be taken in a meeting and shall ordinarily be unanimous. In case a decision is taken by majority, the details of views, for and against the decision, shall be clearly recorded in minutes of meeting and a copy thereof be sent to MoEF.

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

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

S. No.	Attribute	Requirement		
		Members	**Member–Secretary**	**Chairperson**
4	Age	Below 67 years at the time of Notification of the Authority	As per State Government Service Rules	Below 72 Years at the time of the Notification of the Authority
5	Other memberships in Central/State Expert Appraisal committee	Shall not be a member in any SEIAA/EAC/SEAC	Shall not be a member in any SEIAA/EAC/SEAC	Shall not be a member in any SEIAA/EAC/SEAC
6	Tenure of earlier appointment (continuous)	Only one term before this in continuity is permitted	Not applicable	Only one term before this in continuity is permitted
7	Eminent environmental expertise with understanding on environmental aspects and impacts	Desirable	Desirable	Compulsory
8	Expertise in the environmental clearance process	Desirable	Desirable	Compulsory

Notes:

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

2. Chairperson/Member once notified may not be removed prior to the tenure of three years without cause and proper enquiry.

5.2 EAC and SEAC

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

A. Constitution

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

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

B. Composition

- Composition of EAC/SEAC as per the Notification is given in **Annexure XII.**
- Secretary to EAC/SEAC may invite a maximum of two professionals/experts with the prior approval of the Chairperson, if desired, for taking the advisory inputs for appraisal. In such case, the invited experts will not take part in the decision making process.
- The Secretary of each EAC/SEAC preferably be an officer of the level equivalent to or above the level of Director, MoEF, GoI.

C. Decision making

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

D. Operational issues

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

i. Tenure of EAC/SEIAA/SEAC

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

ii. Qualifying criteria for nomination of a member to EAC/SEIAA/SEAC

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

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

These are elaborated subsequently.

a) Professional qualification

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

b) Relevant experience

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

c) Absence of conflict of interest

For the deliberations of the EAC/SEAC to be independent and unbiased, all possibilities of potential conflict of interests have to be eliminated. Therefore, serving government officers; persons engaged in industry and their associations; persons associated with the formulation of development projects requiring prior environmental clearance, and persons associated with environmental activism shall not be considered for membership of SEIAA/ SEAC/ EAC.

iii. Age

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

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

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

S. No.	Attribute		Requirement		
			Expert members	**Secretary**	**Chairperson**
1	Professional qualification as per the Notification		Compulsory	Compulsory	Compulsory
2	Experience (Fulfilling any one of a, b, c)	a	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI
		b	Professional Qualification +PhD+10 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification +PhD+10 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification +PhD+10 years of experience in one of the expertise area mentioned in Appendix VI
		c	Professional Qualification +10 years of experience in one of the expertise area mentioned in the Appendix VI + 5 years interface with environmental issues, problems and their management	Professional Qualification +10 years of experience in one of the expertise area mentioned in the Appendix VI + 5 years interface with environmental issues, problems and their management	-------------
3	Test of independence (conflict of interest) and minimum grade of the Secretary of the Committees		Shall not be a serving government officer Shall not be a person engaged in industry and their associations Shall not be a person associated with environmental activism	In case of EAC, not less than a Director from the MoEF, Government of India Incase of SEAC, not below the level of Director/Chief Engineer from the State Government (DoE)	Shall not be a serving government officer Shall not be a person engaged in industry and their associations Shall not be a person associated with environmental activism
4	Age		Below 67 years at the time of Notification of the Committee	As per state Government Service Rules	Below 72 Years at the time of the Notification of the Committee
5	Membership in Central/State Expert Appraisal committee		Only one other than this nomination is permitted	Shall not be a member in other SEIAA/EAC/SEAC	Shall not be a member in any other SEIAA/EAC/SEAC
6	Tenure of earlier appointment (continuous)		Only one term before this in continuity is permitted	Not applicable	Only one term before this in continuity is permitted

S. No.	**Attribute**	**Requirement**		
		Expert members	**Secretary**	**Chairperson**
7	Eminent environmental expertise with understanding on environmental aspects and impacts	Desirable	Not applicable	Compulsory

Notes:

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

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

E. Other conditions that may be considered

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

ANNEXURE I
Common Unit Processes and Connected Operations

Common Unit Processes and Connected Operations

A) Oxidation

Oxidation generally means the addition of an electron-donating atom (such as oxygen) and/or the removal of hydrogen to a compound. For example, formaldehyde is formed by removing two hydrogen atoms from methanol, as shown in the following equation. Oxygen and a metal catalyst, such as silver, typically are used in the reaction.

Oxidation with inorganic agents

Chemical oxidation with inorganic agents is still industrially important, due to the fact that reactions with molecular oxygen are usually considerably less selective and generally require much higher investment, thereby only becoming economically worthwhile for capacities above about 10000 tonnes per year, depending on the product.

Table 1 gives an overview of the main aspects important in the selection of a suitable oxidation agent, the related by-products and some other characteristics. In case of CrO_3 and MnO_2, the agent by-products are often regenerated.

Table 1: Overview of oxidations with inorganic agents

Agent	**Target molecules**	**Agent by-product**	**Typical solvents/ other aspects**
CrO_3 “Chromic acid”	Benzoic acids, benzaldehydes	Cr_2O_3	Acetic acid, acetic anhydrides
$KmnO_4$	Benzoic acids, benzaldehydes	MnO_2	
MnO_2	Benzaldehydes	Mn^{2+}	Aqueous H_2SO_4
HNO_3	Benzoic acids	NOX	In situ regeneration of NO to HNO_3 with oxygen
NaOCl	Stilbenes	NaCl	
Cl_2	Sulphones, sulphochlorides, chloranil	HCl	
Agent	Target molecules	Agent by-product	Typical solvents/ other aspects
CrO_3 “Chromic acid”	Benzoic acids, benzaldehydes	Cr_2O_3	Acetic acid, acetic anhydrides
$KMnO_4$	Benzoic acids, benzaldehydes	MnO_2	
MnO_2	Benzaldehydes	Mn^{2+}	Aqueous H2SO4
HNO_3	Benzoic acids	NOX	In situ regeneration of NO to HNO3 with oxygen

Agent	Target molecules	Agent by-product	Typical solvents/ other aspects
NaOCl	Stilbenes	NaCl	
Cl_2	Sulphones, sulphochlorides, chloranil	HCl	

The term oxidation includes many different processes, but in general it describes the addition of one or more oxygen atoms to a compound. Atmospheric oxygen is by far the most important, and the cheapest, oxidising agent although the inert nitrogen component will dilute products and generate waste gas streams. Other oxidising agents include nitric acid, sulphuric acid, oleum, hydrogen peroxide, organic peroxides and pure oxygen. In general terms, organic materials can be oxidised either by heterolytic or homolytic reactions, or by catalytic reactions (where the oxidising agent is reduced and then re-oxidised). Heterogeneous catalysts based on noble metals play a dominant role in industrial scale oxidations and an important example is the silver catalysed gas phase reaction between ethylene and oxygen to form ethylene oxide. Ethylene is still the only olefin that can be directly oxidised to its epoxide with high selectivity. Other important industrial oxidation processes are the production of acetic acid, formaldehyde, phenol, acrylic acid, acetone and adipic acid. Oxidation reactions are exothermic and heat can be re-used in the process to generate steam or to preheat other component streams. Fire and explosion risks exist with heterogeneously catalysed direct oxidation processes (e.g. ethylene oxide process) and reactions involving concentrated hydrogen peroxide or organic peroxides.

Environmental Issues of Oxidation Processes

The oxidation of organic compounds produces a number of by-products (including water) and wastes from partial and complete oxidation. In the organic chemical industry, such compounds as aldehydes, ketones, acids and alcohols are often the final products of partial oxidation of hydrocarbons. Careful control of partial oxidation reactions is usually required to prevent the material from oxidising to a greater degree than desired as this produces carbon dioxide and many undesirable gaseous, liquid, or semi-solid toxic by-products.

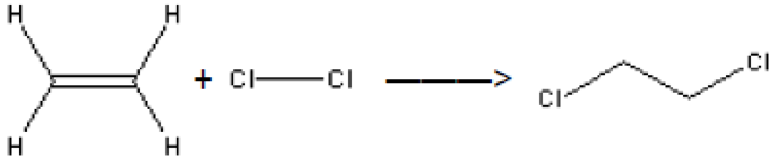
- Air: Emissions of volatile organics can arise from losses of unreacted feed, by-products and products such as aldehydes and acids. Carbon dioxide is an omnipresent by-product in the oxidation of organic compounds since it is impossible to prevent the full oxidation of some carbon. Aldehydes, especially formaldehyde, require strict handling to minimise occupational exposure and this limits atmospheric emissions. Acid gases usually require removal from waste streams. In general terms, oxidation reactions are exothermic and they provide good opportunities for the recovery and re-use of heat.

- Water: To enable biological degradation in a WWTP it will be necessary to neutralise any acidic components and to remove / destroy any chlorinated species that may inhibit biological activity.

- Wastes: oxidation reactions may produce tars and ashes. spent catalysts

B) Halogenation

Halogenation is a process of adding a halogen atom on an organic compound. (Halogen is the collective name for fluorine, chlorine, bromine, and iodine.) This is an important step in making chlorinated solvents such as ethylene dichloride. The following equation shows a simplified version of the halogenation of ethylene to form ethylene dichloride. This particular reaction generally is conducted with an iron chloride catalyst. (A catalyst is material that facilitates a reaction but is not actually consumed in the process).



Chemical reaction

These chemicals are of major relevance on an industrial scale in substitutions of the aromatic nucleus and in the substitution of aliphates. In both cases, hydrogen is replaced by halogen (X) and the related hydrogen halide is created:

$$R-H \quad + \quad X_2 \quad \rightarrow \quad R-X \quad + \quad HX$$

$$Ar-H \quad + \quad X_2 \quad \rightarrow \quad Ar-X \quad + \quad HX$$

Both reactions are exothermic but the aliphate substitution follows a radical chain mechanism, initialised by ultraviolet light (irradiation with mercury vapour lamps), while the halogenation of the aromatic nucleus is based on an electrophilic mechanism supported by Friedel-Crafts catalysts (i.e. Lewis acids such as FeCl3, AlCl3 …). Generally, a mixture of isomers and/or compounds with a different degree of halogenation is obtained and side reactions following alternative mechanisms cannot be completely suppressed. The product mix depends on the aromatic/halogen ratio, the reaction conditions and the choice of the catalyst.

A wide range of organic and aqueous solvents are currently in use, and especially tetrachloromethane, tetrachloroethane, dichlorobenzene and trichlorobenzene are recommended for halogenations Bromine is more efficiently used in aromatic substitution reactions if it is generated in situ from hydrogen bromide using chlorine:

$$ArH \quad + \quad HBr \quad + \quad Cl_2 \quad \rightarrow \quad ArBr \quad + \quad 2\,HCl$$

Another approach is the use of an alcohol as the solvent to co-produce an economically useful alkyl bromide, by the reaction of by-product HBr with the alcohol. Methanol is the solvent of choice since the resulting methyl bromide can be widely marketed as a fumigant.

Side chain chlorination of toluenes

Side chain chlorination (Figure 1) is applied in particular to toluenes, to give the analogue benzyl chlorides, benzyl dichlorides and benzyl trichlorides. The reaction follows the radical chain mechanism and leads in every chlorination step to the formation of hydrogen chloride. The process yields a mixture of all three products, with the product mix depending mainly on the toluene/chlorine ratio.

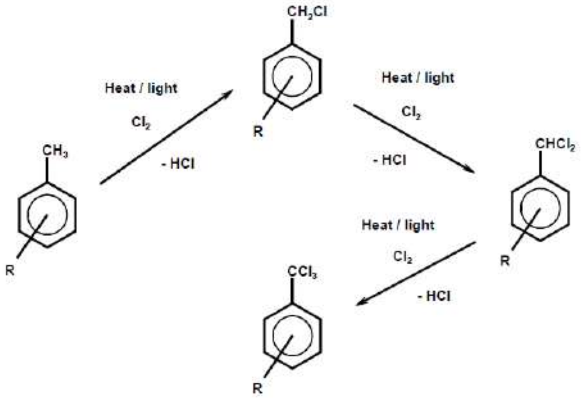


Figure 1: Side chain chlorination of toluene derivates

Possible side reactions can yield polychlorobiphenyls or hexachlorobenzene as shown in the following equations:

A common following step is the partial hydrolysis of the obtained products to the analogue benzaldehydes or benzoyl chlorides by alkaline or acidic agents.

Figure 2 shows a typical sequence of operations for the halogenation to distillable products. Figure 3 shows a typical sequence of operations for the halogenation precipitation of the product.

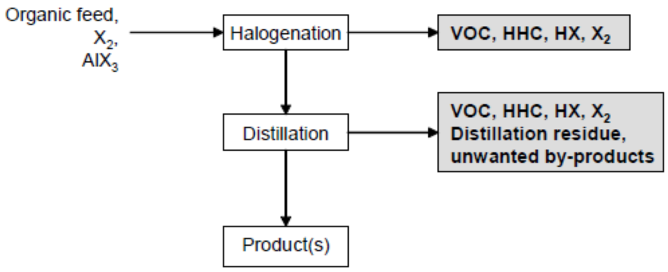


Figure 2: Typical sequence of operations for the halogenation to distillable products (Inputs on left and waste streams on right with grey background)

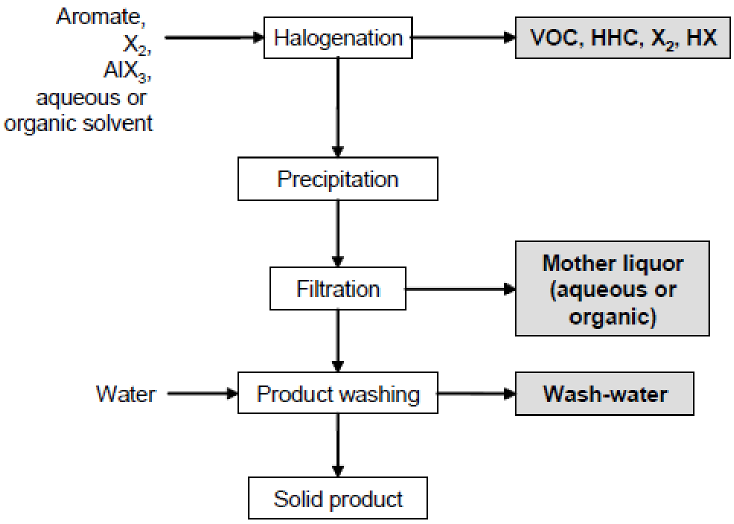


Figure 3: Typical sequence of operations for halogenation with precipitation of the products (Inputs on left and waste streams on right with grey background)

In a typical batch reaction, the halogen is added to the stirred aromatic or a stirred romatic solution. The reactor material depends on the reactants and the chosen reaction mechanism. The exothermic reaction is controlled by the rate of halogen addition, which is dependent on the refrigeration capacity of the reactor cooling system. The choice of temperature profile is based on the reactivity of the aromatic. On completion of the reaction, degassing is carried out with nitrogen. The product is distilled or precipitated (e.g. by cooling or water addition) and the resulting slurry is filtered, washed and dried.

Most side chain chlorinations are carried out continuously or discontinuously in bubble column reactors of enamel or glass, e.g. of the loop type. The reactor is filled with the starting material, heated to at least 80°C and chlorine is introduced until the desired degree of chlorination is reached. The reaction is stopped by the introduction of N2. Products of different degrees of chlorination are separated by distillation to be directly marketed, hydrolised to give the related benzaldehydes or benzoic acids/benzoyl chlorides, or are used for further chlorination.

Halogenation describes the introduction of halogen atoms into an organic molecule by addition or substitution reactions. In organic synthesis this may involve the addition of molecular halogens (e.g. Cl_2, Br_2, I_2 or F_2) or hydrohalogenation (with HCl, HBr or HF) to carbon-carbon double bonds. Substitution reactions involve replacing hydrogen atoms in olefins, paraffins or aromatics with halogen atoms. Chlorination is the most important industrial halogenation reaction. Chlorinated organic products include chlorinated aromatics, phosgene, chlorinated methanes, chlorinated ethanes and toxicity issues may demand additional control measures.

Environmental issues of halogenation processes

Air: The treatment of waste gases first requires a distinction between acidic streams, reaction gases and neutral waste streams. Air streams from tanks, distillation columns and process vents can be collected and treated using such techniques as low temperature condensation or incineration. The treatment of acid streams is more problematic since any equipment in contact with acid gases and water must be constructed in acid-resistant materials or internally coated. The halogen content of the waste gas represents a valuable raw material and pollution control techniques offer an opportunity for its recovery and re-use (either as hydrogen-halogen or aqueous solutions). The techniques may include:

- product recovery (by vapour stripping of liquid streams followed by recycling to the process)
- scrubbing the acid gas with an easily halogenated compound (preferably a raw material used in the process)
- absorbing the acid gas in water to give aqueous acid (often followed by caustic scrubbing for environmental protection)
- washing out organic constituents with organic solvents
- condensing out organic by-products for use as feedstock in another process (e.g. conversion of 1,1,2 trichloroethane to 1,1 dichloroethylene).

Water: There are also significant issues with waste water streams as the biological degradability of halogenated hydrocarbons (especially aromatics) decreases as their halogen content increases. Only chlorinated hydrocarbons with a low degree of chlorination are degradable in biological waste water treatment plants and then only if their concentration does not exceed certain levels. Waste water containing chlorinated compounds usually requires expensive preliminary purification prior to biological treatment, by stripping, extraction and adsorption (on activated carbon or polymeric resins). Waste water contamination can be substantially reduced by avoiding the water quenching of reaction gases to separate hydrogen chloride (for example in the production of chlorinated ethanes and ethylenes). Dry distillation and the use of refrigerator units will further reduce water contamination.

Wastes: Solid wastes may arise from such sources as reactor residues or spent catalyst. Incineration is a common method for destruction of the organic components, although attention must be paid to incineration conditions in order to avoid the formation of dioxins.

C) Hydrogenation

Catalytic hydrogenation refers to the addition of hydrogen to an organic molecule in the presence of a catalyst. It can involve direct addition of hydrogen to the double bond of an unsaturated molecule; amine formation by the replacement of oxygen in nitrogen containing compounds; and alcohol production by addition to aldehydes and ketones. These reactions are used to readily reduce many functional groups; often under mild conditions and with high selectivity. Hydrogenation is an exothermic reaction and the equilibrium usually lies far towards the hydrogenated product under most operating temperatures. It is used to produce a wide variety of chemicals such as cyclohexane, aniline, n-butyl alcohol, hexamethylene diamine, as well as ethyl hexanol and isocyanates such as TDI and MDI. Hydrogenation catalysts may be heterogeneous or homogeneous. Heterogeneous catalysts are solids and form a distinct phase in the gases or liquids. Many metals and metal oxides have general hydrogenation activity. Nickel, copper, cobalt, chromium, zinc, iron and the platinum group are among the elements most frequently used as commercial hydrogenation catalysts.

The general safety precautions that apply to highly flammable gases and vapours apply particularly to hydrogen. Hydrogen is combustible in air and oxygen over wider concentration limits than most other gases. Flammable mixtures in a confined space will explode if ignited by a flame or spark and special precautions are therefore necessary to prevent hydrogen gas leaks from tanks and equipment.

Environmental issues of hydrogenation processes

- **Air:** VOC emissions from hydrogenation reactions are relatively small although hydrogen rich vent streams are typically abated in combustion units. The main issues with hydrogen are likely to arise from sulphur impurities in the feed raw materials or from the dust and ash by-products of the hydrogen production itself. Small quantities of sulphur compounds (e.g. SO_2, H_2S) can for example be absorbed in dilute caustic solutions or adsorbed on activated charcoal. Larger quantities would probably have to be converted to liquid or solid sulphur.
- **Water:** Hydrogenation of oxygenated compounds (e.g. in aniline or TDI process) may generate water, which ends up as waste water. Specific waste water volumes from hydrogenation reactions are generally low. Hydrogenated oxo-products often show good biodegradability and low toxicity whereas aniline compounds may need measures additional to biotreatment.
- **Wastes:** The spent catalysts are sometimes treated as wastes, sometimes reclaimed for precious metals. Hydrogenation reactions generate little or no unwanted by-products.

D) Esterification

Organic esters are of considerable economic importance. Because of their highly lipophilic and hydrophobic nature and low polarity, esters are widely used as solvents, extractants, and diluents. Ethyl acetate is the most common technical solvent. Large quantities of esters, especially phthalates, adipates, and fatty acid esters, are used as plasticisers. Esters with a pleasant odour are used in fragrances, flavours, cosmetics, and soaps. Esters can be converted into various derivatives and are useful intermediates in the synthesis, e.g. of vitamins or pharmaceuticals.

Chemical reaction

A great variety of production methods for carboxylic acid esters are known, but the simplest and most common method of esterification is the reaction of an alcohol with a carboxylic acid with the elimination of water:

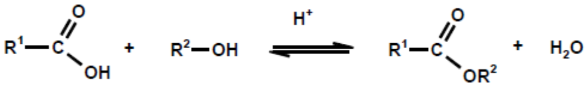


Figure 4: Common Esterification

Esterification is the reverse of hydrolysis and leads to an equilibrium reaction, which is the reason that quantitative esterification is possible only by continuous removal of one of the products, i.e. ester or water. In the case of transesterification, an alcohol is released instead of water.

Suitable catalysts are sulphuric acid, hydrogen chloride, arylsulphonic acids such as p-toluenesulphonic acid, and chlorosulphuric acid. Phosphoric acid, polyphosphoric acids, and mixtures of acids are also recommended. If the acids are adsorbed on a solid support, esterification can be carried out as a continuous process.

Removal of water usually involves the addition of entrainers, which form azeotropes with relatively low boiling points and high water contents (usually toluene, xylene, cyclohexane, seldom also benzene or CCl_4).

Operations

The reaction is generally carried out by refluxing the reaction mixture until all the water has been split off. The water or the ester is removed from the equilibrium by distillation. Water is usually removed by distillation of the azeotrope with the alcohol or an entrainer. After condensation, the azeotrope separates into an aqueous phase and an organic phase, and the entrainer or alcohol is recycled into the reaction mixture. In particular cases, a co-solvent such as benzene or toluene is added to the condensate to achieve separation of the organic phase. Many esters are produced continuously in pipes, distillation columns or plate columns. Ion exchange resins are especially suitable as catalysts in continuous processes. The reactants pass through or over the solid catalyst, and no separation or neutralisation of the catalyst is necessary.

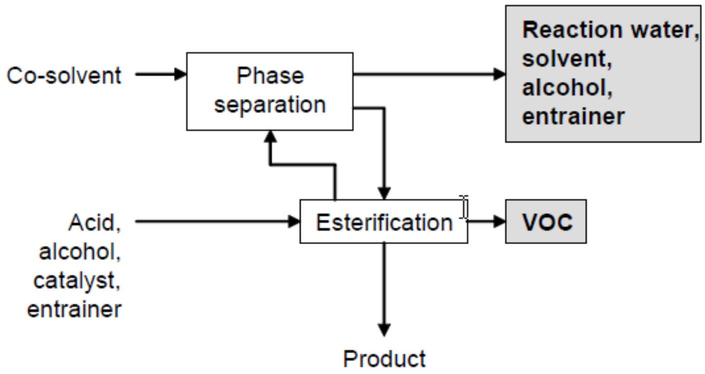


Figure 5: Typical Sequence of Operations for Esterification (Input materials on left and associated waste streams on right with grey background)

Esterification (Figure 5) typically involves the formation of esters from an organic acid and an alcohol. The most common method of esterification is the reaction of a concentrated alcohol and a concentrated carboxylic acid with the elimination of water. Only strong carboxylic acids react sufficiently quickly without a catalyst, so a strong mineral acid (such as sulphuric acid or hydrogen chloride) must usually be added to aid the reaction. Acid anhydrides are also used, e.g. in dialkyl phthalate production. The sulphonic acid group can be bound chemically to a polymeric material and so cation exchangers, such as sulphonated polystyrene, enable esterification under mild conditions. Lewis acids such as boron trifluoride can also be used. The equilibrium of the reaction can be shifted to the ester by increasing the concentration of one of the reactants, usually the alcohol. In production scale esterification the reaction mixture is refluxed until all the condensation water is formed, and the water or the ester product is continuously removed from the equilibrium by distillation. The main products from esterification reactions are dimethyl terephthalate, ethyl acrylate, methyl acrylate and ethyl acetate. They have considerable economic importance in many applications (e.g. fibres, films, adhesives and plastics). Some volatile esters are used as aromatic materials in perfumes, cosmetics and foods.

Environmental issues of esterification processes

- Air: Solvent vapours can be collected and treated (e.g. by incineration, adsorption).
- Water: Effluent generation is generally low, as water is the only by-product of esterification reactions. The choice of solid polymer based ion exchange resins avoids the need for catalyst neutralisation and the associated waste water treatment. Most esters possess low toxicity because they are easily hydrolysed on contact with water or moist air, and so the properties of the acid and alcohol components are more important.
- Wastes: Waste streams can be reduced by recovering (and reusing) any organic solvents, water and alcohol components. Any wastes from waste water treatment can be incinerated (if they have with high boiling points) or recovered by distillation for re-use (for low boiling point components).

E) Alkylation

Alkylations with alkyl halides are important reaction steps in industrial scale chemistry, predominantly for the synthesis of pharmaceuticals or agricultural chemicals. Some often used alkyl halides are methyl chloride, methyl iodide, ethyl chloride, isopropyl chloride, tert-butyl chloride, and benzyl chloride.

Chemical reaction

The following equation shows an example of methylation with methyl chloride:

$$(1)\quad R-NH_2 + 2\,CH_3Cl + 2\,NaOH \rightarrow R-N(CH_3)_2 + 2\,NaCl + 2\,H_2O$$

$$(2)\quad R-N(CH_3)_2 + CH_3Cl \rightarrow R-N(CH_3)_3 + Cl^-$$

Side reactions: The effect of possible side reactions must be considered individually, but generally the use of lower alkyl halides leads to the formation of a variety of lower molecular compounds, *e.g*:

$$CH_3Cl + NaOH \rightarrow CH_3OH + NaCl$$

$$CH_3OH \rightarrow CH_3-O-CH_3 + H_2O$$

Operations

Because alkylation reactions are diverse in nature, there is no universal method of carrying them out. The production of each compound needs to be considered individually, taking into account the chemical, engineering, and economic factors.

Alkylation is the introduction of an alkyl group into an organic compound by substitution or addition. There are six types of alkylation reaction

- substitution for hydrogen bound to carbon (e.g. ethylbenzene from ethylene and benzene)
- substitution for hydrogen attached to nitrogen
- substitution for hydrogen in a hydroxyl group of an alcohol or phenol
- addition to a metal to form a carbon-metal bond
- addition to a tertiary amine to form a quaternary ammonium compound
- miscellaneous additions to sulphur or silicon.

The largest use of alkylation is in refineries for the production of alkylates that are used in Gasoline Other major alkylation products include ethylbenzene, cumene, linear alkylbenzene, tetramethyl lead and tetraethyl lead. Alkylation is commonly carried out in liquid phase at temperatures higher than 200 ºC at aboveatmospheric pressures. Sometimes vapour phase alkylation is more effective. Alkylation agents are usually olefins, alcohols, alkyl sulphates or alkyl halides. Catalysts are HF, sulphuric acid or phosphoric acid. Higher temperatures cause the expected lowering of product specificity and increased by-product formation. Some more recent alkylation processes (e.g. for ethylbenzene and cumene) use zeolite catalysts as they can be more efficient and may have lower emissions. Lewis acids, like aluminum trichloride or boron trifluoride, may also be used as catalysts.

Environmental issues of alkylation processes

- Air: Based on data for the production of ethylbenzene, cumene and linear alkylbenzene, VOC emissions from alkylation reactions tend to be low compared with other unit processes
- Waste: Alkyl halides and sulphates cause problems of waste product disposal

F) Sulphonation

The direct introduction of the sulphonic acid group to an aromatic system is one of the most important reactions in industrial organic chemistry. It gives high yields under relatively mild conditions and usually results in well defined derivatives. Arylsulphonic acids are used chiefly as intermediates in the manufacture of dyes, insecticides, pharmaceuticals, plasticisers, optical brighteners, etc. Among the typical raw materials are also halogenated compounds, thus contributing to the AOX load of waste water streams.

Chemical reaction

Sulphonation (Figure 6) is usually carried out with concentrated sulphuric acid in excess of about 50 to 100 % or using oleum. Due to the fundamental rules of electrophilic aromatic substitution, the product is a mixture of the target molecule and isomers. The reaction is reversible, with the yield and isomer distribution depending on the reaction conditions (e.g. temperature, removal of reaction water by azeotrope distillation or addition of thionyl chloride).

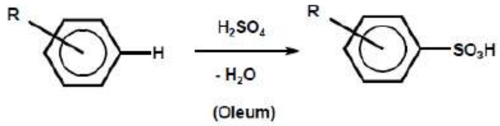


Figure 6: Sulphonation of an aromatic system

Increased temperature and reaction water removal also favour the formation of sulphones as byproducts. Depending on the reactants (aromatic, H_2SO_4, oleum) and temperature, the oxidative effects of sulphuric acid or sulphur trioxide can lead to unwanted oxidation reactions.

Operations

Figure 7 shows a typical sequence of operations for sulphonation, possible input materials and associated waste streams. The reaction is carried out at temperatures of about 60 to 90 ºC in cast steel or enamelled steel vessels. The sulphonating agent is fed into the vessel, the aromatic compound is then added, and the reaction is controlled by means of temperature profiles or metering.

On completion of the reaction, the batch is transferred into water, which causes unconverted aromatic compounds to be released. The dilute sulphonation mass is cooled, and the free acid is separated by filtration. For further purification, recrystallisation may be necessary. If the free acid is too soluble and isolation is not possible in this way, other techniques are carried out, such as:

- salting out with sodium sulphate or sodium chloride
- temperature controlled crystallisation, or
- reactive extraction.

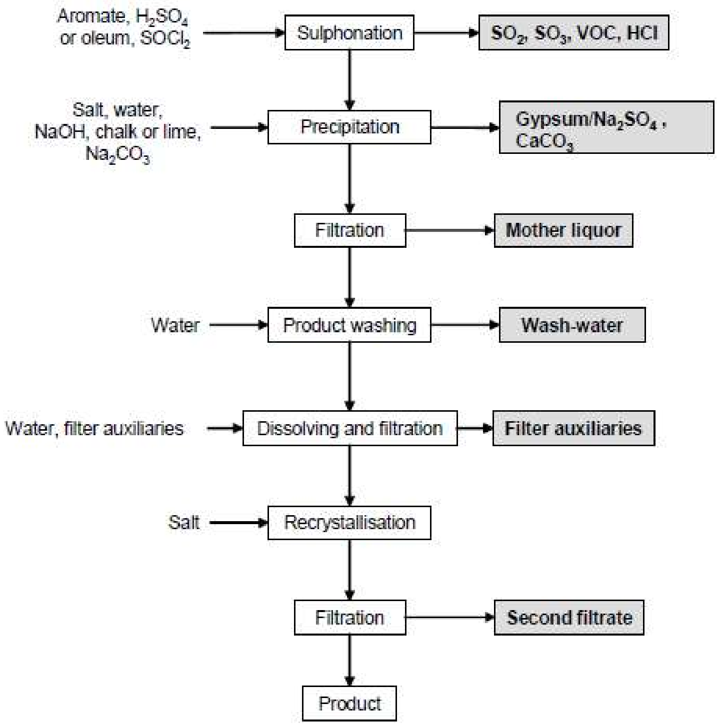


Figure 7: Typical Sequence of Operations for a Sulphonation (Inputs on left and associated waste streams on right with grey background)

In the reactive extraction process, the unconverted sulphuric acid is recovered by converting the arylsulphonic acid into its ammonium salt with a long-chain aliphatic amine. This salt is separated from the sulphuric acid as a liquid phase and then converted with sodium hydroxide solution into sodium sulphonate solution and the amine; the latter can be separated as a liquid phase and can be re-used. Sulphonates practically free from inorganic salts are obtained in this way.

Other isolation methods are based on the neutralisation of the excess sulphuric acid by adding calcium carbonate or sodium hydroxide. This leads to a large amount of gypsum (“liming” or “chalking”) or sodium sulphate, which is removed in the hot state. In liming, the dissolved calcium arylsulphonate is then treated with soda and the precipitated calcium carbonate is removed by filtration. The filtrate contains the sodium arylsulphonate.

Sulphonation with SO_3

Sulphonation with SO_3 is applied in the manufacture of a smaller number of aromatic sulphonic acids produced in higher volumes.

Chemical reaction

Sulphonation with SO_3 is illustrated in Figure 8. The reaction does not lead to the formation of reaction water and shows higher selectivity if carried out at lower temperatures

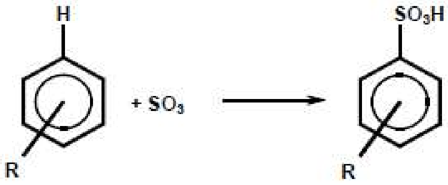


Figure 8: Sulphonation with SO3

Side reactions:

- formation of sulphones
- formation of isomers
- formation of oxidation by-products

If carried out as a liquid phase reaction, halogenated compounds serve as solvents (*e.g.* methylene chloride or dichloroethane)

Operations

Figures 9 and 10 show typical sequences of operations, possible input and related waste streams from the reaction in liquid phase and the gas-liquid reaction respectively.

Liquid phase reaction

Both, the organic feed and SO_3 are dissolved in organic solvents (e.g. methylene chloride or dichloroethane) and continuously added to the reactor. On completion, the reaction mixture is transferred into water and cooled. The organic phase is segregated and the product is precipitated from the aqueous phase by cooling and addition of sulphuric acid with subsequent filtration.

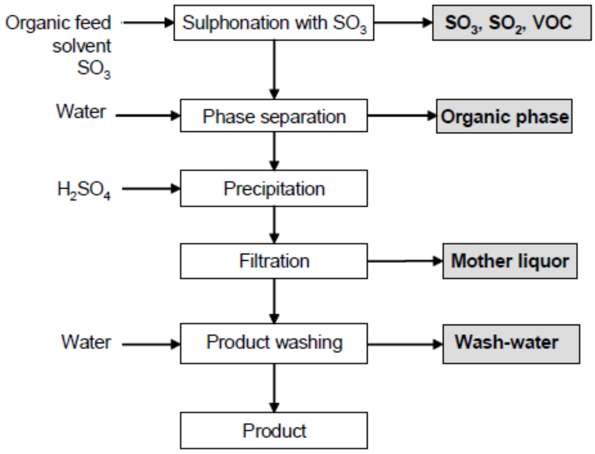


Figure 9: Sulphonation with SO3 in Liquid Phase

Gas-liquid reaction

Depending on the local conditions, SO_3 gas is derived directly from a sulphuric acid facility or generated by combustion of sulphur. The reaction is usually carried out in falling film reactors. In many cases, it is not necessary to perform further work-up steps.

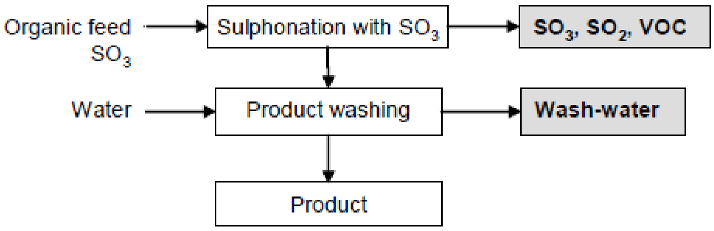


Figure 10: Sulphonation with SO3 in Gas-Liquid Reaction

Sulphochlorination with chlorosulphonic acid

Sulphochlorination leads to organic sulphochlorides, which act as intermediates for a variety of fine chemicals, e.g. sulphonamides, sulphono hydrazides, sulphonic esters, sulphinic acids, sulphones, and thiophenols.

Chemical reaction

Sulphochlorination takes place in a two step reaction as shown:

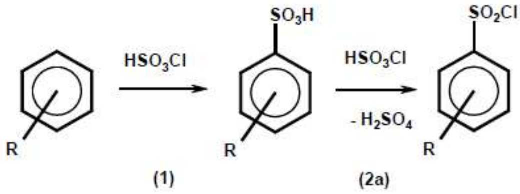


Figure 11: Sulphochlorination with Chlorosulphonic Acid

Side reactions

- formation of sulphones (*e.g.* 35 % in the case of chloro benzene)
- formation of isomers
- formation of other halogenation products.

Operations

Figure 12 shows a typical sequence of operations in sulphochlorination. The chlorosulphonic acid is introduced into a cast-steel or enamelled-steel vessel and 10 - 25 mol % of the aromatic compound is stirred in at 25 – 30 °C, whereupon sulphonation of the aromatic compound and HCl formation occur. The exothermic formation of sulphonyl chloride is initiated by heating the reactants to 50 – 80 °C.

In the case of aromatic compounds that easily take up two sulphochloride groups, e.g. anisole, monochlorosulphonation is carried out with only a little more than the calculated amount of chlorosulphonic acid at a low temperature (0°C) and in the presence of a diluent such as dichloromethane.

The temperature has to be controlled accurately to ensure the uniform release of HCl gas. Restarting the agitator after an interruption of the electricity supply is hazardous and may cause the contents of the vessel to foam over. The product is isolated by draining the reaction mass onto water and by simultaneous cooling. The sulphonyl chloride either precipitates or separates as an organic liquid phase.

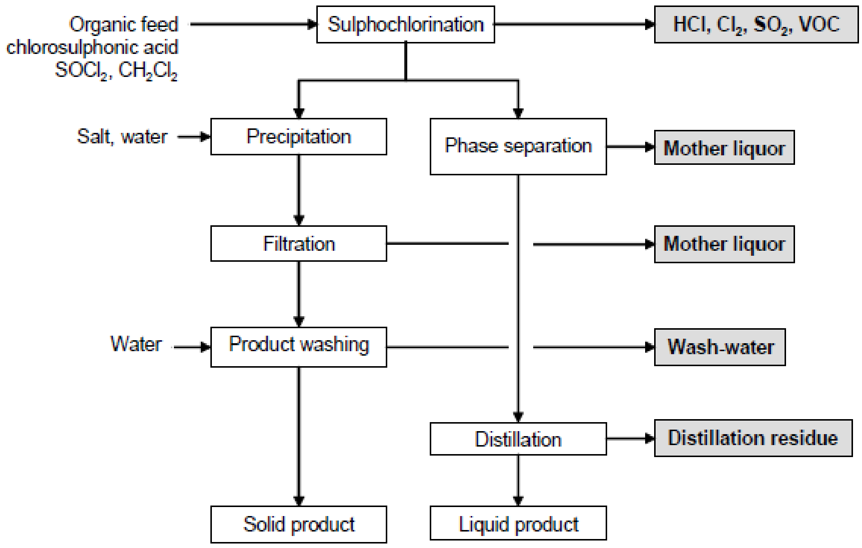


Figure 12: Typical Sequence of Operations for Sulphochlorination

Sulphonation is the process by which a sulphonic acid group (or corresponding salt or sulphonyl halide) is attached to a carbon atom. It is also describes the treatment of any organic compound with sulphuric acid, regardless of the products formed. It is used to produce many detergents (by sulphonating mixed linear alkyl benzenes with sulphur trioxide or oleum) and isopropyl alcohol (by the sulphonation of propylene). The most widely used sulphonating agent for linear alkylbenzenes is oleum (fuming sulphuric acid - a solution of sulphur trioxide in sulphuric acid). Sulphuric acid alone is effective in sulphonating the benzene ring, provided the acid content is above about 75 %. The excess sulphur trioxide in oleum removes the water of reaction and helps to obtain higher product yields. Separating the product sulphonates from the reaction mixture is often difficult. The mother liquor after product separation is an environmental problem, regardless of whether the product is precipitated by dilution or by salt formation upon reaction with a base.

Environmental issues of sulphonation processes

- **Air**: Acid vapours (largely sulphuric acid) from the reaction and quenching. Unreacted sulphonating agent arising from the use of an excess to drive the reaction. VOC emissions.

- **Water**: Acidic waste waters from the reactor and dilute acidic wash waters (from washing the product on the filter) that will require neutralisation. Filtrate from the separation stage contaminated with unreacted raw material and acid.
- **Waste**: Oleum is an extremely strong oxidising agent and produces tar by-products that require disposal.

G) Dehydrogenation

Dehydrogenation is the process by which hydrogen is removed from an organic compound to form a new chemical (e.g. to convert saturated into unsaturated compounds). It is used to produce aldehydes and ketones by the dehydrogenation of alcohols. Important products include acetone, cyclohexanone, methyl ethyl ketone (MEK) and styrene Dehydrogenation is most important in the 'Cracking' process, where saturated hydrocarbons are converted into olefins The process is applied to appropriate hydrocarbon feedstocks (e.g. naphtha) in order to produce the very large volumes of ethylene, propylene, butenes and butadienes that are required as feeds for the chemical industry. Cracking may be achieved by catalytic or thermal process routes:

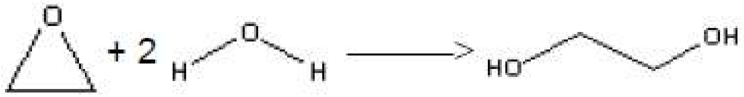
- Catalytic cracking provides a way to convert higher boiling fractions into saturated, nonlinear paraffinic compounds, naphthenes and aromatics. The concentration of olefins in the product stream is very low, so this method is more useful for the preparation of fuels.
- Olefins are more widely produced by the steam cracking of petroleum fractions. A hydrocarbon stream is heated, mixed with steam and, depending on the feedstock, further heated to incipient cracking-temperatures of 600 - 650 ºC. The conversion of saturated hydrocarbons to unsaturated compounds is highly endothermic, and so high energy inputs are necessary. High-temperature cracking is also used to produce pyrolysis gasoline from paraffin gases, naphthas, gas oils, or other hydrocarbons.

Environmental issues of dehydrogenation processes

- **Air:** Large hydrogen-rich vent streams are produced and can be used as a hydrogen feed for other processes or as a fuel. Volatile hydrocarbons will be contained in purge and vent gases and will require collection and treatment (maybe combined with beneficial energy production). Sulphur dioxide emissions can originate from acid-gas incinerators. Nitrogen oxides originate from furnace operations in crackers.
- **Water:** Quench water, dilution steam, decoking water and flare water discharges are the principal process streams that require treatment. Waste water streams with a high pollution load may require pre-treatment prior to acceptance in a biological degradation plant. Other liquid wastes such as 'green oil' (from acetylene conversion in the production of ethylene) can be burned to recover steam or energy.
- **Wastes**: Examples of process wastes are caustic or amines used in sulphide scrubbing, cleaning acids, catalysts, tars, polymers, waste oils, coke and extracting agents (e.g. N-methylpyrolidone) that cannot be recycled

H) Hydrolysis

Hydrolysis involves the addition or substitution of water (H2O) into a compound. This process is used in the manufacturing of ethylene glycol, the main component of antifreeze. The following equation shows how ethylene oxide is hydrolized to form ethylene glycol.



Hydrolysis involves the reaction of an organic with water to form two or more new substances. Hydration is the process variant where water reacts with a compound without causing its decomposition. These routes are used in the manufacture of alcohols (e.g. ethanol), glycols (e.g. ethylene glycol, propylene glycol) and propylene oxide.

Environmental issues of hydrolysis processes

- **Air:** There are generally low VOC arisings from reactors
- **Water:** In most cases, hydrolysis and hydration products are biodegradable.

I) Reforming

Reforming is the decomposition (cracking) of hydrocarbon gases or low octane petroleum fractions by heat and pressure. This is most efficient with a catalyst, but can be achieved without. Reforming is mainly used in refineries to increase the octane number of fuels. The main reactions are the dehydrogenation of cyclohexanes to aromatic hydrocarbons, the dehydrocyclisation of certain paraffins to aromatics, and the conversion of straight chains to branched chains (isomerisation). It is also used to make synthesis gas from methane.

J) Carbonylation

Carbonylation (carboxylation) is the combination of an organic compound with carbon monoxide. It is used to make aldehydes and alcohols containing one additional carbon atom. The major products include acetic acid. Hydroformylation (‘oxo’ process) is a variant where olefins are reacted with carbon monoxide and hydrogen (‘synthesis gas’) in the presence of a cobalt or rhodium catalyst (e.g. in the production of n-butyraldehyde, iso-octyl alcohol, isodecanol).

Environmental issues of carbonylation processes

- **Air:** The process typically generates large volume, hot vent streams containing some VOCs in addition to CO2, CO, H2 and other non-VOCs. Residual gas is recovered and used as fuel or flared Water: Heavy metals (from catalyst) to be removed from waste water prior to biological treatment.
- **Waste:** Spent catalysts.

K) Oxyacetylation

Oxyacetylation involves the addition of oxygen and an acetyl group to an olefin to produce an unsaturated acetate ester. It is used to produce vinyl acetate from ethylene, acetic acid and oxygen.

L) Nitration

Liquid phase nitration is a dominant step in the manufacture of common high explosives and important for the production of a wide range of aromatic intermediates for dyes, agrochemicals, pharmaceuticals or other fine chemicals. A typical nitration reaction is highly exothermic, therefore, for a safe mode of reaction, a dosage controlled process with precautions securing no accumulation of reactants is necessary. Typical nitroaromatic production is based on high yield processes, with more than 80 % of the total cost being the cost of the raw materials. Integral requirements of all efficient nitration processes are sulphuric acid regeneration and isomer control and separation. Nitration of the important naphthalene mono- and disulphonic acids is usually performed with the formed sulphonated mass. Among the typical raw materials are halogenated aromatics, which can contribute to the AOX load of waste water streams.

Chemical reaction

Nitration is the irreversible introduction of one or more nitro groups into an aromatic system by electrophilic substitution of a hydrogen atom. O-nitration to give nitrates and N-nitration to give nitramines are far less important for aromatic compounds but relevant for the manufacture of explosives.

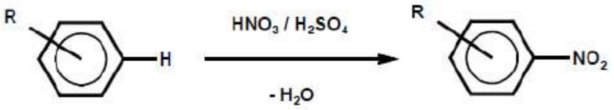


Figure 13: Nitration of an aromatic compound

Nitration is normally carried out in a liquid phase reaction with a mixture of nitric and sulphuric acids (mixed acid) and occasionally with nitric acid. A typical mixed acid, for example for mononitration, consists of 20 % nitric acid, 60 % sulphuric acid and 20 % water (this is referred to as 20/60/20 mixed acid). The strength of the mixed acid and the temperature can be varied to maximise the formation of the required isomer. Stronger mixed acid and higher temperature lead to oxidative side reactions. An important side reaction leads to phenolic by-products.

Operations

Figure 14 shows a typical sequence of operations for the nitration of aromatic compounds, possible input materials and associated waste streams. The reaction is carried out in cast iron, stainless steel or enamel-lined mild steel reactors. Temperatures vary normally between 25 and 100 °C. The substrate is dissolved in the sulphuric acid phase and the mixed acid is subsequently added. On completion of the reaction, the batch is transferred into water to give a two phase mixture of diluted acid and an organic product phase.

After phase separation, liquid products are purified by distillation. The remaining acid hase can be extracted with the feed material in order to recover organic compounds. Solid products are crystallised (where necessary, by the addition of cold water). The crude nitroaromatic is washed with water and diluted NaOH to remove the acids and phenolic by-products. Depending on the quality requirements, a recrystallisation from water or organic solvent may be necessary. Isomer separation is carried out within the crystallisation, washing or distillation steps

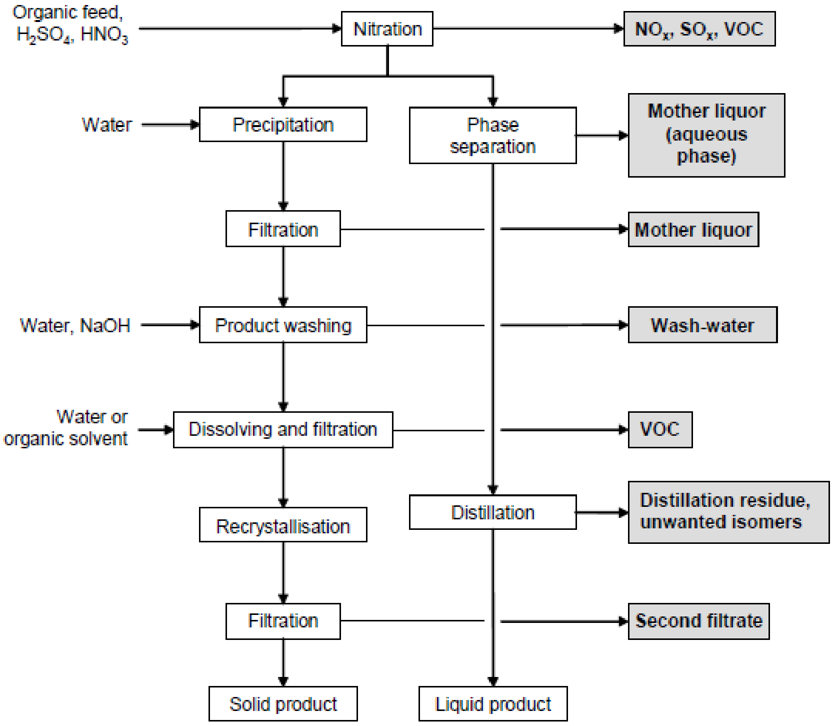


Figure 14: Typical sequence of operations for a nitration

Nitration involves the replacement of a hydrogen atom (in an organic compound) with one or more nitro groups (NO2). By-products may be unavoidable due to the high reaction temperatures and the highly oxidising environment, although many nitration reactions are carried out at low temperature for safety reasons. The nitrations can be of aliphatics (e.g. nitroparrafins) but the nitration of aromatics is more commercially important (e.g. explosives and propellants such as nitrobenzene and nitrotoluenes). This is affected with nitric acid or, in the case of aromatic nitrations, a mixture of nitric and sulphuric acids. Nitration is used in the first step of toluene diisocyanate (TDI) production.

Environmental issues of nitration processes

- **Air:** Acid vapours (largely nitric or sulphuric acid) from the reaction and quenching. Unreacted nitrating agent arising from the use of an excess to drive the reaction. VOC emissions. Gas streams rich in oxides of nitrogen.
- **Water:** Aromatic nitration may produce large quantities of waste mixed acid that requires neutralisation and disposal, or recovery (e.g. by distillation) and re-use. Products and by-products often are poorly biodegradable and toxic, so measures such as extraction or incineration of aqueous wastes are required.

M) Dehydration

Chemical dehydration is a decomposition reaction in which a new compound is formed by the expulsion of water. The major product of this process, urea, is produced by the dehydration of ammonium carbamate.

N) Ammonolysis

Ammonolysis is the process of forming amines using, as aminating agents, ammonia or primary and secondary amines. Ammonolytic reactions also include hydroammonolysis - in which amines are formed directly from carbonyl compounds using an ammonia-hydrogen mixture and a hydrogenation catalyst. The four main ammonolytic reaction types are

- double decomposition (the NH3 is split into NH2, which becomes part of the amine, and H, which reacts with a radical that is being substituted)
- dehydration (ammonia serves as a hydrant to produce water and amines)
- simple addition (both fragments of the NH3 molecule - NH and H - become part of the new amine)
- multiple activity (ammonia reacts with the amine products to form secondary and tertiary amines)

The major products of ammonolysis are carbamic acid, ethanolamines and alkylamines.

Environmental issues of ammonolysis processes

- **Air:** Based on ethanolamine production, the VOC arisings from reactors are small, although there are waste gases associated with distillation. Off-gas containing ammonia or amines is washed or incinerated in order to avoid odour problems. Hydrogen cyanide and acetonitrile are produced in the production of acrylonitrile and the hydrogen cyanide may be recovered.
- **Water:** Unreacted ammonia can be recovered from alkaline effluents by stripping and recycled back to the process. Ammonia remaining in the effluent can be neutralised with sulphuric acid (producing ammonium sulphate precipitate for use as fertiliser) or biologically treated. Waste waters containing impurities such as methanol and amines can be disposed of by incineration or biological treatment.

- **Wastes:** Solid wastes from stripper bottoms are incinerated. Ex. Spent catalysts.

O) Condensation

Condensation is the chemical reaction in which two or more molecules combine and expel water, an alcohol or another low-molecular weight compound. Each of the reactants contributes a part of the separated compound. There is some overlap with addition reactions since the initial step in condensation is addition. Condensation is used in the production of acetic anhydride, bisphenol A, phenol, acetone and ethyl hexanone.

Environmental issues of condensation processes

- **Air:** Reactor emissions are generally small and are typically abated in a combustion unit. Distillation operations may be a source of emissions.
- **Water:** Specific waste water volumes are generally low, effluents mainly consist of reaction water if recycling after phase separation is not possible. The effluent is composed of high-boiling components (condensation products/by-products) that often show moderate or poor biodegradability, and low-boiling components (educts) with better biodegradability.

P) Chlorination

A mixture of the three dichlorobenzenes is produced by the chlorination of chlorobenzene or by the dichlorination of benzene in the presence of iron (III) chloride. The 1,4- isomer is the most easily isolated of the dichlorobenzenes and was first described in 1864; the 1,2- and 1,3-isomers were not recognized until 1875.

Q) Neutralisation

Neutralisation is a chemical reaction whereby an acid and a base react to form water and a salt. Often, neutralization reactions are exothermic, giving out heat to the surroundings (the enthalpy of neutralization). An example of an endothermic neutralization is the reaction between sodium bicarbonate (baking soda) and any weak acid, for example acetic acid (vinegar).

Most generally, the following occurs:

$$\textbf{acid + base} \rightarrow \textbf{salt + water}$$

For example, the reaction between Hydrochloric acid and sodium hydroxide solutions:

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H2O(l)$$

or as a net ionic equation:

$$H+(aq) + OH-(aq) \rightarrow H2O(l)$$

General Formula

acid + alkali → metal salt + water

$HCl + NaOH \rightarrow NaCl + H2O$

acid + metal → metal salt + hydrogen

$2\ HCl + Mg \rightarrow MgCl2 + H2$

acid + metal oxide → metal salt + water

$2\ HCOOH + MgO \rightarrow Mg(HCOO>)2 + H2O$

acid + ammonia → ammonia salt

$HF + NH3 \rightarrow NH4F$

R) Condensation

Condensation represents a widely applied reaction type in industrial organic chemistry. Some examples are the manufacture of aromatic azo and poly azo compounds (intermediates for dyes and pigments) or ring closures to give heterocyclic compounds (e.g. pyrazolones, indoles, triazoles, pyrimidines, thiazoles). is a chemical reaction whereby an acid and a base react to form water and a salt.

In an aqueous solution, solvated hydrogen ions (hydronium ions, $H3O+$) react with hydroxide ions ($OH-$) formed from the alkali to make two molecules of water. A salt is also formed. In non-aqueous reactions, water is not always formed; however, there is always a donation of protons

Chemical reaction

A common feature of condensation reactions is the release of a molecule such as H_2O or NH_3 while the reactants are coupled, e.g:

The removal of $H2O$ is the key to shifting the equilibrium of the reaction to favour the target product.

Operations

Because condensation reactions are diverse in nature, there is no universal method of carrying them out. The production of each compound needs to be considered individually, taking into account the chemical, engineering, and economic factors.

S) Reduction

One of the most industrially important reduction processes in industrial use is the conversion of an aromatic nitro or dinitro compound into an arylamine or arylene diamine. Aromatic amines are widely used as dye intermediates, especially for azo dyes, pigments, and optical brighteners; as intermediates for photographic chemicals, pharmaceuticals, and agricultural chemicals; in polymers via isocyanates for polyurethanes; and as antioxidants. Among reduction methods, there are three of major relevance in organic fine chemistry:

- catalytic hydrogenation, which is extremely important industrially because of its universal applicability; most processes can be carried out successfully by catalytic hydrogenation
- Béchamp and Brinmeyr reduction with iron, which is the classical method
- alkali sulphide reduction, which is the selective method in specific cases, such as in the manufacture of nitroamines from dinitro compounds, the reduction of nitrophenols, the reduction of nitroanthraquinones and the manufacture of aminoazo compounds from the corresponding nitroazo derivative.

All three methods are also applied to halogenated nitro compounds, and can thus contribute to AOX loads in waste water streams.

(i) Catalytic reduction with hydrogen

Chemical reaction: The catalytic reduction (Figure 15) of the nitro compounds is very exothermic. To reduce these hazards, the concentration of nitro compound, the amount and partial pressure of the hydrogen, the temperature, and the activity of the catalyst, are controlled.

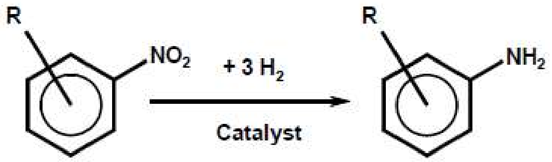


Figure 15: Catalytic reduction of aromatic nitro compounds

Most aromatic nitro compounds are hydrogenated in the liquid phase. In this case, the pressure and temperature can be changed independently. The temperature is limited by the hydrogenation reaction of the aromatic ring which occurs above 170 – 200°C.

Normally, the reduction is carried out at 100 – 170°C. Sensitive compounds are hydrogenated at lower temperatures (20 – 70°C) or at lower pressures (1 – 50 bar). 1 – 50 bar are used normally.

Operations

The vast majority of aromatic amines have small annual volumes (<500 tonnes) and are produced by batch hydrogenation with catalyst slurries. The reaction is carried out in stirred, steel or stainless steel autoclaves or in loop reactors. Loop reactors show increased heat and mass transfers and improved reaction selectivity, shorter batch cycle times and higher product yields. In addition, catalyst usage is often lower. The addition sequence depends on the particular reactants. On completion the reaction mass is cooled and the catalyst is removed by filtration.

(ii) Reduction with iron

Chemical reaction: The reduction of nitroaromatics is carried out in the presence of small amounts of acid (HCl, H2SO4, HCOOH, CH3COOH) as shown in the following equation:

$$4\ Ar - NO_2 \quad + \quad 9\ Fe \quad + \quad 4\ H_2O \quad \rightarrow \quad 4\ Ar - NH_2 \quad + \quad 3\ Fe_3O_4$$

The acid is used for the activation of the iron. Only 2 – 3 % of the hydrogen is derived from the acid but 97 – 98 % comes from the water.

Operations

Normally the nitroaromatic is added to the mixture of iron/water/acid (excess of iron about 15 - 50 %) often in the presence of an organic solvent (toluene, xylol, alcohols) and the mixture is heated to reflux. Depending on the reactivity of the aromatic, other addition sequences may be required. In some cases the acid is omitted (neutral iron reduction). The build-up of unreduced excess nitro compound must be avoided and the final mixture should be tested for its total absence. After basification with soda ash (anhydrous sodium carbonate) to precipitate soluble iron, the iron compounds are removed by filtration.

(iii) Alkali sulphide reduction

Chemical reaction: The alkali sulphide reduction is a mild and selective reaction according to the following equation, without strict stoichiometry:

$$Ar - NO_2 \quad + \quad Na_2S_2 \quad + \quad H_2O \quad \rightarrow \quad Ar - NH_2 \quad + \quad Na_2S_2O_3$$

Other reducing agents in use are Na2S or NaSH, which also form Na2S2O3. Sulphur may be added to reduce the required amount of sulphide.

Operations

Dilute aqueous sulphide is added to the solution or emulsion of the nitro compound. Temperatures (in the range of 80 – 100 °C) and concentrations depend on the reactivity of the nitroaromatic. An excess of sulphide is avoided in the case of the selective reduction of polynitro compounds.

Figure 16 shows a typical sequence of operations for the reduction of aromatic nitro compounds, possible input materials and associated waste streams. The work-up depends on the properties of the amine obtained. Common methods are:

- separation as a liquid
- cooling and salting out
- steam distillation
- extraction with organic solvent, and
- pH adjustment if necessary.

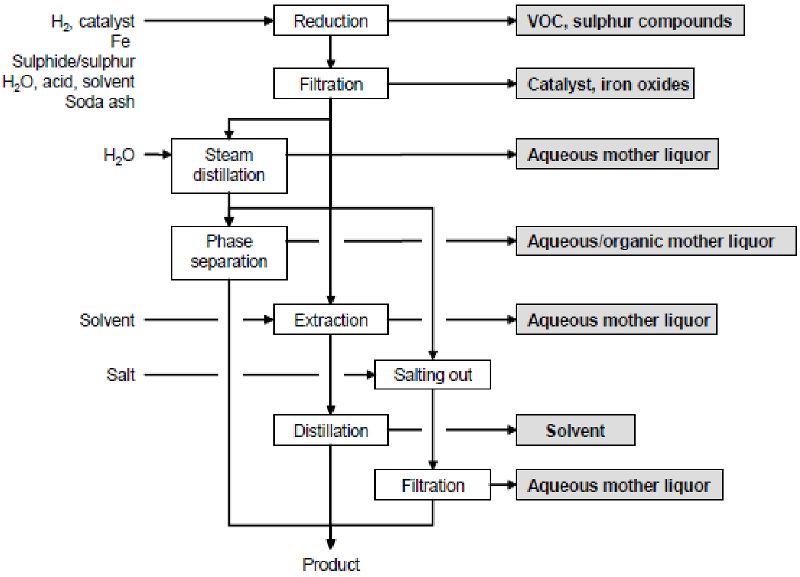


Figure 16: Typical sequence of operations for the reduction of an aromatic nitro compound

T) Diazotisation and coupling

Diazotisation and coupling processes (Figure 3-22)are important for the manufacture of APIs and represent the essence of azo dye manufacture. Azo dyes are the predominant colourant family, accounting for over 50 % of all commercial organic dyes. Diazotisation can also be followed by processes such as hydrazine formation, Sandmeyer reactions and azo double bond reduction.

Diazo and coupling components can be halogenated and can contribute to an AOX load in waste water streams. Often, azo coupling includes an immediate metallisation step involving heavy metals to give metal complex dyes.

Chemical reaction

Diazotisation is the reaction of primary arylamines with nitrites, preferably with sodium nitrite, in a usually aqueous mineral acid solution at around 0°C, whereby the amine is converted into the corresponding diazonium compound.

Weakly basic arylamines require a higher acid concentration (NO2 - surplus), since diazoamino compounds Ar–N=N–HN–Ar may otherwise form. A further reason for using concentrated acids (e.g. concentrated sulphuric acid) is the fact that diazonium compounds of weakly basic arylamines are readily hydrolysable in dilute acids.

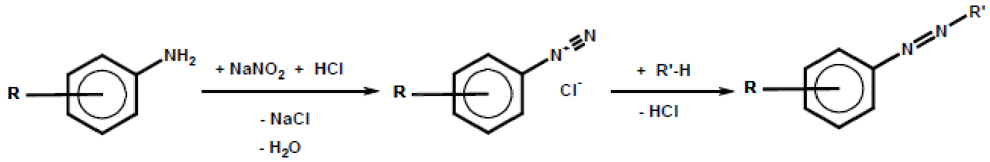


Figure 17: Diazotisation and Azo Coupling

The azo coupling reaction is an electrophilic substitution reaction of the diazonium compound with a coupling component R'H. In order to maintain an optimal reaction sequence, the pH must be kept constant by adding alkalis or buffers.

Coupling components: phenols, naphthols and amines

Side reactions: formation of diazo amino compounds decomposition of diazo salts to phenolic compounds formation of isomers processing of isomers contained in the starting material.

Operations

Figure 18 shows a typical sequence of operations for diazotisation and azo coupling in dyestuff manufacturing. Sodium nitrite is added in excess to a solution or suspension of the arylamine (diazo component) in a diazotisation tank. The reaction is cooled to 0°C by adding ice or by cooling with brine. In a separate tank, the coupling component is dissolved in water and alkali. Both solutions are clarified by filtering and added to the coupling vessel. The addition sequence depends on the particular case, and the precise reaction conditions (pH, temperature) are established by the addition of alkali or ice.

Clarifying may be necessary on completion of the reaction (by filtration over SiO_2, Al_2O_3 or charcoal) to remove unreacted amine and salty, resin-like or oily by-products, followed by precipitation of the product (usually by salting out or pH change), filtration, washing, dissolving and, e.g. spray drying to yield the standardised dyestuff. Alternatively, the reaction mixture is immediately passed through pressure permeation, followed by, e.g. belt, spin flash, spray or oven drying.

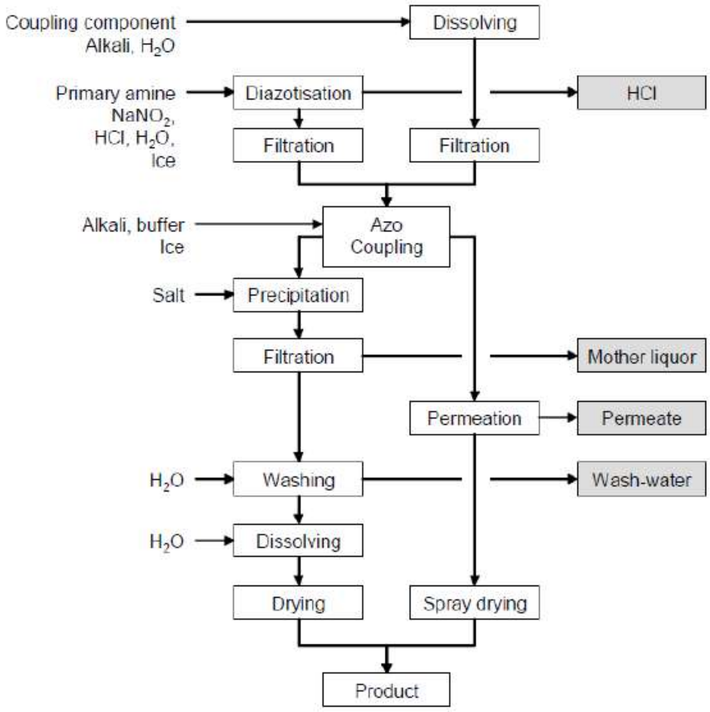


Figure 18: Typical sequence of operations for diazotisation and azo coupling

U) Phosgenation

Phosgene is used in the manufacture of agrochemicals, pharmaceuticals, dyestuffs and polymerisation initiators. Phosgene is usually used as a building block to introduce a carbonyl function or as an agent, e.g. for chlorination or dehydrogenate ions.

Chemical reaction

Phosgenation follows a nucleophilic or Friedel-Crafts related mechanism, depending on the conditions:

$$R-H \quad + \quad COCl_2 \quad \rightarrow \quad R-COCl \quad + \quad HCl$$

Its use as a chlorination or dehydrogenation agent additionally involves the formation of stoichiometric amounts of CO2.

Operations

Because phosgenation reactions are diverse in nature, there is no universal method of carrying them out. The production of each compound is thus considered individually, assessing the chemical, engineering, and economic factors.

V) N-acylation

N-acylation is a widely spread reaction for the protection of anilinic amino groups before chlorinations, nitrations or sulphonations are carried out. Arylides (amides of acetoacetic acid) are important intermediates, e.g. for organic pigments.

Chemical reaction

The most important N-acylation agents are:

- acetic acid
- acetic anhydride, other carboxylic anhydrides
- diketene
- acetoacetic ester
- acetic chloride, other acyl halides
- N-carboxy anhydrides.

They work according to the substitution:

$$R' - NH_2 \quad + \quad X - CO - R \quad \rightarrow \quad R' - NH - CO - R \quad + \quad HX$$

where HX is released. HX may be, e.g. H2O, CH3COOH, C2H5OH, HCl (the reaction with diketene is an addition).

Operations

Figure 19 shows a typical sequence of operations for N-acylations and the typical waste streams. Amine and an equimolar amount of an acylation agent are typically dissolved in H2O or diluted acetic acid (for acetoacetic ester, xylene is often used) and heated. Reaction water or acetic acid or ethanol and solvent are distilled off and the product is obtained directly or following crystallisation (occasionally by salting out) and filtration.

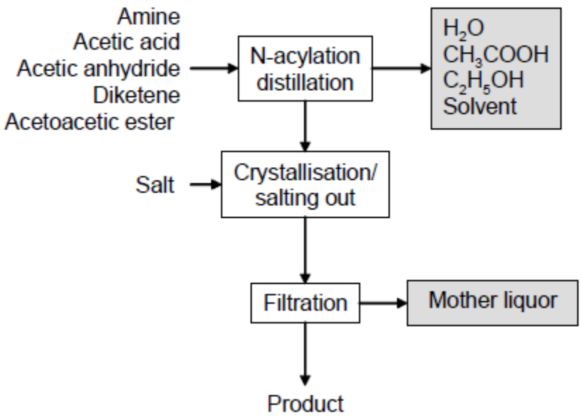


Figure 19: Typical Sequence of Operations for N-acylations and Typical Waste Streams

W) Pyrolysis

Pyrolysis is a process of breaking down a large compound into smaller components by heating it (in the absence of oxygen) and exposing it to a catalyst. This process is also referred to as cracking. Vinyl chloride is produced in this way by pyrolizing ethylene dichloride. Because pyrolysis can result in a variety of products, the catalyst and temperature must be carefully selected and controlled in order to maximize the yield of the desired product. The following equation shows the formation of vinyl chloride in the presence of heat and a catalyst.

X) Wittig reaction

The Wittig reaction is widely used in the production of vitamins, carotenoids, pharmaceuticals and antibiotics. Wittig reactions for the manufacture of fragrances but can no longer due to the difficult handling of the waste streams.

Chemical reaction

The Wittig reaction leads to the formation of a double bond in three steps:

(1) $R' - CH_2 - Cl \quad + \quad P(C_6H_5)_3 \quad \rightarrow \quad R' - CH_2 - P^+(C_6H_5)_3Cl^-$

(2) $R' - CH_2 - P^+(C_6H_5)_3Cl^- \quad \rightarrow \quad R' - CH = P(C_6H_5)_3$

(3) $R' - CH = P(C_6H_5)_3 \quad + \quad R'' - CHO \quad \rightarrow \quad R' - CH = CH - R'' \quad + \quad O = P(C_6H_5)_3$

The deprotonation step (2) requires bases, e.g. alkali metal carbonate or amines. The reaction is carried out in organic solvents such as alcohols or DMF or in aqueous solutions. High yields are achieved under mild reaction conditions. However, equimolar amounts of triphenylphosphine (TPP) must be used, and the inactive triphenylphosphine oxide (TPPO) is formed.

Operations

Because Wittig reactions are diverse in nature, there is no universal method of carrying them out. The production of each compound is thus considered individually, assessing the chemical, engineering, and economic factors.

Y) Processes involving heavy metals

Heavy metals are involved in chemical synthesis:

- if the feedstock or product contains heavy metals
- if the heavy metals are used as auxiliaries (e.g. catalysts, redox partners).

Table 2 gives an impression of the type of processes involving heavy metals

Table2: Typical Processes Involving Heavy Metals

	Metal	Solvents	Agent
Metallization to form chelated metals			
1:1 or 1:2 complexes to form azo dyes	▪ Chromium ▪ Nickel ▪ Cobalt ▪ Copper	▪ Water ▪ Dilute NaOH ▪ Formic acid ▪ Formamide	▪ Cr_2O_3 ▪ $CrCl_3$ *6H_2O ▪ $K_2Cr_2O_7$ *2H_2O/glucose ▪ Cr formate ▪ NaKCr salicylate ▪ $CoSO_4$ *7H_2O/$NaNO_2$ ▪ $CuSO_4$ *5H_2O ▪ $CuCl_2$
Unit Processes			
Oxidations	▪ Manganese ▪ Chromium ▪ Molybdenum		▪ MnO_2 ▪ CrO_3
Reductions	▪ Zinc ▪ Copper ▪ Mercury ▪ Tin		▪ Metal, metal chlorides
Hydrogenation	▪ Nickel		▪ Raney nickel
Catalyst			
	▪ Nickel ▪ Copper ▪ Cobalt ▪ Manganese ▪ Palladium ▪ Platinum ▪ Ruthenium ▪ Bismuth ▪ Titanium ▪ Zirconium		▪ Metals, metal oxides, chlorides or acetates, carbonyls

ANNEXURE II
A Compilation of Legal Instruments

Sl. No.	Legal Instrument (Type, Reference, Year)	Responsible Ministries or Bodies	Chemical Use Categories/ Pollutants	Objective of Legislation	Relevant Articles/Provisions
1	Air (Prevention and Control of Pollution) Act, 1981 amended 1987	Central Pollution Control Board and State Pollution Control Boards	Air pollutants from chemical industries	The prevention, control and abatement of air pollution	Section 2: Definitions Section 21: Consent from State Boards Section 22: Not to allow emissions exceeding prescribed limits Section 24: Power of Entry and Inspection Section 25: Power to Obtain Information Section 26: Power to Take Samples Section 37-43: Penalties and Procedures
2	Air (Prevention and Control of Pollution) (Union Territories) Rules, 1983	Central Pollution Control Board and State Pollution Control Boards	Air pollutants from chemical industries	The prevention, control and abatement of air pollution	Rule 2: Definitions Rule 9: Consent Applications
3	Water (Prevention and Control of Pollution) Act, 1974 amended 1988	Central Pollution Control Board and State Pollution Control Boards	Water Pollutants from water polluting industries	The prevention and control of water pollution and also maintaining or restoring the wholesomeness of water	Section 2: Definitions Section 20: Power to Obtain Information Section 21: Power to Take Samples Section 23: Power of Entry and Inspection Section 24: Prohibition on Disposal Section 25: Restriction on New Outlet and New Discharge Section 26: Provision regarding existing discharge of sewage or trade effluent Section 27: Refusal or withdrawal of consent by state boards Section 41-49: Penalties and Procedures
4	Water (Prevention and Control of Pollution) Rules, 1975	Central Pollution Control Board and State Pollution Control Boards	Water Pollutants from water polluting industries	The prevention and control of water pollution and also maintaining or restoring the wholesomeness of water	Rule 2: Definitions Rule 30: Power to take samples Rule 32: Consent Applications
5	The Environment (Protection) Act, 1986,	Ministry of Environment and	All types of environmental pollutants	Protection and Improvement of the Environment	Section 2: Definitions Section 7: Not to allow emission or discharge of

	amended 1991	Forests, Central Pollution Control Board and State Pollution Control Boards			environmental pollutants in excess of prescribed standards Section 8: Handing of Hazardous Substances Section 10: Power of Entry and Inspection Section 11: Power to take samples Section 15-19: Penalties and Procedures
6	Environmental (Protection) Rules, 1986 (Amendments in 1999, 2001, 2002, 2002, 2002, 2003, 2004)	Ministry of Environment and Forests, Central Pollution Control Board and State Pollution Control Boards	All types of Environmental Pollutants	Protection and Improvement of the Environment	Rule 2: Definitions Rule 3: Standards for emission or discharge of environmental pollutants Rule 5: Prohibition and restriction on the location of industries and the carrying on process and operations in different areas Rule 13: Prohibition and restriction on the handling of hazardous substances in different areas Rule 14: Submission of environmental statement
7	Hazardous Waste (Management and Handling) Rules, 1989 amended 2000 and 2003	MoEF, CPCB, SPCB, DGFT, Port Authority and Customs Authority	Hazardous Wastes generated from industries using hazardous chemicals	Management & Handling of hazardous wastes in line with the Basel convention	Rule 2: Application Rule 3: Definitions Rule 4: Responsibility of the occupier and operator of a facility for handling of wastes Rule 4A: Duties of the occupier and operator of a facility Rule 4B: Duties of the authority Rule 5: Grant of authorization for handling hazardous wastes Rule 6: Power to suspend or cancel authorization Rule 7: Packaging, labeling and transport of hazardous wastes Rule 8: Disposal sites Rule 9: Record and returns Rule 10: Accident reporting and follow up Rule 11: Import and export of hazardous waste for dumping and disposal Rule 12: Import and export of hazardous waste for recycling and reuse

					Rule 13: Import of hazardous wastes Rule 14: Export of hazardous waste Rule 15: Illegal traffic Rule 16: Liability of the occupier, transporter and operator of a facility Rule 19: Procedure for registration and renewal of registration of recyclers and re-refiners Rule 20: Responsibility of waste generator
8	Manufacture Storage and Import of Hazardous Chemicals Rules, 1989 amended 2000	Ministry of Environment & Forests, Chief Controller of Imports and Exports, CPCB, SPCB, Chief Inspector of Factories, Chief Inspector of Dock Safety, Chief Inspector of Mines, AERB, Chief Controller of Explosives, District Collector or District Emergency Authority, CEES under DRDO	Hazardous Chemicals - Toxic, Explosive, Flammable, Reactive	Regulate the manufacture, storage and import of Hazardous Chemicals	Rule 2: Definitions Rule 4: responsibility of the Occupier Rule 5: Notification of Major Accidents Rule 7-8: Approval and notification of site and updating Rule 10-11: Safety Reports and Safety Audit reports and updating Rule 13: Preparation of Onsite Emergency Plan Rule 14: Preparation of Offsite Emergency Plan Rule 15: Information to persons likely to get affected Rule 16: Proprietary Information Rule 17: Material Safety Data Sheets Rule 18: Import of Hazardous Chemicals
9	Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	CCG, SCG, DCG, LCG and MAH Units	Hazardous Chemicals - Toxic, Explosive, Flammable, Reactive	Emergency Planning Preparedness and Response to chemical accidents	Rule 2: Definitions Rule 5: Functions of CCG Rule 7: Functions of SCG Rule 9: Functions of DCG Rule 10: Functions of LCG
10	Ozone Depleting Substances (Regulation and Control) Rules, 2000	Ministry of Environment & Forests	Ozone depleting substances	Regulate the production, import, use, sale, purchase and phase-out of the ODS	Rule 2: Definitions Rule 3: Regulation of production and consumption of ozone depleting substances Rule 4: Prohibition on export to or import from countries not specified in Schedule VI Rule 5: Ozone depleting substances are to be exported to or imported from countries specified in

					Schedule VI under a license Rule 6: Regulation of the sale of ozone depleting substances Rule 7: Regulation on the purchase of ozone depleting substances Rule 8: Regulation on the use of ozone depleting substance Rule 9: Prohibition on new investments with ozone depleting substances Rule 10: Regulation of import, export and sale of products made with or containing ozone depleting substances Rule 11: Regulation on reclamation and destruction of ozone depleting substances Rule 12: Regulation on manufacture, import and export of compressors Rule 13: Procedure for registration, cancellation of registration and appeal against such orders Rule 14: Monitoring and reporting requirements
11	EIA Notification, 2006	MoEF, SPCB	For all the identified developmental activities in the notification	Requirement of environmental clearance before establishment of or modernization / expansion of identified developmental projects.	Requirements and procedure for seeking environmental clearance of projects
12	Batteries (Management and Handling) Rules, 2001.	SPCB, CPCB and MoEF	Lead Acid Batteries	To control the hazardous waste generation (lead waste) from used lead acid batteries	Rule 2: Application Rule 3: Definitions Rule 4: Responsibilities of manufacturer, importer, assembler and re-conditioner Rule 5: Registration of Importers Rule 7: Responsibilities of dealer Rule 8: Responsibilities of recycler Rule 9: Procedure for registration / renewal of registration of recyclers Rule 10: Responsibilities of consumer or bulk consumer Rule 11: Responsibilities of auctioneer Rule 14: Computerization of Records and Returns

13	Public Liability Insurance Act, 1991 amended 1992	Ministry of Environment & Forests, District Collector	Hazardous Substances	To provide immediate relief to persons affected by accident involving hazardous substances	Section 2: Definitions Section 3: Liability to give relief in certain cases on principle of no fault Section 4: Duty of owner to take out insurance policy Section 7A: Establishment of Environmental Relief Fund Section 14-18: Penalties and Offences
14	Public Liability Insurance Rules, 1991 amended 1993	Ministry of Environment & Forests, District Collector	Hazardous Substances	To provide immediate relief to persons affected by accident involving hazardous substances and also for Establishing an Environmental Relief fund	Rule 2: Definitions Rule 6: Establishment of administration of fund Rule 10: Extent of liability Rule 11: Contribution of the owner to environmental relief fund
15	Factories Act, 1948	Ministry of Labour, DGFASLI and Directorate of Industrial Safety and Health/Factories Inspectorate	Chemicals as specified in the Table	Control of workplace environment, and providing for good health and safety of workers	Section 2: Interpretation Section 6: Approval, licensing and registration of factories Section 7A: General duties of the occupier Section 7B: General duties of manufacturers etc., as regards articles and substances for use in factories Section 12: Disposal of wastes and effluents Section 14: Dust and fume Section 36: Precautions against dangerous fumes, gases, etc. Section 37: Explosion or inflammable dust, gas, etc. Chapter IVA: Provisions relating to Hazardous processes Section 87: Dangerous operations Section 87A: Power to prohibit employment on account of serious hazard Section 88: Notice of certain accident Section 88A: Notice of certain dangerous occurrences Chapter X: Penalties and procedures
16	The Petroleum Act, 1934	Ministry of Petroleum and Natural Gas	Petroleum (Class A, B and C - as defined in the rules)	Regulate the import, transport, storage, production, refining and	Section 2: Definitions Section 3: Import, transport and storage of petroleum Section 5: Production, refining and blending of

				blending of petroleum	petroleum Section 6: Receptacles of dangerous petroleum to show a warning Section 23-28 Penalties and Procedure
17	The Petroleum Rules, 2002	Ministry of Petroleum and Natural Gas, Ministry of Shipping (for notification of authorized ports for import), Ministry of Environment & Forests or SPCB (for clearance of establishment of loading/unloading facilities at ports) Chief Controller of Explosives, district authority, Commissioner of Customs, Port Conservator, State Maritime Board (Import)	Petroleum (Class A, B and C - as defined in the rules)	Regulate the import, transport, storage, production, refining and blending of petroleum	Rule 2: Definition Chapter I part II: General Provision Chapter II: Importation of Petroleum Chapter III: Transport of Petroleum Chapter VII: Licenses
18	The Calcium Carbide Rules, 1987	Ministry of Petroleum and Natural Gas, Chief Controller of Explosives, Customs Collector, Port Conservator, DGCA, District Authority	Calcium Carbide	To regulate the import, production, storage, transportation, sale, use and handling and disposal of Calcium carbide with a view to prevent accidents	Rule 2: Definitions Chapter II: General provisions Chapter III: Importation of Carbide Chapter IV: Transportation of carbide Chapter V: Storage of carbide Chapter VI: Licensing Chapter VII: Notice of accident
19	The Explosives Act, 1884	Ministry of Commerce and Industry (Department of Explosives)	Explosive substances as defined under the Act	To regulate the manufacture, possession, use, sale, transport, export and import of explosives with a view to prevent accidents	Section 4: Definition Section 6: Power for Central government to prohibit the manufacture, possession or importation of especially dangerous explosives Section 6B: Grant of Licenses

20	The Explosive Rules, 1983	Ministry of Commerce and Industry and Chief Controller of Explosives, port conservator, customs collector, railway administration	Explosive substances as defined under the Act	To regulate the manufacture, possession, use, sale, transport, export and import of explosives with a view to prevent accidents	Rule 2: Definition Chapter II: General Provisions Chapter III: Import and Export Chapter IV: Transport Chapter V: Manufacture of explosives Chapter VI: Possession sale and use Chapter VII: Licenses
21	The Gas Cylinder Rules, 2004	Ministry of Commerce and Industry and Chief Controller of Explosives, port conservator, customs collector, DGCA, DC, DM, Police (sub inspector to commissioner)	Gases (Toxic, non toxic and non flammable, non toxic and flammable, Dissolved Acetylene Gas, Non toxic and flammable liquefiable gas other than LPG, LPG	Regulate the import, storage, handling and transportation of gas cylinders with a view to prevent accidents	Rule 2: Definition Chapter II: General Provisions Chapter III: Importation of Cylinder Chapter IV: Transport of Cylinder Chapter VII: Filling and Possession
22	The Static and Mobile Pressure Vessels (Unfired) Rules, 1981	Ministry of Commerce and Industry and Chief Controller of Explosives, port conservator, customs collector, DGCA, DC, DM, Police (sub inspector to commissioner)	Gases (Toxic, non toxic and non flammable, non toxic and flammable, Dissolved Acetylene Gas, Non toxic and flammable liquefiable gas other than LPG, LPG	Regulate the import, manufacture, design, installation, transportation, handling, use and testing of mobile and static pressure vessels (unfired) with a view to prevent accidents	Rule 2: Definition Chapter III: Storage Chapter IV: Transport Chapter V: Licenses
23	The Motor Vehicle Act, 1988	Ministry of Shipping, Road Transport and Highways	Hazardous and Dangerous Goods	To consolidate and amend the law relating to motor vehicles	Section 2: Definition Chapter II: Licensing of drivers of motor vehicle Chapter VII: Construction equipment and maintenance of motor vehicles
24	The Central Motor Vehicle Rules, 1989	Ministry of Shipping, Road Transport and Highways	Hazardous and Dangerous Goods	To consolidate and amend the law relating to motor vehicles including to regulate the transportation of dangerous goods with a view	Rule 2: Definition Rule 9: Educational qualification for driver’s of goods carriages carrying dangerous or hazardous goods Rule 129: Transportation of goods of dangerous or

				to prevent loss of life or damage to the environment	hazardous nature to human life Rule 129A: Spark arrestors Rule 130: Manner of display of class labels Rule 131: Responsibility of the consignor for safe transport of dangerous or hazardous goods Rule 132: Responsibility of the transporter or owner of goods carriage Rule 133: Responsibility of the driver Rule 134: Emergency Information Panel Rule 135: Driver to be instructed Rule 136: Driver to report to the police station about accident Rule 137: Class labels
25	The Mines Act 1952	Ministry of Coal and Mines	Use of toxic and inflammable gases, dust or mixtures	Safety of the mine workers	Section 2: Definitions Chapter IV: Mining operations and management of mines Chapter V: Provisions as to health and safety Chapter IX: Penalties and procedure
26	The Insecticide Act, 1968	Ministry of Agriculture and Central Insecticides Board and Registration Committee	Insecticides including fungicides and weedicides	regulate the import, manufacture, sale, transport, distribution and use of insecticides with a view to prevent risk to human beings or animals	Section 3: Definitions Section 9: Registration of Insecticides Section 13: Grant of License Section 17: Prohibition of import and manufacture of certain insecticides Section 18: Prohibition of sale, etc. of certain insecticides Section 25: Confiscation Section 26: Notification of poisoning Section 27: Prohibition of sale, etc. of insecticide for reasons of public safety Section 28: Notification of cancellation of registration, etc. Section 29: Offences and Punishment
27	The Insecticide Rules, 1971	Ministry of Agriculture and Central Insecticides Board and Registration Committee	Insecticides including fungicides and weedicides	regulate the import, manufacture, sale, transport, distribution and use of insecticides with a view to prevent risk to human beings or animals	Rule 2: Definition Rule 6: Manner of registration Rule 9: License to manufacture insecticides Rule 10: License for sale, etc., of insecticides Rule 10A: Segregation and disposal of date-expired pesticides

					Rule 10B: Special provision with regard to sulphur Rule 10C: Prohibition against sale or storage of insecticides in certain places Rule 15: Issuing cash memo and maintenance of records Rule 16: Prohibition of sale or distribution unless packed and labeled Rule 17: Packaging of insecticides Rule 18: Leaflet to be contained in a package Rule 19: Manner of labeling Rule 20: Prohibition against altering inscriptions, etc. on containers, labels or wrappers of insecticides Rule 35: Manner of packing, storage while in transit by rail Rule 36: Conditions to be specified for storage of insecticides Rule 37: Medical Examination Rule 38: First aid measures Rule 39: Protective clothing Rule 40: Respiratory devices Rule 41: Manufacturers, etc. to keep sufficient quantities of antidotes and first-aid medicines Rule 42: Training of workers Rule 43: Aerial spraying operations Rule 44: Disposal of used packages, surplus materials and washings of insecticides Rule 45: Places at which the insecticides may be imported
28	The Custom Act, 1962	CBEC, Ministry of Finance	Hazardous Goods	To prevent entry of illegal hazardous goods or banned goods including hazardous or banned chemicals	Section 2: definitions Section 11: Power to Prohibit Importation or Exportation of Goods
29	The Merchant Shipping Act, 1958 amended in 2002 and 2003	Ministry of Shipping, Road Transport and Highways	All packaged cargo including Dangerous and hazardous goods as defined in the rules	For safe handling and transportation of cargo including dangerous goods to prevent accident	Section 3: Definitions Section 331: Carriage of Dangerous Goods
30	Merchant Shipping (carriage of Cargo)	Ministry of Shipping, Road	All packaged cargo including Dangerous and hazardous goods	For safe handling and transportation of cargo	

	Rules 1995	Transport and Highways	as defined in the rules	including dangerous goods to prevent accident	
31	The Indian Port Act, 1908	Ministry of Shipping, Road Transport and Highways	All Chemicals - handling and storage	For control of activities on ports including safety of shipping and conservation of ports	Section 2: Definitions Chapter IV: Rules for the safety of shipping and the conservation of ports Chapter VII: Provisions with respect to penalties
32	The Dock Workers, (Safety, Health and Welfare) Act, 1986	Ministry of Labour, DGFASLI and Directorate of Dock Safety	All Chemicals termed as dangerous goods	Safety of Dock workers including handling of dangerous goods	
33	The Dock Workers, (Safety, Health and Welfare) Rules, 1990	Ministry of Labour, DGFASLI and Directorate of Dock Safety	All Chemicals termed as dangerous goods	Safety of Dock workers including handling of dangerous goods	
34	Drug and Cosmetics Act, 1940	Ministry of Health and Family Welfare	To all types of drugs and cosmetics	To regulate the import, manufacture, distribution and sale of drugs	Section 2: Definitions Chapter III: Import of Drugs and Cosmetics Chapter IV: Manufacture, Sale and Distribution of Drugs and Cosmetics
35	The Prevention of Food Adulteration Act, 1954	Ministry of Health and Family Welfare	All food grade chemicals, colorants, preservatives, poison metals, etc.	To prevent the food adulteration	Section 2: Definitions Section 5: Prohibition of import of certain articles of food Section 7: Prohibition of manufacture, sale etc., of certain articles of food Section 15: Notification of food poisoning Section 16: Penalties
36	The Prevention of Food Adulteration Rules, 1955	Ministry of Health and Family Welfare	All food grade chemicals, colorants, preservatives, poison metals, etc.	To prevent the food adulteration	Section 2: Definitions Part VI: Colouring Matter Part X: Preservatives Part XI: Poisonous Metals Part XIA: Crop Contaminants and Naturally Occurring Toxic Substances Part XII: Anti-Oxidants, Emulsifying and Stabilizing and Anticaking Agents Part XIII: Flavoring Agents and Related Substances Part XIII-A: Carry Over of Food Additives Part XVI: Sequestering and Buffering Agents

					(Acids, Bases and Salts) Part XVIII: Antibiotic and other Pharmacologically Active Substances Part XIX: Use of Food Additives in Food Products

ANNEXURE III
General Standards for Discharge of Environmental Pollutants as per CPCB

Table: Water Quality Standards

S. No.	Parameter	Standards			
		Inland Surface Water	Public Sewer	Land for Irrigation	Marine Coastal Areas
1.	2.	3.			
		(a)	(b)	(c)	(d)
1.	Colour and odour	See Note-1	—	See Note-1	See Note-1
2.	Suspended Solids, mg/l, Max	100	600	200	(a) For process waste water-100 (b) For cooling water effluent-10 per cent above total suspended matter of influent cooling water.
3.	Particle size of suspended solids	Shall pass 850 micron IS Sieve	—	—	(a) Floatable solids, Max 3 mm (b) Settleable solids Max 850 microns.
4.	Dissolved solids (inorganic), mg/a, mac	2100	2100	2100	—
5.	pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
6.	Temperature ^{o}C, Max	Shall not exceed 40 in any section of the stream within 15 meters down stream from the effluent outlet	45 at the point of discharge	—	45 at the point of discharge
7.	Oil and grease, mg/l, max	10	20	10	20
8.	Total residual chlorine, mg/l, Max.	1.0	—	—	1.0
9.	Ammonical nitrogen (as N), mg/l, Max.	50	50	—	50
10.	Total Kjeldahl nitrogen (as N), mg/l, Max.	100	—	—	100
11.	Free Ammonia (as NH3), mg/l, Max.	5.0	—	—	5.0
12.	Biochemical Oxygen Demand (5 days at 20^{o}C) Max.	30	350	100	100
13.	Chemical Oxygen Demand, mg/l, Max.	250	—	—	250
14.	Arsenic (as As), mg/l, Max.	0.2	0.2	0.2	0.2
15.	Mercury (as Hg), mg/l, Max.	0.01	0.01	—	0.01
16.	Lead (as Pb), mg/l, Max.	0.1	1.0	—	1.0
17.	Cadmium (as Cd), mg/l, Max.	2.0	1.0	—	2.0

18.	Hexavalent chromium (as Cr+6) mg/l, Max.	0.1	2.0	—	1.0
19.	Total chromium as (Cr), mg/l, Max.	2.0	2.0	—	2.0
20.	Copper (as Cu), mg/l, Max.	3.0	3.0	—	3.0
21.	Zinc (as Zn), mg/l, Max.	5.0	15	—	15
22.	Selenium (as Se), mg/l, Max.	0.05	0.05	—	0.05
23.	Nickel (as Ni), mg/l, Max.	3.0	3.0	—	5.0
24.	Boron (as B), mg/l, Max.	2.0	2.0	2.0	—
25.	Percent Sodium, Max.	—	60	60	—
26.	Residual sodium carbonate, mg/l, Max.	—	—	5.0	—
27.	Cyanide (as CN), mg/l, Max.	0.2	2.0	0.2	0.2
28.	Chloride (as Cl), mg/l, Max.	1000	1000	600	(a)
29.	Fluoride (as F), mg/l, Max.	2.0	15	—	15
30.	Dissolved Phosphates (as P), mg/l, Max.	5.0	—	—	—
31.	Sulphate (as SO4), mg/l, Max.	1000	1000	1000	—
32.	Sulphide (as S), mg/l, Max.	2.0	—	—	5.0
33.	Pesticides	Absent	Absent	Absent	Absent
34.	Phenolic compounds (as C6H5OH), mg/l, Max.	1.0	5.0	—	5.0
35.	Radioactive materials (a) Alpha emitters MC/ml, Max. (b) Beta emitters uc/ml, Max.	10^{-7} 10^{-6}	10^{-7} 10^{-6}	10^{-8} 10^{-7}	10^{-7} 10^{-6}

Note :-

1. All efforts should be made to remove colour and unpleasant odour as far as practicable.
2. The standards mentioned in this notification shall apply to all the effluents discharged such as industrial mining and mineral processing activities municipal sewage etc.

Table: Noise Standards

Ambient air quality standards in respect of noise

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 is reckoned in between 6.00 AM and 9.00 PM
2. Night time is reckoned in between 9.00 PM and 6.00 AM
3. Silence zone is defined as areas upto 100 meters around such premises as hospitals, educational institutions and courts. The Silence zones are to be declared by the Competent Authority.
4. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
5. Mixed categories of areas should be declared as one of the four above mentioned categories by the Competent Authority and the corresponding standards shall apply.

Standards/Guidelines for Control of Noise Pollution from Stationary Diesel Generator (DG) Sets

(A) Noise Standards for DG Sets (15-500 KVA)

The total sound power level, Lw, of a DG set should be less than, 94+10 log10 (KVA), dB (A), at the manufacturing stage, where, KVA is the nominal power rating of a DG set.

This level should fall by 5 dB (A) every five years, till 2007, i.e. in 2002 and then in 2007.

(B) Mandatory acoustic enclosure/acoustic treatment of room for stationary DG sets (5 KVA and above)

Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the room acoustically.

The acoustic enclosure/acoustic treatment of the room should be designed for minimum 25 dB(A) Insertion Loss or for meeting the ambient noise standards, whichever is on the higher side (if the actual ambient noise is on the higher side, it may not be possible to check the performance of the acoustic enclosure/acoustic treatment. Under such circumstances the performance may be checked for noise reduction upto actual ambient noise level, preferably, in the night time). The measurement for Insertion Loss may be done at different points at 0.5m from the acoustic enclosure/room, and then averaged.

The DG set should also be provide with proper exhaust muffler with Insertion Loss of minimum 25 dB(A).

(C) Guidelines for the manufacturers/users of DG sets (5 KVA and above)

1. The manufacturer should offer to the user a standard acoustic enclosure of 25 dB(A) Insertion Loss and also a suitable exhaust muffler with Insertion Loss of 25 dB(A).

2. The user should make efforts to bring down the noise levels due to the DG set, outside his premises, within the ambient noise requirements by proper siting and control measures.
3. The manufacturer should furnish noise power levels of the unlicensed DG sets as per standards prescribed under (A)
4. The total sound power level of a DG set, at the user's end, shall be within 2 dB(A) of the total sound power level of the DG set, at the manufacturing stage, as prescribed under (A).
5. Installation of a DG set must be strictly in compliance with the recommendation of the DG set manufacturer.
6. A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

Order of the Lt. Governor of Delhi in respect of D.G. Sets (5th December, 2001)

In exercise of the powers conferred by section 5 of the Environment (Protection) Act, 1986, (29 of 1986), read with the Government of India, Ministry of Home Affairs notification S.O. 667 (E) bearing No. F.No. U-11030/J/91-VTL dated 10th September, 1992, the Lt. Governor of Government of National Capital of Delhi hereby directs to all owners/users of generators sets in the National Capital Territory of Delhi as follows :-

1. that generator sets above the capacity of 5 KVA shall not be operated in residential areas between the hours of 10.00 PM to 6.00 AM;
2. that the generator sets above the capacity of 5 KVA in all areas residential/commercial/industrial shall operate only with the mandatory acoustic enclosures and other standards prescribed in the Environment (Protection) Rules, 1986;
3. that mobile generator sets used in social gatherings and public functions shall be permitted only if they have installed mandatory acoustic enclosures and adhere to the prescribed standards for noise and emission as laid down in the Environment (Protection) Rules, 1986.

The contravention of the above directions shall make the offender liable for prosecution under section 15 of the said Act which stipulates punishment of imprisonment for a term which may extend to five years with fine which may extend to one lakh rupees, or with both, and in case the failure of contravention continues, with additional fine which may extend to five thousand rupees for every day during which such failure or contravention continues after the conviction for the first such failure or contravention and if still the failure or contravention continues beyond a period of one year after the date of contravention, the offender continues beyond a period of one year after the date of contravention, the offender shall be punishable with imprisonment for a term which may extend to seven years.

Order Dated: 21st June, 2002

In exercise of the powers conferred by section 5 of the Environment (Protection) Act, 1986 (29 of 1986) read with the Govt. of India, Ministry of Home Affairs notification S.O. 667(E) bearing No. U-11030/J/91-VTL dated the 10th September, 1992, the Lt. Governor Govt. of the National Capital Territory of Delhi hereby makes the following amendment/modification in his order dated the 5th December, 2001 regarding the operation of generator sets, namely:-

Amendments/modifications

In the above said order, for clause(1), the following shall be substituted, namely:-

“(1) that the generator sets above 5KVA shall not be operated in residential areas between the hours from 10.00 p.m. to 6.00 a.m. except generator sets of Group Housing Societies and Multi-storey residential apartments”.

DIESEL GENERATOR SETS: STACK HEIGHT

The minimum height of stack to be provided with each generator set can be worked out using the following formula:

$H = h + 0.2 \times \sqrt{KVA}$

H = Total height of stack in metre

h = Height of the building in metres where the generator set is installed

KVA = Total generator capacity of the set in KVA

Based on the above formula the minimum stack height to be provided with different range of generator sets may be categorized as follows:

For Generator Sets	Total Height of stack in metre
50 KVA	Ht. of the building + 1.5 metre
50-100 KVA	Ht. of the building + 2.0 metre
100- 150 KVA	Ht. of the building + 2.5 metre
150-200 KVA	Ht. of the building + 3.0 metre
200-250 KVA	Ht. of the building + 3.5 metre
250-300 KVA	Ht. of the building + 3.5 metre

Similarly for higher KVA ratings a stack height can be worked out using the above formula

Source: Evolved By CPCB

[Emission Regulations Part IV: COINDS/26/1986-87]

ANNEXURE IV
Form 1 (Application Form for Obtaining EIA Clearance)

FORM 1

(I) BASIC INFORMATION

S. No.	Item	Details
1.	Name of the project/s	
2.	S.No. in the schedule	
3.	Proposed capacity/area/length/tonnage to be handled/command area/lease area/number of wells to be drilled	
4.	New/Expansion/Modernization	
5.	Existing Capacity/Area etc.	
6.	Category of Project i.e., 'A' or 'B'	
7.	Does it attract the general condition? If yes, please specify.	
8.	Does it attract the specific condition? If yes, Please specify.	
9.	Location	
	Plot/Survey/Khasra No.	
	Village	
	Tehsil	
	District	
	State	
10.	Name of the applicant	
11.	Registered Address	
12.	Address for correspondence:	
	Name	
	Designation (Owner/Partner/CEO)	
	Address	
	Pin Code	
	E-mail	
	Telephone No.	
	Fax No.	
13.	Details of alternative Sites examined, if any location of these sites should be shown on a toposheet.	Village-District-State 1. 2. 3.

S. No.	Item	Details
14.	Interlined Projects	
15.	Whether separate application of interlined project has been submitted	
16.	If yes, date of submission	
17.	If no, reason	
18.	Whether the proposal involves approval/clearance under: The Forest (Conservation) Act, 1980 The Wildlife (Protection) Act, 1972 The C.R.Z. Notification, 1991	
19.	Forest land involved (hectares)	
20.	Whether there is any litigation pending against the project and/or land in which the project is propose to be set up Name of the Court Case No. Orders/directions of the Court, if any and its relevance with the proposed project.	

(II) ACTIVITY

1. Construction, operation or decommissioning of the Project involving actions, which will cause physical changes in the locality (topography, land use, changes in water bodies, etc.)

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
1.1	Permanent or temporary change in land use, land cover or topography including increase in intensity of land use (with respect to local land use plan)		
1.2	Clearance of existing land, vegetation and buildings?		
1.3	Creation of new land uses?		
1.4	Pre-construction investigations e.g. bore houses, soil testing?		
1.5	Construction works?		

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
1.6	Demolition works?		
1.7	Temporary sites used for construction works or housing of construction workers?		
1.8	Above ground buildings, structures or earthworks including linear structures, cut and fill or excavations		
1.9	Underground works including mining or tunneling?		
1.10	Reclamation works?		
1.11	Dredging?		
1.12	Offshore structures?		
1.13	Production and manufacturing processes?		
1.14	Facilities for storage of goods or materials?		
1.15	Facilities for treatment or disposal of solid waste or liquid effluents?		
1.16	Facilities for long term housing of operational workers?		
1.17	New road, rail or sea traffic during construction or operation?		
1.18	New road, rail, air waterborne or other transport infrastructure including new or altered routes and stations, ports, airports etc?		
1.19	Closure or diversion of existing transport routes or infrastructure leading to changes in traffic movements?		
1.20	New or diverted transmission lines or pipelines?		
1.21	Impoundment, damming, culverting, realignment or other changes to the hydrology of watercourses or aquifers?		
1.22	Stream crossings?		
1.23	Abstraction or transfers of water form ground or surface waters?		
1.24	Changes in water bodies or the land surface affecting drainage or run-off?		
1.25	Transport of personnel or materials for construction, operation or decommissioning?		

S.No.	**Information/Checklist confirmation**	**Yes/No**	**Details thereof (with approximate quantities /rates, wherever possible) with source of information data**
1.26	Long-term dismantling or decommissioning or restoration works?		
1.27	Ongoing activity during decommissioning which could have an impact on the environment?		
1.28	Influx of people to an area in either temporarily or permanently?		
1.29	Introduction of alien species?		
1.30	Loss of native species or genetic diversity?		
1.31	Any other actions?		

2. Use of Natural resources for construction or operation of the Project (such as land, water, materials or energy, especially any resources which are non-renewable or in short supply):

S.No.	Information/checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
2.1	Land especially undeveloped or agricultural land (ha)		
2.2	Water (expected source & competing users) unit: KLD		
2.3	Minerals (MT)		
2.4	Construction material – stone, aggregates, sand / soil (expected source – MT)		
2.5	Forests and timber (source – MT)		
2.6	Energy including electricity and fuels (source, competing users) Unit: fuel (MT), energy (MW)		
2.7	Any other natural resources (use appropriate standard units)		

3. Use, storage, transport, handling or production of substances or materials, which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health.

S.No	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
3.1	Use of substances or materials, which are hazardous (as per MSIHC rules) to human health or the environment (flora, fauna, and water supplies)		
3.2	Changes in occurrence of disease or affect disease vectors (e.g. insect or water borne diseases)		
3.3	Affect the welfare of people e.g. by changing living conditions?		
3.4	Vulnerable groups of people who could be affected by the project e.g. hospital patients, children, the elderly etc.,		
3.5	Any other causes		

4. Production of solid wastes during construction or operation or decommissioning (MT/month)

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
4.1	Spoil, overburden or mine wastes		
4.2	Municipal waste (domestic and or commercial wastes)		
4.3	Hazardous wastes (as per Hazardous Waste Management Rules)		
4.4	Other industrial process wastes		
4.5	Surplus product		
4.6	Sewage sludge or other sludge from effluent treatment		
4.7	Construction or demolition wastes		
4.8	Redundant machinery or equipment		

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
4.9	Contaminated soils or other materials		
4.10	Agricultural wastes		
4.11	Other solid wastes		

5. Release of pollutants or any hazardous, toxic or noxious substances to air (kg/hr)

S.No	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
5.1	Emissions from combustion of fossil fuels from stationary or mobile sources		
5.2	Emissions from production processes		
5.3	Emissions from materials handling including storage or transport		
5.4	Emissions from construction activities including plant and equipment		
5.5	Dust or odours from handling of materials including construction materials, sewage and waste		
5.6	Emissions from incineration of waste		
5.7	Emissions from burning of waste in open air (e.g. slash materials, construction debris)		
5.8	Emissions from any other sources		

6. Generation of Noise and Vibration, and Emissions of Light and Heat:

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data with source of information data
6.1	From operation of equipment e.g. engines, ventilation plant, crushers		
6.2	From industrial or similar processes		
6.3	From construction or demolition		
6.4	From blasting or piling		
6.5	From construction or operational traffic		
6.6	From lighting or cooling systems		
6.7	From any other sources		

7. Risks of contamination of land or water from releases of pollutants into the ground or into sewers, surface waters, groundwater, coastal waters or the sea:

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
7.1	From handling, storage, use or spillage of hazardous materials		
7.2	From discharge of sewage or other effluents to water or the land (expected mode and place of discharge)		
7.3	By deposition of pollutants emitted to air into the land or into water		
7.4	From any other sources		
7.5	Is there a risk of long term build up of pollutants in the environment from these sources?		

8. Risk of accidents during construction or operation of the Project, which could affect human health or the environment

S.No	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
8.1	From explosions, spillages, fires etc from storage, handling, use or production of hazardous substances		
8.2	From any other causes		
8.3	Could the project be affected by natural disasters causing environmental damage (e.g. floods, earthquakes, landslides, cloudburst etc)?		

9. Factors which should be considered (such as consequential development) which could lead to environmental effects or the potential for cumulative impacts with other existing or planned activities in the locality

S. No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
9.1	Lead to development of supporting facilities, ancillary development or development stimulated by the project which could have impact on the environment e.g.: ▪ Supporting infrastructure (roads, power supply, waste or waste water treatment, etc.) ▪ housing development ▪ extractive industries ▪ supply industries ▪ other		
9.2	Lead to after-use of the site, which could have an impact on the environment		
9.3	Set a precedent for later developments		
9.4	Have cumulative effects due to proximity to other existing or planned projects with similar effects		

(III) ENVIRONMENTAL SENSITIVITY

S.No.	**Areas**	**Name/ Identity**	**Aerial distance (within 15 km.)** **Proposed project location boundary**
1	Areas protected under international conventions, national or local legislation for their ecological, landscape, cultural or other related value		
2	Areas which are important or sensitive for ecological reasons - Wetlands, watercourses or other water bodies, coastal zone, biospheres, mountains, forests		
3	Areas used by protected, important or sensitive species of flora or fauna for breeding, nesting, foraging, resting, over wintering, migration		
4	Inland, coastal, marine or underground waters		
5	State, National boundaries		
6	Routes or facilities used by the public for access to recreation or other tourist, pilgrim areas		
7	Defence installations		
8	Densely populated or built-up area		
9	Areas occupied by sensitive man-made land uses *(hospitals, schools, places of worship, community facilities)*		
10	Areas containing important, high quality or scarce resources *(ground water resources, surface resources, forestry, agriculture, fisheries, tourism, minerals)*		
11	Areas already subjected to pollution or environmental damage. *(those where existing legal environmental standards are exceeded)*		
12	Areas susceptible to natural hazard which could cause the project to present environmental problems (*earthquakes, subsidence, landslides, erosion, flooding or extreme or adverse climatic conditions*)		

(IV) PROPOSED TERMS OF REFERENCE FOR EIA STUDIES

“I hereby given undertaking that the data and information given in the application and enclosure are true to the best of my knowledge and belief and I am aware that if any part of the data and information submitted is found to be false or misleading at any stage, the project will be rejected and clearance give, if any to the project will be revoked at our risk and cost.

Date:______________
Place:______________

Signature of the applicant
With Name and Full Address
(Project Proponent / Authorized Signatory)

NOTE:

1. The projects involving clearance under Coastal Regulation Zone Notification, 1991 shall submit with the application a C.R.Z. map duly demarcated by one of the authorized, agencies, showing the project activities, w.r.t. C.R.Z. and the recommendations of the State Coastal Zone Management Authority. Simultaneous action shall also be taken to obtain the requisite clearance under the provisions of the C.R.Z. Notification, 1991 for the activities to be located in the CRZ.
2. 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.”

ANNEXURE V
Critically Polluted Industrial Areas and Clusters/Potential Impact Zones

Table 1: Details of Critically Polluted Industrial Areas and Clusters / Potential Impact Zone (Ref: Office Memorandum No. J-11013/5/2010-IA.II(I) Dated 13.1.2010)

S. No.	Critically Polluted Industrial Area and CEPI	Industrial Clusters/ Potential Impact Zones
1.	Ankeshwar (Gujarat) CEPI-88.50(Ac_Wc_Lc)	▪ GIDC Ankeshwar and GIDC, Panoli
2	Vapi (Gujarat) CEPI-88.09(Ac_Wc_Lc)	▪ GIDC Vapi
3	Ghaziabad (Uttar Pradesh) 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 are Sub-cluster D ▪ Loni industrial area ▪ Loni Road industrial area ▪ Roop nagar industrial area Sub-cluster E ▪ Hapur Road industrial area ▪ Dasna ▪ Philkura 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	Kobra (Chhatisgarh) CEPI-83.00 (Ac_Ws_Lc)	▪ Industrial areas and their townships of NTPC, BALCO, CSEB (East) & CSEB (West) ▪ Korba town
6	Bhiwadi (Rajasthan) CEPI-82.91 (Ac_Wc_Ls)	▪ RIICO industrial areas Phase I to IV ▪ Bhiwadi town ▪ Other surrounding industrial areas: Chopanki, Rampura Mundana, Khuskhera Phase I to III
7	Angul Talcer(Orissa) CEPI-82.09 (Ac_Wc_Lc)	▪ MCL Coal mining area, Augul – Talcer region ▪ Industrial area (60 km x 45 km) Following blocks of Augul district: ▪ Kohina block ▪ Talcher block

		▪ Angul block ▪ Chhendipada block ▪ Banarpal block ▪ Odapada block of Dhenkamal district
8	Vellore (North Arcot) (Tamil Nadu) CEPI-81.79 (Ac_Wc_Lc)	▪ Ranipet, SIPCOT industrial complex
9	Singrauli (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 Jaynat, Nigahi, Dudhichua, Amlohri & Jhingurdah townships
10	Ludhiana (Punjab) CEPI-81.66 (Ac_Wc_Ls)	Ludhiana municipal limits covering industrial clusters: ▪ Focal point along with NH-I- Total eight phase ▪ Industrial area-B- from sherpur chowk to Gill road & Gill road to Miller Kotla road (left side of road) ▪ Mixed industrial area – right side of Gill road ▪ Industrial area –C (near Juglana village) ▪ Industrial area A & extension: area between old GT road and Ludhiana bypass road ▪ Industrial estate: near Dholwal chowk ▪ Mixes industrial area (MIA) Miller gunj ▪ MIA – bypass 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 industrial 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 (Uttar Pradesh) CEPI-78.09 (Ac_Wc_Ls)	Industrial areas: ▪ Dada nagar ▪ Panki ▪ Fazalganj ▪ Vijay nagar ▪ Jajmau
16	Cuddalore (Tamil Nadu) 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, 27, 31, 59 ▪ Industrial area Hatin ▪ Industrial model township
19	Agra (Uttar Pradesh) CEPI-76.48 (As_Wc_Ls)	▪ Nunihai industrial estate, Rambag nagar, UPSIDC industrial area, and Runukata industrial area
20	Manali (Tamil Nadu) CEPI-76.32 (Ac_Ws_Ls)	▪ Manali industrial area
21	Haldia (West Bengal) CEPI-75.43 (As_Wc_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 municipal area & Sutahata block – I and II
22	Ahmedabad (Gujarat) CEPI-75.28 (Ac_Ws_Ls)	▪ 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 Tanwada & Salawas. ▪ Jodhpur city
24	Greater Cochin (Kerala) CEPI-75.08 (As_Wc_Ls)	▪ Eloor-Edayar industrial 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)	▪ Liluah-Bamangachhi region, Howrah ▪ Jalan industrial complex-1, Howrah
27	Vatva (Gujarat) CEPI-74.77 (Ac_Wc_Ls)	▪ GIDC Vatva, Narol industrial area (Villages Piplaj, Shahwadi, Narol)
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, Varansi ▪ UPSIC, industrial estate, Phoolpur ▪ Industrial area, Ramnagar, Chandauli
30	Navi Mumbai (Maharashtra) CEPI-73.77 (Ac_Ws_Ls)	▪ TTC industrial area, MIDC, Navi Mumbai (including Bocks-D, C, EL, A, R, General, Kalva)

31	Pali (Rajasthan) CEPI-73.73 (As_Wc_Ls)	▪ Existing industrial areas: Mandia road, Puniyata road, Sumerpur ▪ 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_Ls)	▪ Panipat municipal limit and its industrial clusters
38	Indore (Madhya Pradesh) CEPI-71.26 (As_Ws_Ls)	Following 09 industrial area: ▪ Sanwer road ▪ Shivaji nagar ▪ Pologround ▪ Laxmibai nagar ▪ Scheme no.71 ▪ Navlakha ▪ Pipliya ▪ Palda ▪ Rau Indore city Other surrounding industrial areas: Manglia, Rajoda, Asrawad, Tejpur Gadwadi
39	Bhavnagar (Gujarat) CEPI-70.99 (As_Ws_Ls)	▪ GIDI 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 direction)
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)	▪ Bumpur 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.

ANNEXURE VI
Pre-Feasibility Report: Points for Possible Coverage

Table 1: Points for Possible Coverage in Pre-feasibility Report

S. No.	Contents	Points of Coverage in Pre-feasibility Report
I.	**Executive summary**	▪ A miniature report of entire pre feasibility report
II.	**Project Details**	
	Need/Justification of the Project	▪ Current demand scenario of the product ▪ Alternatives to meet the demand ▪ Post project scenario on residual demand, *etc.*
	Capacity of Synthetic Organic Chemicals Industry	▪ Production capacity of the industry ▪ Sustainability of raw material supply and quality ▪ Optimization of plant capacity, *etc.*
	Process technology	▪ Analysis of available/advanced technologies, etc. ▪ Analysis of possible configurations for each technology or a combination of these technologies from available manufactures ▪ Broad specifications for the proposed industrial units including but not limited to: - Plant outputs and process flow diagrams for each alternative - General plant layout, - Process technologies, - Process equipments, *etc.*
	Resources/raw materials	▪ Details on raw material, by products/co-products ▪ Water - Water requirement for process, utilities, domestic, gardening etc. - Source of construction water and potable water - Source of circulating/consumptive water - Quality of raw water, treated water - Water budget calculations and effluent generation - Approved water allocation quota (drinking, irrigation and industrial use) and surplus availability - Feasible ways of bringing water to site indicating constraints if any. - Lean season water availability and allocation source in case main source not perennial. ▪ Manpower ▪ Infrastructure ▪ Electrical power ▪ Construction material like sand, brick, stone chips, borrow earth *etc.*
	Rejects (Pollution potential)	▪ Air emissions ▪ Water pollution ▪ Solid / hazardous waste ▪ Noise ▪ Odour
	Technical profile	▪ Construction details - Estimated duration - Number of construction workers including migrating workers - Construction equipment - Vehicular traffic - Source, mode of transportation and storage of construction material

		▪ Traffic that would arise during different phases of the project and transportation mechanism to handle such traffic ▪ New facilities needed ▪ Technical parameters of the plant & equipments to be used ▪ Product storage and associated transportation system ▪ Product demand & supply position data on regional basis, *etc.*
	Project schedule	▪ Project implementation schedule
	Future prospects	▪ Ascertain the costs and benefits of the proposed project for project life ▪ Technical and logistic constraints/ requirements of project sustainability, *etc.*
III.	**Selection of site based on least possible impacts**	
i.	**Choice of site selection**	
	Major techno-economic feasibility considerations	▪ Land availability & its development ▪ Product demand around the selected site ▪ Access to site for transportation of equipments/construction machinery, material, *etc.* ▪ Raw material availability and its transportation ▪ Water availability and consumptive use ▪ Product transportation ▪ Infrastructure availability at selected site ▪ Inter-state issue, if any, *etc.*
	Incompatible landuse and ecologically sensitive attributes with respect to identified suitable sites	▪ If any incompatible land-use attributes fall within the study area, the following details has to be provided: - Public water supply areas from rivers/surface water bodies, from groundwater - Scenic areas/tourism areas/hill resorts - Religious places, pilgrim centers that attract over 10 lakh pilgrims a year - Protected tribal settlements (notified tribal areas where industrial activity is not permitted); CRZ - Monuments of national significance, World Heritage Sites - Cyclone, Tsunami prone areas (based on last 25 years); - Airport areas - Any other feature as specified by the State or local government and other features as locally applicable, including prime agricultural lands, pastures, migratory corridors, etc. ▪ If ecologically sensitive attributes fall within the study area, please give details. Ecologically sensitive attributes include - National parks - Wild life sanctuaries Game reserve - Tiger reserve/elephant reserve/turtle nesting ground - Mangrove area - Wetlands - Reserved and protected forests - Endangered species of flora and fauna - Any other eco-sensitive areas, *etc.*
	Social aspects	▪ Corporate social responsibilities ▪ Employments and infrastructure added in the vicinity of the plant

		▪ Status of land availability, current and post project land use variation ▪ Social sensitivity and likely project affected people, *etc.*
ii.	**Details of selected site**	
	Land details	▪ Land requirement and availability ▪ Land ownership details such as Government, private, tribal, non-tribal, *etc.* ▪ Total area of the project/site ▪ Prevailing land cost details, *etc.*
	Location	▪ Geographical details - Longitude & latitude, village, taluka, district, state ▪ Approach to site – roads, railways and airports ▪ Distance from nearest residential and industrial areas ▪ Distance from nearest water bodies such as river, canal, dam, etc ▪ Distance from ecologically sensitive areas ▪ In case of flood prone areas, HFL of the site ▪ In case of seismic areas, seismic zone, active faults, occurrence on earthquakes, etc. ▪ Proximity from infrastructural facilities, *etc.*
	Physical characteristics	▪ Demography ▪ Meteorological data ▪ Landuse pattern such as agricultural, barren, forest, *etc.* and details thereof ▪ Topography of the area ▪ Drainage patterns ▪ Soil condition and soil investigation results ▪ Ground profile and levels, *etc.*
IV.	**Anticipated impacts based on project operations on receiving environment**	▪ Population ▪ Flora and fauna ▪ Water ▪ Soil ▪ Air ▪ Climate ▪ Landscape, *etc.*
V.	**Proposed broad mitigation measures which could effectively be internalized as project components to have environmental and social acceptance of the proposed site**	▪ Preventive measures ▪ Source control measures ▪ Mitigation measures at the receiving environment, ▪ Health and safety measures, *etc.*
VI.	**An indication of any difficulties (technical deficiencies or lack of know-how) encountered by the developer in compiling the required information.**	

The above listing is not exhaustive. Thus the proponent may provide additional necessary information, felt appropriate, to include in the pre-feasibility study report in support of selecting the site for the proposed developmental activities. The Concerned EAC/SEAC during scrutiny, may specifically ask for any additional information/data required to substantiate the requirement to prescribe the ToR for EIA studies. However, it is to make clear that all the required further information by EAC/SEAC may be mentioned in one single letter, within the prescribed time.

ANNEXURE VII
Types of Monitoring and Network Design Considerations

TYPES OF MONITORING AND NETWORK DESIGN CONSIDERATIONS

A. Types of Monitoring

Monitoring refers to the collection of data using a series of repetitive measurements of environmental parameters (or, more generally, to a process of systematic observation). The environmental quality monitoring programme design will be dependent upon the monitoring objectives specified for the selected area of interest. The main types of EIA monitoring activities are:

- Baseline monitoring is the measurement of environmental parameters during the pre-project period for the purpose of determining the range of variation of the system and establishing reference points against which changes can be measured. This leads to the assessment of the possible (additional available) assimilative capacity of the environmental components in pre-project period w.r.t. the standard or target level.
- Effects monitoring is the measurement of environmental parameters during project construction and implementation to detect changes which are attributable to the project to provide the necessary information to:
  - verify the accuracy of EIA predictions; and
  - determine the effectiveness of measures to mitigate adverse effects of projects on the environment.
  - Feedback from environmental effect monitoring programs may be used to improve the predictive capability of EIAs and also determine whether more or less stringent mitigation measures are needed
- Compliance monitoring is the periodic sampling or continuous measurement of environmental parameters to ensure that regulatory requirements and standards are being met.

Compliance and effects monitoring occurs during the project construction, operation, and abandonment stages. The resources and institutional set-up should be available for the monitoring at these stages. All large-scale construction projects will require some construction stage monitoring. To control the environmental hazards of construction as specified in the EIA, a monitoring program should be established to ensure that each mitigation measure is effectively implemented. There are numerous potential areas for monitoring during operations.

The scope of monitoring topics discussed in this chapter is limited to Baseline and Effects monitoring. In addition, this chapter will also discuss the Compliance monitoring during the construction phase. Post-project monitoring requirements are discussed in the EMP.

Before any field monitoring tasks are undertaken there are many institutional, scientific, and fiscal issues that must be addressed in the implementation of an environmental monitoring program. Careful consideration of these issues in the design and planning stages will help avoid many of the pitfalls associated with environmental monitoring programs. Although these issues are important but the discussions here are confined to the monitoring network design component.

B. Network Design

Analysis of Significant Environmental Issues

At the outset of planning for an environmental monitoring network, the EIA manager may not know exactly what should be monitored, when monitoring should begin, where it should monitor, which techniques should be employed, and who should take responsibility for its conduct. Because there are usually a number of objective decisions associated with network design to be made, it is important to start with an analysis of environmental issues. The scoping phase of an EIA is designed to identify and focus on the major issues. Scoping should provide a valuable source of information on the concerns that need to be addressed by the monitoring network design. These are project specific as well as specific to the environmental setting of the location where the project is proposed to be located

Hence, the network designs are associated with questions like:

- What are the expected outputs of the monitoring activity?
- Which problems do we need to address to? *etc*.

Defining the output will influence the design of the network and optimize the resources used for monitoring. It will also ensure that the network is specially designed to optimize the information on the problems at hand

What to Monitor?

The question of what to monitor is associated with the identification of VECs.

VECs are generally defined as environmental attributes or components of the environment that are valued by society as identified during the scoping stage of the project. They are determined on the basis of perceived public concerns. For example, changes to water quality and quantity could have implications on fish by affecting habitat, food supply, oxygen, and contaminant uptake. Similarly, employment and business, and economies are both VECs that serve as pathways.

The choice of VECs is also related to the perceived significant impact of the project implementation on important environmental components. In general, the significance or importance of environmental components is judged based on:

- legal protection provided (for example, rare and endangered species)
- political or public concerns (for example, resource use conflicts and sustainable development)
- scientific judgment (for example, ecological importance); or
- commercial or economic importance

However, in addition to their economic, social, political or ecological significance, the chosen VEC should also have unambiguous operational ease, be accessible to prediction and measurement; and be susceptible to hazard. Once the VECs are defined, the VECs may be directly measured (for example, extent of habitat for an endangered species). In cases where it is impossible or impractical to directly measure the VECs, the chosen measurement endpoints or environmental indicators must correspond to, or be predictive of assessment endpoints.

The chosen environmental indicators must be: 1) measurable; 2) appropriate to the scale of disturbance/ contamination; 3) appropriate to the impact mechanism; 4) appropriate and proportional to temporal dynamics; 5) diagnostic; and 6) standardized; as well as have: 1) a low natural variability; 2) a broad applicability; and 3) an existing data series.

Where, How and How Many Times to Monitor?

These are the other components of Monitoring Network Design. These questions are best answered based on local field conditions, capacity and resources available, prevailing legal and regulatory priorities, *etc*. For this screening or reconnaissance Surveys of the study area also necessary. This may also include some simple inexpensive measurements and assimilative/dispersion modeling. The data will give some information on the prevailing special and temporal variations, and the general background air pollution in the area. The number of monitoring stations and the indicators to be measured at each station in the final permanent network may then be decided upon based on the results of the screening study as well as on the knowledge of the sources of the proposed development and prevailing local environmental/meteorological conditions. The best possible definition of the air pollution problem, together with the analysis of the resources: personnel, budget and equipment available, represent the basis for the decision on the following questions:

- What spatial density (number) of sampling stations is required? How many samples are needed and during what period (sampling (averaging) time and frequency)?
- Where should the stations be located?
- What kind of equipment should be used?
- What additional background information is needed?
    - meteorology
    - topography
    - population density
    - emission sources and emission rates
    - effects and impacts
- How will the data be made available/communicated?

C. Site Selection

This normally means that for designing a monitoring programme in an (study) area which might have an impact, several monitoring stations are needed for characterizing the baseline conditions of the impacted area. When considering the location of individual samplers, it is essential that the data collected are representative for the location and type of area without the undue influence from the immediate surroundings. In any measurement point in the study area the total ambient concentration is the representative of:

- natural background concentration
- regional background
- impact of existing large regional sources such as Industrial emissions and other power plants

To obtain the information about the importance of these different contributions it is therefore necessary to locate monitoring stations so that they are representative for different impacts. In addition to the ambient pollution data, one would often need other data governing the variations such as meteorological data for air pollution, to identify and quantify the sources contributing to the measurements.. When considering the location of individual samplers, it is essential that the data collected are representative for the location and type of area without undue influence from the immediate surroundings.

ANNEXURE VIII
Guidance for Assessment of Baseline Components and Attributes

GUIDANCE FOR ASSESSMENT OF BASELINE COMPONENTS AND ATTRIBUTES*

Attributes	Sampling		Measurement Method	Remarks
	Network	**Frequency**		
A. Air				
Meteorological ▪ Wind speed ▪ Wind direction ▪ Dry bulb temperature ▪ Wet bulb temperature ▪ Relative humidity ▪ Rainfall ▪ Solar radiation ▪ Cloud cover	▪ Minimum 1 site in the project impact area requirements ▪ Other additional site(s) are require depending upon the model applied or site sensitivities	▪ Min: 1 hrly observations from continuous records	▪ Mechanical / automatic weather station ▪ Rain gauge ▪ As per IMD ▪ As per IMD	▪ IS 5182 Part 1-20 Sit-specific primary data is essential ▪ Secondary data from IMD, New Delhi for the nearest IMD station
Pollutants ▪ SPM ▪ PM10, PM2.5 ▪ SO_2 ▪ NO_2 ▪ CO ▪ H_2S* ▪ $NH*_3$ ▪ HC* ▪ Fluoride* ▪ Pb* ▪ VOC-PAH* ▪ Ozone ▪ Benzene ▪ Benzo(a)pyrene (Particulate phase only) ▪ Arsenic ▪ Nickel (parameters to be proposed by the proponent, in draft ToR, which will be reviewed and approved by	▪ 10 to 15 locations in the project impact area	▪ 24 hrly twice a week ▪ 8 hrly twice a week ▪ 24 hrly twice a week	▪ Gravimetric (High – Volume) ▪ Gravimetric (High – Volume with Cyclone) ▪ EPA Modified West & Gaeke method ▪ Arsenite Modified Jacob & Hochheiser ▪ NDIR technique ▪ Methylene-blue ▪ Nessler's Method ▪ Infra Red analyzer ▪ Specific lon meter ▪ TOEM ▪ Beta attenuation ▪ UV photometric ▪ Chemilminescence ▪ Chemical method ▪ Gas chromatography based continuos analyzer ▪ Adsorption and desorption followed by GC analysis	▪ Monitoring Network ▪ Minimum 2 locations in upwind side, more sites in downwind side / impact zone ▪ All the sensitive receptors need to be covered ▪ Measurement Methods ▪ As per CPCB standards for NAQM, 1994

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
EAC/SEAC)			▪ Solvent extraction folllowed by HPLC/GC analysis ▪ AAS/ICP method after sampling on EPM 2000 or equivalent filter paper	
B. Noise				
Hourly equivalent noise levels	▪ Same as for Air Pollution along with others Identified in study area	▪ At lest one day continuous in each season on a working and non-working day	▪ Instrument : Sensitive Noise level meter (preferably recording type)	▪ Min: IS: 4954- 1968 as adopted by CPCB
Hourly equivalent noise levels	▪ Inplant (1.5 m from machinery or high emission processes)	▪ Same as above for day and night	▪ Instrument : Noise level metre	▪ CPCB / OSHA
Hourly equivalent noise levels	▪ Highways (within 500 metres from the road edge)	▪ Same as above for day and night	▪ Instrument : Noise level meter	▪ CPCB / IS : 4954-1968
Peak particle velocity	▪ 150- 200m from blast site	▪ Based on hourly observations	▪ PPV meter	▪
C. Water				
Parameters for water quality ▪ Ph, temp, turbidity, magnesium hardness, total alkalinity, chloride, sulphate, nitrate, fluoride, sodium, potassium salinity ▪ Total nitrogen, total phosphorus, DO, BOD, COD, Phenol ▪ Heavy metals ▪ Total coliforms, faecal coliforms ▪ Phyto plankton ▪ Zooplankton	▪ Set of grab samples during pre and post-monsoon for ground and surface water for the whole study zone. For lab analysis the samples should be preserved for transport safe	▪ Diurnal and season-wise	▪ Samples for water quality should be collected and analyzed as per: ▪ IS: 2488 (Part 1-5) methods for sampling and testing of industrial effluents ▪ Standard methods for examination of water and waste water analysis published by American Public Health Association. ▪ International standard practices for benthos and	

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
▪ Fish & other aquatic flora & fauna (parameters are given in ToR for EIA studies based on nature of project, raw material & process technology, location-nature/activities within of air basin)			aquatic flora & fauna	
For Surface Water Bodies				
▪ Total Carbon ▪ PH ▪ Dissolved Oxygen ▪ Biological Oxygen ▪ Demand ▪ Free NH_4 ▪ Boron ▪ Sodium Absorption ratio ▪ Electrical Conductivity	▪ Monitoring locations should include up-stream, on site, down stream of proposed discharge point. Besides sampling should cover width of the river in case water quality modeling is proposed. ▪ Standard methodology for collection of surface water (BIS standards) ▪ At least one grab sample per location per season	▪ Yield & impact on water sources to be measured during critical season ▪ River Stretch within project area be divided in grids (say 1 km length and 1/3 width) and samples should be from each grid at a time when the wastewater discharged by other sources of pollution is expected to be maximum	▪ Samples for water quality should be collected and analyzed as per: ▪ IS: 2488 (Part 1-5) methods for sampling and testing of industrial effluents ▪ Standard methods for examination of water and wastewater analysis published by American Public Health Association. ▪ ▪	▪ Historical data should be collected from relevant offices such as central water commission, state and central ground water board, Irrigation dept. ▪
Parameters for wastewater characterization				
▪ Temp, colour, odour, turbidity, TSS, TDS ▪ PH , alkalinity as CaCO3, p value, M value, tatal hardness as CaCO3, chloride as cl, sulphate as S04, Nitrate as NO3, Floride as F, Phosphate as P04, Chromium as Cr (Hexavalent, total) Ammonical Nitrogen as N, TKN, % sodium, BOD at 20 C, COD,	▪ Implant Source depending upon the different waste streams the parameters can be optimized ▪ Grab and composite sampling representing avg of different process operations as well as worst emission scenario should be represented	▪ Different operational cycles as well as raw material variations should be reflected in the analysis	▪ Samples for water quality should be collected and analyzed as per: ▪ IS: 2488 (Part 1-5) methods for sampling and testing of industrial effluents ▪ Standard methods for examination of water and wastewater analysis published by American	All plant sources categorized as: ▪ Different Process waste streams as well as run-off conditions ▪ ETP wastewater ▪ Domestic/ sanitary wastewater

Attributes	**Sampling**		**Measurement Method**	**Remarks**
	Network	**Frequency**		
DO, total residual chlorine as Cl_2, oil and grease, sulphide, phenolic compound			Public Health Association.	
D. Land Environment				
▪ Soil ▪ Particle size distribution ▪ Texture ▪ pH ▪ Electrical conductivity ▪ Caution exchange capacity ▪ Alkali metals ▪ Sodium Absorption Ratio (SAR) ▪ Permeability ▪ Porosity	▪ One surface sample from each landfill and/or hazardous waste site (if applicable) and prime villages, (soil samples be collected as per BIS specifications) in the study area	▪ Season-wise	▪ Collected and analyzed as per soil analysis reference book, M.I.Jackson and soil analysis reference book by C.A. Black ▪	▪ The purpose of impact assessment on soil (land environment) is to assess the significant impacts due to leaching of wastes or accidental releases and contaminating ▪
Landuse / Landscape				
▪ Location code ▪ Total project area ▪ Topography ▪ Drainage (natural) ▪ Cultivated, forest plantations, water bodies, roads and settlements	▪ At least 20 points along with plant boundary and general major land use categories in the study area.	▪ Drainage once in the study period and land use categories from secondary data (local maps) and satellite imageries	▪ Global positioning system ▪ Topo-sheets ▪ Satellite Imageries (1:25,000)	▪ Drainage within the plant area and surrounding is very important for storm water impacts. ▪ From land use maps sensitive receptors (forests, parks, mangroves etc.) can be identified

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
E. Solid Waste				
Quantity: ▪ Based on waste generated from per unit production ▪ Per capita contribution ▪ Collection, transport and disposal system ▪ Process Waste ▪ Quality (oily, chemical, biological)	▪ For green field unites it is based on secondary data base of earlier plants.	▪ Process wise or activity wise for respective raw material used. Domestic waste depends upon the season also	Guidelines ▪ IS 9569 : 1980 ▪ IS 10447 : 1983 ▪ IS 12625 : 1989 ▪ IS 12647 : 1989 ▪ IS 12662 (PTI) 1989	
Quality: ▪ General segregation into biological/organic/inert/hazardous ▪ Loss on heating ▪ pH ▪ Electrical Conductivity ▪ Calorific value, metals etc.	▪ Grab and Composite samples	▪ Process wise or activity wise for respective raw material used. Domestic waste depends upon the season also	Analysis ▪ IS 9334 : 1979 ▪ IS 9235 : 1979 ▪ IS 10158 : 1982	
Hazardous Waste				
▪ Permeability And porosity ▪ Moisture pH ▪ Electrical conductivity ▪ Loss on ignition ▪ Phosphorous ▪ Total nitrogen ▪ Caution exchange capacity ▪ Particle size distribution ▪ Heavy metal ▪ Ansonia ▪ Fluoride	▪ Grab and Composite samples. Recyclable components have to analyzed for the recycling requirements	▪ Process wise or activity wise for respective raw material used.	Analysis ▪ IS 9334 : 1979 ▪ IS 9235 : 1979 ▪ IS 10158 : 1982	▪ Impacts of hazardous waste should be performed critically depending on the waste characteristics and place of discharge. For land disposal the guidelines should be followed and impacts of accidental releases should be assessed
F. Biological Environment Aquatic				
▪ Primary productivity ▪ Aquatic weeds	▪ Considering probable impact, sampling points	▪ Season changes are very important	▪ Standards techniques (APHA et. Al. 1995, Rau	▪ Seasonal sampling for aquatic biota

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
▪ Enumeration of ▪ phytoplankton, zooplankton and benthos ▪ Fisheries ▪ Diversity indices ▪ Trophic levels ▪ Rare and endangered species ▪ Sanctuaries / closed areas / Coastal regulation zone (CRZ) ▪ Terrestrial ▪ Vegetation – species, list, economic importance, forest produce, medicinal value ▪ Importance value index (IVI) of trees ▪ Wild animals	and number of samples to be decided on established guidelines on ecological studies based on site eco-environment setting within 10/25 km radius from the proposed site ▪ Samples to collect from upstream and downstream of discharge point, nearby tributaries at down stream, and also from dug wells close to activity site		and Wooten 1980) to be followed for sampling and measurement	▪ One season for terrestrial biota, in addition to vegetation studies during monsoon season ▪ Preliminary assessment ▪ Microscopic analysis of plankton and meiobenthos, studies of macrofauna, aquatic vegetation and application of indices, viz. Shannon, similarity, dominance IVI etc ▪ Point quarter plot-less method (random sampling) for terrestrial vegetation survey.
Avifauna ▪ Rare and endangered species ▪ Sanctuaries / National park / Biosphere reserve	▪ For forest studies, chronic as well as short-term impacts should be analyzed warranting data on micro climate conditions			▪ Secondary data to collect from Government offices, NGOs, published literature ▪ Plankton net ▪ Sediment dredge ▪ Depth sampler ▪ Microscope ▪ Field binocular
G. Socio Economic				
▪ Demographic structure ▪ Infrastructure resource base ▪ Economic resource base ▪ Health status: Morbidity pattern ▪ Cultural and aesthetic attributes	▪ Socio-economic survey is based on proportionate, stratified and random sampling method	▪ Different impacts occurs during construction and operational phases of the project	▪ Primary data collection through R&R surveys (if require) or community survey are based on personal interviews and questionnaire	▪ Secondary data from census records, statistical hard books, toposheets, health records and relevant official records available with Govt. agencies

* Project Specific concerned parameters needs to be identified by the project proponent and shall be incorporated in the draft ToR, to be submitted to the Authority for the consideration and approval by the EAC/SEAC.

ANNEXURE IX
Sources of Secondary Data

Annexure IXA: Potential Sources of Data For EIA

	Information	Source
	Air Environment	
1.	Meteorology- Temperature, Rainfall, Humidity, Inversion, Seasonal Wind rose pattern (16 point compass scale), cloud cover, wind speed, wind direction, stability, mixing depth	⑨ Indian Meteorology Department, Pune
2.	Ambient Air Quality- 24 hourly concentration of SPM, RPM, SO$_2$, NO$_x$, CO	⑨ Central Pollution Control Board (CPCB), ⑨ State Pollution Control Board (SPCB), ⑨ Municipal Corporations ⑨ Ministry of Environment and Forests (MoEF) ⑨ State Department of Environment (DoEN)
	Water Environment	
3.	Surface water- water sources, water flow (lean season), water quality, water usage, Downstream water users Command area development plan Catchment treatment plan	⑨ Central Water Commission (CWC), ⑨ Central Pollution Control Board (CPCB), ⑨ State Pollution Control Board (SPCB), Central Water and Power Research Institute (CWPRS), Pune ⑨ State Irrigation Department ⑨ Hydel Power generation organizations such as NHPC, State SEBs
4.	Ground Water- groundwater recharge rate/withdrawal rate, ground water potential groundwater levels (pre monsoon, post monsoon), ground water quality, changes observed in quality and quantity of ground water in last 15 years	⑨ Central Ground Water Board (CGWB) ⑨ Central Ground Water Authority (CGWA) ⑨ State Ground Water Board (SGWB) ⑨ National Water Development Authority (NWDA)
5.	Coastal waters- water quality, tide and current data, bathymetry	⑨ Department of Ocean Development, New Delhi ⑨ State Maritime Boards ⑨ Naval Hydrographer's Office, Dehradun ⑨ Port Authorities ⑨ National Institute of Oceanography (NIO), Goa
	Biological Environment	
6.	Description of Biological Environment- inventory of flora and fauna in 7 km radius, endemic species, endangered species, Aquatic Fauna, Forest land, forest type and density of vegetation, biosphere, national parks, wild life sanctuaries, tiger reserve, elephant reserve, turtle nesting ground, core zone of biosphere reserve, habitat of migratory birds, routes of migratory birds	⑨ District Gazetteers ⑨ National Remote Sensing Agency (NRSA), Hyderabad ⑨ Forest Survey of India, Dehradun ⑨ Wildlife Institute of India ⑨ World Wildlife Fund ⑨ Zoological Survey of India ⑨ Botanical Survey of India ⑨ Bombay Natural History Society, (BNHS), Mumbai ⑨ State Forest Departments ⑨ State Fisheries Department ⑨ Ministry of Environment and Forests ⑨ State Agriculture Departments ⑨ State Agriculture Universities
	Land Environment	
7.	Geographical Information-Latitude, Longitude, Elevation (above MSL)	⑨ Toposheets of Survey of India, Pune ⑨ National Remote Sensing Agency (NRSA), Hyderabad ⑨ Space Application Centre (SAC), Ahmedabad

	Information	Source
8.	Nature of Terrain, topography map indicating contours (1:2500 scale)	⑨ Survey of India Toposheets ⑨ National Remote Sensing Agency (NRSA), Hyderabad ⑨ State Remote Sensing Centre, ⑨ Space Application Centre (SAC), Ahmedabad
9.	Hydrogeology- Hydrogeological report (in case of ground water is used/area is drought prone/wastewater is likely to discharged on land) Geomorphological analysis (topography and drainage pattern) Geological analysis (Geological Formations/Disturbances- geological and structural maps, geomorphological contour maps, structural features, including lineaments, fractures, faults and joints) Hydrogeological analysis (disposition of permeable formations, surface-ground water links, hydraulic parameter determination etc) Analysis of the natural soil and water to assess pollutant absorption capacity	⑨ NRSA, Hyderbad ⑨ Survey of India Toposheets ⑨ Geological Survey of India ⑨ State Geology Departments ⑨ State Irrigation Department ⑨ Department of Wasteland Development, Ministry of Rural Areas ⑨ National Water Development Authority (NWDA)
10.	Nature of Soil, permeability, erodibility classification of the land	⑨ Agriculture Universities ⑨ State Agriculture Department ⑨ Indian Council for Agriculture Research ⑨ State Soil Conservation Departments ⑨ National Bureau of Soil Survey and Landuse Planning ⑨ Central Arid Zone Research Institute (CAZRI), Jodhpur
11.	Landuse in the project area and 10 km radius of the periphery of the project	⑨ Survey of India- Toposheets ⑨ All India Soil and Landuse Survey; Delhi ⑨ National Remote Sensing Agency (NRSA), Hyderabad ⑨ Town and County Planning Organisation ⑨ State Urban Planning Department ⑨ Regional Planning Authorities (existing and proposed plans) ⑨ Village Revenue Map- District Collectorate ⑨ Directorate of Economics and Statistics-State Government ⑨ Space Application Centre, Ahmedabad
12.	Coastal Regulation Zones- CRZMP, CRZ classification, Demarcation of HTL and LTL*	⑨ Urban Development Department ⑨ State Department of Environment ⑨ State Pollution Control Board ⑨ Space Application Centre* ⑨ Centre for Earth Sciences Studies, Thiruvanthapuram* ⑨ Institute of Remote Sensing, Anna University Chennai* ⑨ Naval Hydrographer's Office, Dehradun* ⑨ National Institute of Oceanography, Goa* ⑨ National Institute of Ocean Technology, Chennai ⑨ Centre for Earth Science Studies

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· *Agencies authorized for approval of demarcation of HTL and LTL*

	Information	Source
	Social	
13.	Socioeconomic - population, number of houses and present occupation pattern within 7 km from the periphery of the project	⑨ Census Department ⑨ District Gazetteers- State Government ⑨ District Statistics- District Collectorate ⑨ International Institute of Population Sciences, Mumbai (limited data) ⑨ Central Statistical Organisation
14.	Monuments and heritage sites	District Gazetteer Archeological Survey of India, INTACH District Collectorate Central and State Tourism Department State Tribal and Social Welfare Department
	Natural Disasters	
15.	Seismic data (Mining Projects)- zone no, no of earthquakes and scale, impacts on life, property existing mines	⑨ Indian Meteorology Department, Pune ⑨ Geological Survey of India
16.	Landslide prone zone, geomorphological conditions, degree of susceptibility to mass movement, major landslide history (frequency of occurrence/decade), area affected, population affected	⑨ Space Application Centre
17.	Flood/cyclone/droughts- frequency of occurrence per decade, area affected, population affected	⑨ Natural Disaster Management Division in Department of Agriculture and Cooperation ⑨ Indian Meteorological Department
	Industrial	
18.	Industrial Estates/Clusters, Growth Centres	⑨ State Industrial Corporation ⑨ Industrial Associations ⑨ State Pollution Control Boards ⑨ Confederation Indian Industries (CII) ⑨ FICCI
19.	Physical and Chemical properties of raw material and chemicals (Industrial projects); fuel quality	⑨ Material and Safety Data Sheets ⑨ ENVIS database of Industrial Toxicological Research Centre, Lucknow ⑨ Indian Institute Petroleum
20.	Occupational Health and Industrial Hygiene- major occupational health and safety hazards, health and safety requirements, accident histories	⑨ Central Labour Institute, Mumbai ⑨ Directorate of Industrial Safety ⑨ ENVIS Database of Industrial Toxicological Research Centre, Lucknow ⑨ National Institute of Occupational Health, Ahmedabad
21.	Pollutant release inventories (Existing pollution sources in area within 10 km radius)	⑨ Project proponents which have received EC and have commenced operations
22.	Water requirement (process, cooling water, DM water, Dust suppression, drinking, green belt, fire service)	⑨ EIA Reports ⑨ National and International Benchmarks

Annexure IXB: Summary of Available Data with Potential Data Sources for EIA

	Agency	Information Available
1.	Archaeological Survey of India Department of Culture Government of India Janpath, New Delhi - 110011 Asi@del3.vsnl.net.in	⑨ Inventory of monuments and sites of national importance- Listing and documentation of monuments according to world heritage, pre historic, proto historic and secular, religious places and forts
2.	Botanical Survey Of India P-8, Brabourne Road Calcutta 700001 Tel#033 2424922 Fax#033 2429330 Email: envis@cal2.vsnl.net.in. . RO - Coimbatore, Pune, Jodhpur, Dehradun, Allahabad, Gantok, Itanagar, Port Blair	⑨ Photodiversity documentation of flora at National, State and District level and flora of protected areas, hotspots, fragile ecosystems, sacred groves etc ⑨ Identification of threatened species including endemics, their mapping, population studies ⑨ Database related to medicinal plants, rare and threatened plant species ⑨ Red data book of Indian plants (Vol 1,2, and 3) ⑨ Manual for roadside and avenue plantation in India
3.	Bureau of Indian Standards Manak Bhawan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002 Tel#3230131, 3233375, 3239402 (10 lines) Fax : 91 11 3234062, 3239399, 3239382 Email- bis@vsnal.com	⑨ Bureau of Indian Standards Committees on Earthquake Engineering and Wind Engineering have a Seismic Zoning Map and the Wind Velocity Map including cyclonic winds for the country
4.	Central Water Commission (CWC) Sewa Bhawan, R.K.Puram New Delhi - 110066 cmanoff@niccwc.delhi.nic.in RO- Bangalore, Bhopal, Bhubaneshwar, Chandigarh, Coimbatore/Chennai, Delhi, Hyderabad, Lucknow, Nagpur, Patna, Shillong, Siliguri and Vadodara	⑨ Central Data Bank -Collection, collation and Publishing of Hydrological, Hydrometeorological, Sediment and Water Quality data-. ⑨ Basin wise Master Plans ⑨ Flood atlas for India ⑨ Flood Management and Development and Operation of Flood Forecasting System- CWC operate a network of forecasting stations Over 6000 forecasts are issued every year with about 95% of the forecasts within the permissible limit. ⑨ Water Year Books, Sediment Year Books and Water Quality Year Books. ⑨ Also actively involved in monitoring of 84 identified projects through National, State and Project level Environmental Committees for ensuring implementation of environmental safeguards
5.	Central Ground Water Board (HO) N.H.IV, New CGO Complex, Faridabad - 121001 RO - Guwahati, Chandigarh, Ahemadabad, Trivandrum, Calcutta, Bhopal, Lucknow, Banglore, Nagpur, Jammu, Bhubneshwar, Raipur, Jaipur, Chennai, Hyderabad, Patna	⑨ surveys, exploration, monitoring of ground water development

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[16] *Based on web search and literature review*

6.	Central Pollution Control Board Parivesh Bhawan, CBD-cum-Office Complex East Arjun Nagar, DELHI - 110 032 INDIA E-mail : cpcb@alpha.nic.in	⑨ National Air Quality Monitoring Programme ⑨ National River Water Quality Monitoring Programme- Global Environment Monitoring , MINARS ⑨ Zoning Atlas Programme ⑨ Information on 17 polluting category industries (inventory, category wise distribution, compliance, implementation of pollution control programmes
7.	Central Arid Zone Research Institute, Jodhpur Email : cazri@x400.nicgw.nic.in Regional Centre at Bhuj in Gujarat	⑨ AGRIS database on all aspects of agriculture from 1975 to date ⑨ Also have cell on Agriculture Research Information System; ⑨ Working on ENVIS project on desertification ⑨ Repository of information on the state of natural resources and desertification processes and their control ⑨ The spectrum of activities involves researches on basic resource inventories; monitoring of desertification, rehabilitation and management of degraded lands and other areas
8.	Central Inland Capture Fisheries Research Institute, Barrackpore-743101, Tel#033-5600177 Fax#033-5600388 Email : cicfri@x400.nicgw.nic.in	⑨ Data Base on Ecology and fisheries of major river systems of India. Biological features of commercially important riverine and estuarine fish species. Production functions and their interactions in floodplain wetlands. ⑨ Activities - Environmental Impact Assessment for Resource Management ; Fisheries Resource surveys
9.	Central Institute of Brackish Water Aquaculture 141, Marshalls Road, Egmore , Chennai - 600 008, Tel# 044-8554866, 8554891, Director (Per) 8554851 Fax#8554851,	⑨ Repository of information on brackish water fishery resources with systematic database of coastal fishery resources for ARIS ⑨ Agricultural Research Information System (ARIS) database covers State wise data on soil and water quality parameters, land use pattern, production and productivity trends, ⑨ Social, economic and environmental impacts of aquaculture farming, ⑨ Guidelines and effluent standards for aquaculture farming
10.	Central Marine Fisheries Research Institute (CMFRI), Cochin	⑨ Assessing and monitoring of exploited and un-exploited fish stocks in Indian EEZ ⑨ Monitoring the health of the coastal ecosystems, particularly the endangered ecosystems in relation to artisanal fishing, mechanised fishing and marine pollution ⑨ The institute has been collecting data on the catch and effort and biological characteristics for nearly half a century based on scientifically developed sampling scheme, covering all the maritime States of the country ⑨ The voluminous data available with the institute is managed by the National Marine Living Resources Data Centre (NMLRDC)
11.	Central Water and Power Research Station, Pune Tel#020-4391801-14; 4392511; 4392825 Fax #020-4392004,4390189	⑨ Numerical and Physical models for hydro-dynamic simulations
12.	Central Institute of Road Transport, Bhosari, Pune 411 026, India. Tel : +91 (20) 7125177, 7125292, 7125493, 7125494	⑨ Repository of data on all aspects of performance of STUs and a host of other related road transport parameters

13.	Department of Ocean Development	⑨ Assessment of environment parameters and marine living resources (primary and secondary) in Indian EEZ (Nodal Agency NIO Kochi) ⑨ Stock assessment, biology and resource mapping of deep sea shrimps, lobsters and fishes in Indian EEZ (Nodal agency-Fisheries Survey of India) ⑨ Investigations of toxical algal blooms and benthic productivity in Indian EEZ (Nodal agency- Cochin University of Science and technology) ⑨ Coastal Ocean Monitoring and Prediction System (COMAP) - monitoring and modelling of marine pollution along entire Indian coast and islands. Parameters monitored are temp, salinity, DO, pH, SS, BOD, inorganic phosphate, nitrate, nitrite, ammonia, total phosphorus, total nitrite, total organic carbon, petroleum hydrocarbons, pathogenic vibros, pathogenic E.coli, shigella, salmonella, heavy metals (Cd, Hg, Pb) and pesticide residues (DDT, BHC, Endosulfan). Monitoring is carried out along the ecologically sensitive zones and urban areas (NIO Mumbai- Apex coordinating agency). ⑨ Sea Level Measurement Programe (SELMAM)- sea level measurement at selected stations (Porbandar, Bombay, Goa, Cochin, Tuticorin, Madras, Machilipatnam, Visakhapatnam, Paradeep, Calcutta and Kavaratti (Lakshadweep Island)) along Indian coast and islands using modern tide gauges ⑨ Detailed coastal maps through Survey of India showing contour at 1/2 a metre interval in the scale of 1:25000. (Nellore- Machhalipatnam work already over) ⑨ Marine Data Centre (MDC) IMD for Ocean surface meteorology, GSI for marine geology, SOI for tide levels, Naval Hydrographic Office for bathymetry, NIO Goa for physical chemical and biological oceanography, NIO Mumbai for marine pollution, CMFRI for coastal fisheries, Institute of Ocean Management Madras for coastal geomorphology ⑨ DOD has setup Indian National Centre for Ocean Information Services (INCOIS) at Hyderabad for generation and dissemination of ocean data products (near real time data products such as sea surface temperature, potential fishing zones, upwelling zones, maps, eddies, chlorophyll, suspended sediment load etc). MDC will be integrated with INCOIS ⑨ Integrated Coastal and Marine Area Management (ICMAM) programme - GIS based information system for management of 11 critical habitats namely Pichavaram, Karwar, Gulf of Mannar, Gulf of Khambat, Gulf of Kutch, Malvan, Cochin, Coringa mangroves, Gahirmata, Sunderbans and Kadamat (Lakshadeep) ⑨ Wetland maps for Tamil Nadu and Kerala showing the locations of lagoons, backwaters, estuaries, mudflats etc (1:50000 scale) ⑨ Coral Reef Maps for Gulf of Kachch, Gulf of Mannar, Andaman and Nicobar and Lakshadeep Islands (1:50,000 scale) indicating the condition of corals, density etc
14.	Environment Protection Training and Research Institute Gachibowli, Hyderabad - 500 019, India Phone: +91-40-3001241, 3001242, 3000489 Fax: +91-40- 3000361 E-mail: info@eptri.com	⑨ Environment Information Centre- has appointed EPTRI as the Distributed Information Centre for the Eastern Ghats region of India. EIC Collaborates with the Stockholm Environment Institute Sweden Database on Economics of Industrial Pollution Prevention in India Database of Large and Medium Scale Industries of Andhra Pradesh Environmental Status of the Hyderabad Urban Agglomeration Study on 'water pollution-health linkages' for a few Districts of A.P

		⑨ Environment Quality Mapping Macro level studies for six districts in the State of Andhra Pradesh Micro level studies for two study zones presenting the permissible pollutant load and scoping for new industrial categories Zonation of the IDA, Parwada which helped APIIC to promote the land for industrial development Disaster management plan for Visakhapatnam Industrial Bowl Area
15.	Forest Survey of India (FSI) Kaulagarh Road, P.O., IPE Dehradun - 248 195 Tel# 0135-756139, 755037, 754507 Fax # 91-135-759104 E-Mail : fsidir@nde.vsnl.net.in fsihq@nde.vsnl.net.in RO- Banglore, Calcutta, Nagpur and Shimla	⑨ State of Forest Report (Biannual) ⑨ National Forest Vegetation Map (Biannual exercise) (on 1: 1 million scale) ⑨ Thematic mapping on 1:50,000 scale depicting the forest type, species composition, crown density of forest cover and other landuse National ⑨ Basic Forest Inventory System ⑨ Inventory survey of non forest area ⑨ Forest inventory report providing details of area estimates, topographic description, health of forest, ownership pattern, estimation of volume and other growth parameters such as height and diameter in different types of forest, estimation of growth, regeneration and mortality of important species, volume equation and wood consumption of the area studied
16.	Geological Survey of India 27 Jawaharlal Nehru Road, Calcutta 700 016, India Telephone +91-33-2496941 FAX 91-33-2496956 gsi_chq@vsnl.com	⑨ Environmental hazards zonation mapping in mineral sector ⑨ Codification of base line information of geo-environmental appreciation of any terrain and related EIA and EMP studies ⑨ Lineament and geomorphological map of India on 1:20,000 scale. ⑨ Photo-interpreted geological and structural maps of terrains with limited field checks.
17.	Indian Council of Agriculture Research, Krishi Bhawan, New Delhi, Tel#011-338206 – ICAR complex, Goa- Agro metrology – Central Arid Zone Research Institute- Agro forestry – Central Soil salinity Research Institute, – Indian Institute of Soil Science – Central Soil and Water Conservation Research and Training Institute – National Bureau of Soil Survey and Landuse Planning	⑨ A total of 80,000 profiles at 10 kms grid across the country were analyzed to characterize the soils of India. ⑨ Detailed soil maps of the Country (1:7 million), State (1:250,000) and districts map (1:50,000) depicting extent of degradation (1:4.4 millions) have been prepared. ⑨ Thematic maps depicting soil depth, texture drainage, calcareousness, salinity, pH, slope and erosion have been published ⑨ Agro-climate characterization of the country based on moisture, thermal and sunshine regimes ⑨ Agro-ecological zones (20) and sub-zones (60) for the country were delineated based on physiography, soils, climate, Length of Growing Period and Available Water Content, and mapped on 1:4.4 million scale. ⑨ Digitization of physiography and soil resource base on 1:50,000 scale for 14 States have been completed. ⑨ .Soil fertility maps of N,P,K,S and Zn have also been developed ⑨ Water quality guidelines for irrigation and naturally occurring saline/sodic water ⑨ Calibration and verification of ground water models for predicting water logging and salinity hazards in irrigation commands
18.	Indian Bureau of Mines Indira Bhawan, Civil Lines Nagpur Ph no - 0712-533 631, Fax- 0712-533 041	⑨ National mineral inventory for 61 minerals and mineral maps ⑨ Studies on environmental protection and pollution control in regard to the mining and mineral beneficiation operations ⑨ Collection, processing and storage of data on mines, minerals and mineral-based industries, collection and maintenance of world mineral intelligence, foreign mineral legislation and other related matters

19.	Indian Meteorology Department Shivaji nagar, Pune 41100 RO- Mumbai, Chennai, Calcutta, New Delhi, Nagpur, Guwahati	⑨ Meteorological data ⑨ Background air quality monitoring network under Global Atmospheric Watch Programme (operates 10 stations) ⑨ Seismicity map, seismic zoning map; seismic occurrences and cyclone hazard monitoring; list of major earthquakes ⑨ Climatological Atlas of India , Rainfall Atlas of India and Agroclimatic Atlas of India ⑨ Monthly bulletin of Climate Diagnostic Bulletin of India ⑨ Environmental Meteorological Unit of IMD at Delhi to provide specific services to MoEF
20.	INTACH Natural Heritage, 71 Lodi Estate, New Delhi-110 003 Tel. 91-11-4645482, 4632267/9, 4631818, 4692774, 4641304 Fax : 91-11-4611290 E-mail : nh@intach.net	⑨ Listing and documentation of heritage sites identified by municipalities and local bodies (Listing excludes sites and buildings under the purview of the Archaeological Survey of India and the State Departments of Archaeology)
21.	Industrial Toxicology Research Centre Post Box No. 80, Mahatma Gandhi Marg, Lucknow-226001, Phone: +91-522-221856,213618,228227; Fax : +91-522 228227 Email: itrc@itrcindia.org	⑨ Activities include health survey on occupational diseases in industrial workers, air and water quality monitoring studies, ecotoxicological impact assessment, toxicity of chemicals, human health risk assessment ⑨ Five databases on CD-ROM in the area of environmental toxicology viz: TOXLINE, CHEMBANK, POISINDEX, POLTOX and PESTBANK. The Toxicology Information Centre provides information on toxic chemicals including household chemicals ⑨ ENVIS centre and created a full-fledged computerized database (DABTOC) on toxicity profiles of about 450 chemicals
22.	Indian Institute of Forest Management Post Box No. 357, Nehru Nagar Bhopal - 462 003 Phone # 0755-575716, 573799, 765125, 767851 Fax # 0755-572878	⑨ Consultancy and research on joint forest management (Ford Foundation, SIDA, GTZ, FAO etc)
23.	Indian Institute of Petroleum Mohkampur , Dehradun, India, 248005 0135- 660113 to 116 0135- 671986	⑨ Fuel quality characterisation ⑨ Emission factors
24.	Ministry of Environment and Forest	⑨ Survey of natural resources ⑨ National river conservation directorate ⑨ Environmental research programme for eastern and western ghats ⑨ National natural resource management system ⑨ Wetlands conservation programme- survey, demarcation, mapping landscape planning, hydrology for 20 identified wetlands National ⑨ wasteland identification programme
25.	Mumbai Metropolitan Regional Development Authority	⑨ Mumbai Urban Transport Project ⑨ Mumbai Urban Development Project ⑨ Mumbai Urban Rehabilitation Project ⑨ Information on MMR; statistics on councils and corporations Regional ⑨ Information Centre- Basic data on population, employment, industries and other sectors are regularly collected and processed

26.	Municipal Corporation of Greater Mumbai	⑨ Air Quality Data for Mumbai Municipal Area ⑨ Water quality of lakes used for water supply to Mumbai
27.	Ministry of Urban Development Disaster Mitigation and Vulnerability Atlas of India Building Materials & Technology Promotion Council G-Wing,Nirman Bhavan, New Delhi-110011 Tel: 91-11-3019367 Fax: 91-11-3010145 E-Mail: bmtpc@del2.vsnl.net.in	⑨ Identification of hazard prone area ⑨ Vulnerability Atlas showing areas vulnerable to natural disasters ⑨ Land-use zoning and design guidelines for improving hazard resistant construction of buildings and housing ⑨ State wise hazard maps (on cyclone, floods and earthquakes)
28.	Natural Disaster Management Division in Department of Agriculture and Cooperation	⑨ Weekly situation reports on recent disasters, reports on droughts, floods, cyclones and earthquakes
29.	National Bureau Of Soil Survey & Land Use Planning P.O. Box No. 426, Shankar Nagar P.O., Nagpur-440010 Tel#91-712-534664,532438,534545 Fax#:91-712-522534 RO- Nagpur, New Delhi, Banglore, Calcutta, Jorhat, Udaipur	⑨ NBSS&LUP Library has been identified as sub centre of ARIC (ICAR) for input to AGRIS covering soil science literature generated in India ⑨ Research in weathering and soil formation, soil morphology, soil mineralogy, physicochemical characterisation, pedogenesis, and landscape-climate-soil relationship. ⑨ Soil Series of India- The soils are classified as per Soil Taxonomy. The described soil series now belong to 17 States of the country. ⑨ Landuse planning- watershed management, land evaluation criteria, crop efficiency zoning ⑨ Soil Information system is developed state-wise at 1:250,000 scale. Presently the soil maps of all the States are digitized, processed and designed for final output both digital and hardcopy. The thematic layers and interpreted layers of land evaluation (land capability, land irrigability and crop suitability), Agro-Ecological Zones and soil degradation themes are prepared. ⑨ Districts level information system is developed for about 15 districts at 1: 50, 000 scale. The soil information will be at soil series level in this system. Soil resource inventory of States, districts water-sheds (1:250,000; 1:50,000; 1:10,000/8000)
30.	National Institute of Ocean Technology, Velacherry-Tambaram main road Narayanapuram Chennai, Tamil Nadu Tel#91-44-2460063 / 2460064/ 2460066/ 2460067 Fax#91-44-2460645	⑨ Waste load allocation in selected estuaries (Tapi estuary and Ennore creek) is one the components under the Integrated Coastal and Marine Area Management (ICMAM) programme of the Department of Ocean Development ICMAM is conducted with an IDA based credit to the Government of India under the Environmental Capacity Building project of MoEF (waste assimilation capacity of Ennore creek is over) ⑨ Physical oceanographic component of Coastal & Ocean monitoring Predictive System (COMAPS) a long term monitoring program under the Department of Ocean Development ⑨ Identification of suitable locations for disposal of dredge spoil using mathematical models & environmental criteria ⑨ EIA Manual and EIA guidelines for port and harbour projects
31.	National Institute of Oceanography, Goa RO- Mumbai, Kochi	⑨ Coastal Ocean Monitoring and Predictions(COMAP)-Monitoring of coastal waters for physicochemical and biological parameters including petroleum hydrocarbons, trace metals, heavy metals, and biomass of primary (phytoplankton) and secondary (zooplankton, microbial and benthic organisms) ⑨ Marine Biodiversity of selected ecosystem along the West Coast of India

32.	National Botanical Research Institute, Post Box No 436 Rana Pratap Marg Lucknow- 226001, Tel: (+91) 522 271031-35 Fax: (+91) 522 282849, 282881 Lucknow	⑨ Dust filtering potential of common avenue trees and roadside shrubs has been determined, besides studies have also been conducted on heavy-metals accumulation potential of aquatic plants supposedly useful as indicators of heavy metal pollution in water bodies and capable of reducing the toxic metals from water bodies. ⑨ Assessment of bio-diversity of various regions of India
33.	National Geophysical Research Institute, Uppal Road, Hyderabad Telephone:0091-40-7171124, FAX:0091-40-7171564	⑨ Exploration, assessment and management of ground water resources including ground water modelling and pollution studies
34.	National Environmental Engineering Research Institute, Nagpur RO- Mumbai, Delhi, Chennai, Calcutta, Ahmedabad, Cochin, Hyderabad, Kanpur	⑨ National Air Quality Monitoring (NAQM) for CPCB ⑨ Database on cleaner technologies of industrial productions
35.	National Hydrology Institute, Roorkee RO- Belgaum (Hard Rock Regional Centre), Jammu (Western Himalayan Regional Centre), Guwahati (North Eastern Regional Centre), Kakinada (Deltaic Regional Centre), Patna (Ganga Plains North Regional Centre), and Sagar (Ganga Plains South)	⑨ Basin studies, hydrometeorological network improvement, hydrological year book, hydrological modelling, regional flood formulae, reservoir sedimentation studies, environmental hydrology, watershed development studies, tank studies, and drought studies.
36.	National Institute Of Urban Affairs, India Habitat Centre, New Delhi	⑨ Urban Statistics Handbook
37.	National Institute of Occupational Health Meghaninagar, Ahmedabad RO- Banglore, Calcutta	⑨ epidemiological studies and surveillance of hazardous occupations including air pollution, noise pollution, agricultural hazards, industrial hazards in organised sectors as well as small scale industries, carcinogenesis, pesticide toxicology, etc ⑨ WHO collaborative centre for occupational health for South East Asia region and the lead institute for the international programme on chemical safety under IPCS (WHO)
38.	NRSA Data Centre Department of Space, Balanagar, Hyderabad 500 037 Ph- 040-3078560 3078664 sales@nrsa.gov.in	⑨ Satellite data products (raw data, partially processed (radiometrically corrected but geometrically uncorrected), standard data (radiometrically and geometrically corrected), geocoded data(1:50,000 and 1:25000 scale), special data products like mosaiced, merged and extracted) available on photographic (B?W and FCC in form of film of 240 mm X 240mm or enlargements/paper prints in scale varying between 1:1M and 1:12500 and size varying between 240mm and 1000mm) and digital media (CD-ROMs, 8 mm tapes)
39.	Rajiv Gandhi National Drinking Water Mission	⑨ Database for groundwater using remote sensing technology (Regional Remote Sensing Service Centre involved in generation of ground water prospect maps at 1:50,000 scale for the State of Kerala, Karnataka, AP, MP and Rajasthan for RGNDWM)
40.	Space Application Centre Value Added Services Cell (VASC) Remote Sensing Application Area Ahmedabad 380 053 079-676 1188	⑨ National Natural Resource Information System ⑨ Landuse mapping for coastal regulation zone (construction setback line) upto 1:12500 scale ⑨ Inventory of coastal wetlands, coral reefs, mangroves, seaweeds ⑨ Monitoring and condition assessment of protected coastal areas

	Fax- 079-6762735	⑨ Wetland mapping and inventory ⑨ Mapping of potential hotspots and zoning of environmental hazards ⑨ General geological and geomorphological mapping in diverse terrain ⑨ Landslide risk zonation for Tehre area
41.	State Pollution Control Board	⑨ State Air Quality Monitoring Programme ⑨ Inventory of polluting industries ⑨ Identification and authorization of hazardous waste generating industries ⑨ Inventory of biomedical waste generating industries ⑨ Water quality monitoring of water bodies receiving wastewater discharges ⑨ Inventory of air polluting industries ⑨ Industrial air pollution monitoring ⑨ Air consent, water consent, authorization, environment monitoring reports
42.	State Ground Water Board	
43.	Survey of India	⑨ Topographical surveys on 1:250,000 scales, 1:50,000 and 1:25,000 scales ⑨ Digital Cartographical Data Base of topographical maps on scales 1:250,000 and 1:50,000 ⑨ Data generation and its processing for redefinition of Indian Geodetic Datum ⑨ Maintenance of National Tidal Data Centre and receiving/ processing of tidal data of various ports. ⑨ Coastal mapping along the Eastern coast line has been in progress to study the effect of submergence due to rise in sea-level and other natural phenomenon. Ground surveys have been completed for the proposed coastal region and maps are under printing. ⑨ District planning maps containing thematic information (135 maps) have been printed out of 249 maps covering half the districts of India. Districts planning maps for remaining half of the area are being processed by National Atlas and Thematic Mapping Organisation (NATMO)
44.	Town and Country Planning Organisation	⑨ Urban mapping - Thematic maps and graphic database on towns (under progress in association with NRSA and State town planning department)
45.	Wildlife Institute of India Post Bag No. 18, Chandrabani Dehradun - 248 001, Uttaranchal Tel#0135 640111 -15, Fax#0135 640117 email : wii@wii .	⑨ Provide information and advice on specific wildlife management problems. ⑨ National Wildlife Database
46.	Zoological Survey of India Prani Vigyan Bhawan 'M' Block, New Alipore Calcutta - 700 053 Phone # 91-33-4786893, 4783383 Fax # 91-33-786893 RO - Shillong, Pune, Dehradun, Jabalpur, Jodhpur, Chennai, Patna, Hyderabad, Canning, Behrampur, Kozikode, Itanagar, Digha, Port Bliar, Solan	⑨ Red Book for listing of endemic species ⑨ Survey of faunal resources

ANNEXURE X
Impact Prediction Tools

Table 1: Choice of Models for Impact Prediction: Air Environment*

Model	Application	Remarks
ISCST 3	▪ Appropriate for point, area and line sources ▪ Application for flat or rolling terrain ▪ Transport distance up to 50 km valid ▪ Computes for 1 hr to annual averaging periods	▪ Can take up to 99 sources ▪ Computes concentration on 600 receptors in Cartesian on polar coordinate system ▪ Can take receptor elevation ▪ Requires source data, meteorological and receptor data as input.
AERMOD with AERMET	▪ Settling and dry deposition of particles; ▪ Building wake effects (excluding cavity region impacts); ▪ Point, area, line, and volume sources; ▪ Plume rise as a function of downwind distance; ▪ Multiple point, area, line, or volume sources; ▪ Limited terrain adjustment; ▪ Long-term and short-term averaging modes; ▪ Rural or urban modes; ▪ Variable receptor grid density; ▪ Actual hourly meteorology data	▪ Can take up to 99 sources ▪ Computes concentration on 600 receptors in Cartesian on polar coordinate system ▪ Can take receptor elevation ▪ Requires source data, meteorological and receptor data as input.
PTMAX	▪ Screening model applicable for a single point source ▪ Computes maximum concentration and distance of maximum concentration occurrence as a function of wind speed and stability class	▪ Require source characteristics ▪ No met data required ▪ Used mainly for ambient air monitoring network design
PTDIS	▪ Screening model applicable for a single point source ▪ Computes maximum pollutant concentration and its occurrences for the prevailing meteorological conditions	▪ Require source characteristics ▪ Average met data (wind speed, temperature, stability class *etc.*) required ▪ Used mainly to see likely impact of a single source
MPTER	▪ Appropriate for point, area and line sources applicable for flat or rolling terrain ▪ Transport distance up to 50 km valid ▪ Computes for 1 hr to annual averaging periods ▪ Terrain adjustment is possible	▪ Can take 250 sources ▪ Computes concentration at 180 receptors up to 10 km ▪ Requires source data, meteorological data and receptor coordinates
CTDM PLUS (Complex Terrain Dispersion Model)	▪ Point source steady state model, can estimate hrly average concentration in isolated hills/ array of hills	▪ Can take maximum 40 Stacks and computes concentration at maximum 400 receptors ▪ Does not simulate calm met conditions ▪ Hill slopes are assumed not to exceed 15 degrees ▪ Requires sources, met and terrain characteristics and receptor details
UAM (Urban Airshed Model)	▪ 3-D grid type numerical simulation model ▪ Computes O_3 concentration short term episodic conditions lasting for 1 or 2 days resulting from NOx and VOCs ▪ Appropriate for single urban area having significant O_3 problems	▪

Model	Application	Remarks
RAM (Rural Airshed Model)	▪ Steady state Gaussian plume model for computing concentration of relatively stable pollutants for 1 hr to 1 day averaging time ▪ Application for point and area sources in rural and urban setting	▪ Suitable for flat terrains ▪ Transport distance less than 50 km.
CRESTER	▪ Applicable for single point source either in rural or urban setting ▪ Computes highest and second highest concentration for 1hr, 3hr, 24hr and annual averaging times ▪ Tabulates 50 highest concentration for entire year for each averaging times	▪ Can take up to 19 Stacks simultaneously at a common site. ▪ Unsuitable for cool and high velocity emissions ▪ Do not account for tall buildings or topographic features ▪ Computes concentration at 180 receptor, circular wing at five downwind ring distance 36 radials ▪ Require sources, and met data
OCD (Offshore and coastal Dispersion Model)	▪ It determines the impact of offshore emissions from point sources on the air quality of coastal regions ▪ It incorporates overwater plume transport and dispersion as well as changes that occur as the plume crosses the shore line ▪ Most suitable for overwater sources shore onshore receptors are below the lowest shore height	▪ Requires source emission data ▪ Require hrly met data at offshore and onshore locations like water surface temperature; overwater air temperature; relative humidity *etc.*
FDM (Fugitive Dust Model)	▪ Suitable for emissions from fugitive dust sources ▪ Source may be point, area or line (up to 121 source) ▪ Require particle size classification max. up to 20 sizes ▪ Computes concentrations for 1 hr, 3hr, 8hr, 24hr or annual average periods	▪ Require dust source particle sizes ▪ Source coordinates for area sources, source height and geographic details ▪ Can compute concentration at max. 1200 receptors ▪ Require met data (wind direction, speed, Temperature, mixing height and stability class) ▪ Model do not include buoyant point sources, hence no plume rise algorithm
RTDM (Rough Terrain Diffusion Model)	▪ Estimates GLC is complex/rough (or flat) terrain in the vicinity of one or more co-located point sources ▪ Transport distance max. up to 15 km to up to 50 km ▪ Computes for 1 to 24 hr. or annual ave5rage concentrations	▪ Can take up to 35 co-located point sources ▪ Require source data and hourly met data ▪ Computes concentration at maximum 400 receptors ▪ Suitable only for non reactive gases ▪ Do not include gravitational effects or depletion mechanism such as rain/ wash out, dry deposition
CDM(Climatologically Dispersion Model)	▪ It is a climatologically steady state GPM for determining long term (seasonal or annual) ▪ Arithmetic average pollutant concentration at any ground level receptor in an urban area	▪ Suitable for point and area sources in urban region, flat terrain ▪ Valid for transport distance less than 50 km ▪ Long term averages: One month to one year or longer
PLUVUE-II (Plume Visibility Model)	▪ Applicable to assess visibility impairment due to pollutants emitted from well defined point sources ▪ It is used to calculate visual range reduction	▪ Require source characteristics, met data and receptor coordinates & elevation ▪ Require atmospheric aerosols

Model	Application	Remarks
	and atmospheric discoloration caused by plumes - It predicts transport, atmospheric diffusion, chemical, conversion, optical effects, and surface deposition of point source emissions.	(back ground & emitted) characteristics, like density, particle size - Require background pollutant concentration of SO_4, NO_3, NOx, NO_2, O_3, SO_2 and deposition velocities of SO_2, NO_2 and aerosols
MESO-PUFF II (Meso scale Puff Model)	- It is a Gaussian, Variable trajectory, puff superposition model designed to account fro spatial and temporal variations in transport, diffusion, chemical transformation and removal mechanism encountered on regional scale. - Plume is modeled as a series of discrete puffs and each puff is transported independently - Appropriate for point and area sources in urban areas - Regional scale model.	- Can model five pollutants simultaneously (SO2, SO4, NOx, HNO3 and NO3) - Require source characteristics - Can take 20 point sources or 5 area source - For area source – location, effective height, initial puff size, emission is required - Computes pollutant concentration at max. 180 discrete receptors and 1600 (40 x 40) grided receptors - Require hourly surface data including cloud cover and twice a day upper air data (pressure, temp, height, wind speed, direction) - Do not include gravitational effects or depletion mechanism such as rain/ wash out, dry deposition

Table 2: Choice of Models for Impact Modeling: Noise Environment*

Model	Application
FHWA (Federal Highway Administration)	Noise Impact due to vehicular movement on highways
Dhwani	For predictions of impact due to group of noise sources in the industrial complex (multiple sound sources)
Hemispherical sound wave propagation	Fore predictive impact due to single noise source
Air Port	For predictive impact of traffic on airport and rail road

Table 3: Choice of Models for Impact Modeling: Land Environment*

Model	Application	Remarks
Digital Analysis Techniques	Provides land use / land cover distribution	
Ranking analysis for soil suitability criteria	Provides suitability criteria for developmental conversation activities	Various parameters viz. depth, texture, slope, erosion status, geomorphology, flooding hazards, GW potential, land use *etc*., are used.

Table 4: Choice of Models for Impact Modeling: Water Environment*

Model	Application	Remarks
QUAL-II E	Wind effect is insignificant, vertical dispersive effects insignificant applicable to streams Data required Deoxygenation coefficients, re-aeration coefficients for carbonaceous, nitrogenous and benthic substances, dissolved oxygen deficit	Steady state or dynamic model
	The model is found excellent to generate water quality parameters Photosynthetic and respiration rate of suspended and attached algae	
	Parameters measured up to 15 component can be simulated in any combination, e.g. ammonia, nitrite, nitrate, phosphorous, carbonaceous BOD, benthic oxygen demand, DO, coliforms, conservative substances and temperature	
DOSAG-3, USEPA: (1-D) RECEIV – II, USEPA	Water quality simulation model for streams & canal A general Water quality model	Steady-state
Explore –I, USEPA	A river basin water quality model	Dynamic, Simple hydrodynamics
HSPE, USEPA	Hydrologic simulation model	Dynamic, Simple hydrodynamics
RECEIVE-II, USEPA	A general dynamic planning model for water quality management	
Stanford watershed model	This model simulates stream flows once historic precipitation data are supplied The major components of the hydrologic cycle are modeled including interception, surface detention, overland inflow, groundwater, evapo-transpiration and routing of channel flows, temperature, TDS, DO, carbonaceous BOD coliforms, algae, zooplanktons, nitrite, nitrate, ammonia, phosphate and conservative substances can be simulated	
Hydrocomp model	Long-term meteorological and wastewater characterization data is used to simulate stream flows and stream water quality	Time dependant (Dynamic)
Stormwater Management model (SWMM)	Runoff is modeled from overland flow, through surface channels, and through sewer network Both combined and separate sewers can be modeled. This model also enables to simulate water quality effects to stormwater or combined sewer discharges. This model simulates runoff resulting from individual rainfall events.	Time Dependent
Battelle Reservoir model	Water body is divided into segments along the direction of the flow and each segment is divided into number of horizontal layers. The model is found to generate excellent simulation of temperature and good prediction of water quality parameters. The model simulates temperature, DO, total and	Two Dimensional multi-segment model

Model	Application	Remarks
	benthic BOD, phytoplankton, zooplankton, organic and inorganic nitrogen, phosphorous, coliform bacteria, toxic substances and hydrodynamic conditions.	
TIDEP (Turbulent diffusion temperature model reservoirs)	Horizontal temperature homogeneity Coefficient of vertical turbulent diffusion constant for charge of area with depth negligible coefficient of thermal exchange constant Data required wind speed, air temperature, air humidity, net incoming radiation, surface water temperature, heat exchange coefficients and vertical turbulent diffusion coefficients.	Steady state model
BIOLAKE	Model estimates potential fish harvest from a take	Steady state model
Estuary models/ estuarial Dynamic model	It is simulates tides, currents, and discharge in shallow, vertically mixed estuaries excited by ocean tides, hydrologic influx, and wind action Tides, currents in estuary are simulated	Dynamic model
Dynamic Water Quality Model	It simulates the mass transport of either conservative or non-conservative quality constituents utilizing information derived from the hydrodynamic model Bay-Delta model is the programme generally used. Up to 10 independent quality parameters of either conservative or non-conservative type plus the BOD-DO coupled relationship can be handled	Dynamic model
HEC -2	To compute water surface profiles for stead7y, gradually: varying flow in both prismatic & non-prismatic channels	
SMS	Lake circulation, salt water intrusion, surface water profile simulation model	Surface water Modeling system Hydrodynamic model
RMA2	To compute flow velocities and water surface elevations	Hydrodynamic analysis model
RMA4	Solves advective-diffusion equations to model up to six non-interacting constituents	Constituent transport model
SED2D-WES	Model simulates transport of sediment	Sediment transport model
HIVEL2D	Model supports subcritical and supercritical flow analysis	A 2-dimensional hydrodynamic model
MIKE-II, DHI	Model supports, simulations of flows, water quality, and sediment transport in estuaries, rives, irrigation systems, channels & other water bodies	Professional Engineering software package

Table 5: Choice of Models for Impact Modeling: Biological Environment*

Name	Relevance	Applications	Remarks
Flora			
Sample plot methods	Density and relative density Density and relative	Average number of individuals species per unit area Relative degree to which a	The quadrant sampling technique is applicable in all types of plant communities and for the study of submerged, sessile (attached at the base) or

Name	Relevance	Applications	Remarks
	dominance	species predominates a community by its sheer numbers, size bulk or biomass	sedentary plants
	Frequency and relative frequency importance value	Plant dispersion over an area or within a community	Commonly accepted plot size: 0.1 m^2- mosses, lichens & other mat-like plants
		Average of relative density, relative dominance and relative frequency	0.1 m^2- herbaceous vegetation including grasses
			10.20 m^2 – for shrubs and saplings up to 3m tall, and
			100 m^2 – for tree communities
Transects & line intercepts methods	Cover	Ratio of total amount of line intercepted by each species and total length of the line intercept given its cover	This methods allows for rapid assessment of vegetation transition zones, and requires minimum time or equipment of establish
	Relative dominance	It is the ratio of total individuals of a species and total individuals of all species	Two or more vegetation strata can be sampled simultaneously
Plot-less sampling methods	Mean point plant Mean area per plant	Mean point – plant distance Mean area per plant	Vegetation measurements are determined from points rather than being determined in an area with boundaries
	Density and relative density		Method is used in grass-land and open shrub and tree communities
	Dominance and relative dominance		It allows more rapid and extensive sampling than the plot method
	Importance value		Point- quarter method is commonly used in woods and forests.
Fauna			
Species list methods	Animal species list	List of animal communities observed directly	Animal species lists present common and scientific names of the species involved so that the faunal resources of the area are catalogued
Direct Contact Methods	Animal species list	List of animals communities observed directly	This method involves collection, study and release of animals
Count indices methods (Roadside and aerial count methods)	Drive counts Temporal counts	Observation of animals by driving them past trained observers	Count indices provide estimates of animal populations and are obtained from signs, calls or trailside counts or roadside counts
	Call counts	Count of all animals passing a fixed point during some stated	These estimates, through they do not provide absolute population

Name	Relevance	Applications	Remarks
		interval of time	numbers, Provide an index of the various species in an area
			Such indices allow comparisons through the seasons or between sites or habitats
Removal methods	Population size	Number of species captured	Removal methods are used to obtain population estimates of small mammals, such as, rodents through baited snap traps
Market capture methods	Population size estimate (M)	Number of species originally marked (T) Number of marked animals recaptured (t) and total number of animals captured during census (n) N = nT/t	It involves capturing a portion of the population and at some later date sampling the ratio of marked to total animals caught in the population

Table 6: Choice of Models for Impact Predictions: Socio-economic Environment*

Relevance		
Name	**Application**	**Remarks**
Extrapolative Methods	A prediction is made that is consistent with past and present socio-economic data, e.g. a prediction based on the linear extrapolation of current trends	
Intuitive Forecasting (Delphi techniques)	Delphi technique is used to determine environmental priorities and also to make intuitive predictions through the process of achieving group consensus	Conjecture Brainstorming Heuristic programming Delphi consensus
Trend extrapolation and correlation	Predictions may be obtained by extrapolating present trends Not an accurate method of making socio-economic forecasts, because a time series cannot be interpreted or extrapolated very far into the future with out some knowledge of the underlying physical, biological, and social factors	Trend breakthrough precursor events correlation and regression
Metaphors and analogies	The experience gained else where is used to predict the socio-economic impacts	Growth historical simulation commonsense forecasts
Scenarios	Scenarios are common-sense forecasts of data. Each scenario is logically constructed on model of a potential future for which the degrees of “confidence” as to progression and outcome remain undefined	Common-sense
Dynamic modeling (Input- Out model)	Model predicts net economic gain to the society after considering all inputs required for conversion of raw materials along with cost of finished product	
Normative Methods	Desired socio-economic goals are specified and an attempt is made to project the social environment backward in time to the present to examine whether existing or planned resources and	Morphological analysis technology scanning contextual mapping - functional array

Relevance		
Name	**Application**	**Remarks**
	environmental programmes are adequate to meet the goals	- graphic method Mission networks and functional arrays decision trees & relevance trees matrix methods scenarios

* **NOTE:** (i) If a project proponent prefer to use any model other than listed, can do so, with prior concurrence of concerned appraisal committee. (ii) Project-specific proposed prediction tools need to be identified by the project proponent and shall be incorporated in the draft ToR to be submitted to the Authority for the consideration and approval by the concerned EAC/SEAC.

ANNEXURE XI

Form through which the State Governments/Administration of the Union Territories Submit Nominations for SEIAA and SEAC for the Consideration and Notification by the Central Government

Form for Nomination of a professional/expert as Chairperson / Member / Secretary of the SEIAA / EAC / SEAC

1	Name (in block letters)					
2	Address for communication					
3	Age & Date of Birth (Shall be less than 67 years for the members and 72 years for the Chairman)					
4	Area of Expertise (As per Appendix VI)					
5	Professional Qualifications (As per Appendix VI)	Qualification(s)	University	Year of passing	Percentage of marks	
6	Work experience (High light relevant experience as per Appendix VI)	Position	Years of association			Nature of work. If required, attach separate sheets
			From	to	Period in years	
7	Present position and nature of job	Serving Central / State Government Office?	Yes/No			
		Engaged in industry or their associations?	Yes/No			
		Associated with environmental activism?	Yes/No			
		If no is the answer for above three, please specify the present position and name of the organization				
8	Whether experienced in the process of prior environmental clearance?	Yes/No. If yes, please specify the experience in a separate sheet (Please restrict to 500 words)				
9	Whether any out-standing expertise has been acquired?	Yes/ No If yes, please provide details in a separate sheet (Please restrict to 500 words).				
10	Any other relevant information?	May like to attach separate sheets (Research projects, consultancy projects, publications, memberships in associations, trainings undergone, international exposure cum experience etc.)				

The Government of……………………is pleased to forward the Nomination of Dr./Sh. ……………………..….. for the position of Chairperson / Member / Secretary of the SEIAA / SEAC / EAC to the Ministry of Environment & Forests, the Government of India for the Notification.

(Authorized Signature with Seal)

ANNEXURE XII
Composition of EAC/SEAC

Composition of the EAC/SEAC

The Members of the EAC shall be Experts with the requisite expertise and experience in the following fields /disciplines. In the event that persons fulfilling the criteria of “Experts” are not available, Professionals in the same field with sufficient experience may be considered:

- Environment Quality Experts: Experts in measurement/monitoring, analysis and interpretation of data in relation to environmental quality
- Sectoral Experts in Project Management: Experts in Project Management or Management of Process/Operations/Facilities in the relevant sectors.
- Environmental Impact Assessment Process Experts: Experts in conducting and carrying out Environmental Impact Assessments (EIAs) and preparation of Environmental Management Plans (EMPs) and other Management plans and who have wide expertise and knowledge of predictive techniques and tools used in the EIA process
- Risk Assessment Experts
- Life Science Experts in floral and faunal management
- Forestry and Wildlife Experts
- Environmental Economics Expert with experience in project appraisal

ANNEXURE XIII

Best Practices & Latest Technologies available and reference

Best Practices & Latest Technologies available and reference

Laws and initiatives regarding hazardous emissions generated during organic chemical production and use are important dynamics that shape the industry. The chemical business is by far the largest polluting industry generating at least three times more pollution than the second greatest offending industry.

As late as 1991, chemical producers released more than 1.5 billion pounds of toxins as defined by the Environmental Protection Agency's (EPA's) Toxics Release Inventory (TRI). This figure represented a full 46 percent of all U.S. industrial toxic emissions. Forty percent of this waste was dumped into the air, 40 percent into underground wells, and the remainder was released into water and land.

To minimize the detrimental effects of chemical industry pollutants, multiple local, state, and federal laws govern producers. For example, the federal Emergency Planning and Community Right-to-Know Act require many manufacturers to submit detailed emissions data to the EPA. Similarly, the Pollution Prevention Act (1990) requires those same companies to report their waste management and pollution reduction activities.

Other federal regulations impacting producers include the Safe Drinking Water Act, the Clean Air Act Amendments of 1990, and other laws that restrict hazardous wastes. In addition to legal restrictions, both the EPA and the Chemical Manufacturers Association (CMA) sponsor successful voluntary pollution reduction programs that encourage environmental sensitivity. The EPA has continued to monitor the industry, and in today's current political climate, which places strong emphasis on chemical safety and pollution controls, it is likely that regulations will continue to be added and modified.

The chemical industry's future and its key technology needs and pathways are the subject of a joint effort of the Chemical Manufacturers Association, American Chemical Society, American Institute of Chemical Engineers, Council for Chemical Research, the Synthetic Organic Chemical Manufacturers Association and the chemical industry to:

- Provide technology vision and establish technical priorities in areas critical to improving the chemical industry's competitiveness.
- Develop recommendations to strengthen cooperation among industry, government and academe.
- Provide direction for continuous improvement through step-change technology.

Pollution prevention opportunities

The best way to reduce pollution is to prevent it in the first place. This can be done in many ways such as reducing material inputs, reengineering processes to reuse by-products, improving management practices, and using substitutes for toxic chemicals. Some smaller facilities are able to get below regulatory thresholds just by reducing pollutant releases through aggressive pollution prevention policies.

Pollution outputs from the rubber products industry occur at many stages of the manufacturing process. Most facilities are reducing these outputs by using the many reasonable and effective pollution prevention options that exist.

Chemicals

The compounding and mixing area of a rubber products manufacturing facility, where dry chemicals are weighed, put into small containers, and loaded into the rubber mixer, is generally a minor source of particulate emissions. Some mixing facilities have practically eliminated particulate emissions by purchasing their chemicals in small preweighed, sealed polyethylene bags. The sealed bags are put directly into the Banbury mixer and the bag itself becomes part of the rubber matrix, thus eliminating this formerly dusty operation. For facilities not purchasing their chemicals in preweighed bags, a variety of other pollution prevention options exist. The following pollution prevention methods have been used by various facilities:

- Careful Transportation Mechanisms - Receiving chemicals in closed docks in sealed containers or in bulk rail or truck shipments with a minimal history of spills. Storing chemical piles inside the facility to ensure that any fugitive emissions can be contained within the facility.
- Sealed Containers - Providing sealed containers for all open materials. Sealed containers should have air space between the chemical and the container cover to minimise "puffing" losses when the container is opened. Similarly, placing secondary containment mechanisms around all storage containers provides further protection from spills and leaks.
- Automatic Dispensing - Utilizing automatic dispensing and weighing equipment whenever possible. Automatic dispensing minimises waste due to spills from manual dispensing and provides quality control.
- Reduced Toxic Chemical Usage - Reducing the use of toxic chemicals via reformulation. Rubber manufacturers continually research opportunities for pollution prevention through product reformulation.
- However, rubber manufacturers must adhere to stringent product performance requirements. Therefore, pollution prevention opportunities must be balanced with product specifications.
- Computer Inventories - Providing computer inventory control methods to minimise the amount of stock purchased.
- Spills and Sweeping Protocols - Providing protocols for cleaning up spills and sweeping to ensure the proper segregation of waste.

Spent solvents

Spent solvents known to contribute to ozone depletion is not a problem in rubber products manufacturing facilities. A major initiative by the rubber products industry to eliminate ozone-depleting chemicals in 1994 and early 1995 resulted in many innovative spent solvent pollution prevention activities. Among the accomplishments were replacing solvent cleaning applications with high pressure water systems, using caustic cleaning solutions, and substituting old solvents with cleaner, citrus-based solvents. Many mold release compounds, coatings, and adhesives that formerly used ozone-depleting chemicals as carriers were reformulated to eliminate the offending chemicals. In some cases, process changes directly eliminated the chemicals of concern. Most rubber products are now free from having been manufactured with ozone-depleting chemicals.

Disposal

A significant issue in the rubber products industry is the disposal of waste rubber. To prevent the improper disposal of scrap rubber, facilities can segregate and recycle rubber wastes. Properly segregating waste streams may be as simple as placing a screen over part of the molding equipment, so that waste rubber stock produced during preforming operations can be segregated from the oily wastewaters and recycled back into the process. Other segregation processes may include separating cured from uncured rubber, and recycling the uncured portion back into the process.

Reclaiming and recycling cured, off-specification rubber is also a waste minimisation option. Reprocessing rubber involves taking used rubber products and processing them in a manner such that they can be incorporated into virgin rubber compounds.

Scrap rubber that cannot be recycled within the manufacturing process is being used in the following manner:

- Adding it to coal and wood waste fuels for firing process boilers;
- Making it into sheets and various shapes to use as athletic area surfaces and other floor coverings;
- Making it into sheet gasket material; and
- Making it into loading dock bumpers.

An important factor that limits recycling post-consumer and post-production scrap into products is the increased performance requirements of the materials. Automobile components are continuously being designed for greater endurance (*e.g.*, automobiles capable of 150,000 miles without maintenance or a tune-up). Such performance standards require manufacturers to use high-purity chemicals and quality, precision manufacturing processes. These rubber products, whether they are tires, belts, hoses, motor mounts, gaskets, or seals, turn out to be highly engineered entities with strict quality standards. Introducing used, off-specification, or unknown quality ingredients into the dynamically stressed, high-performance rubber product can be a problem. As a result, recycling of the post-consumer and postproduction waste applies to materials used in less demanding applications.

Because of the large investment in current technology and the lifetime of capital equipment, pollution prevention at the earliest stages is unlikely unless a company undertakes the design of a new production line or facility. Also, producers of specialty chemicals in particular must work within the specifications of customers and maintain the flexibility required to manufacture many chemicals at a single facility. Despite these limitations, there are numerous pollution prevention opportunities that can be realized by current processes and equipment.

Chemical substitution, particularly of water for non-aqueous solvents, can also prevent pollution. For example, Du Pont at the Chamber Works in New Jersey is using a high-pressure water-jet system to clean polymer reaction vessels. This replaces organic solvent cleaning that annually produced 40,000 pounds of solvent waste. Installing the new cleaning system cost $125,000 but it will save $270,000 annually.

Improved separations design also offers a pollution prevention opportunity since separations account for about 20 percent of energy use in the chemical process industry. In one case, a solvent was replaced by an excess of a reaction component, thus eliminating the need to separate the solvent from the waste stream while reducing separation costs.

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