1.0 Introduction

The purpose of this Environmental impact Assessment (EIA) guideline is to provide clear and concise information to all stakeholders (Proponents, Consultants, Government Ministries, Departments and Agencies, Members of the Public, Expert in relevant disciplines and interested groups, the organized private sector, non-governmental organizations, professional bodies, host and project affected communities) to improve and streamline the EIA study carried out for fertilizers, Phosphates and Urea Projects. This guideline will also assist stakeholders to identify the environmental issues, mitigation measures and alternatives that need to be assessed and considered during the study.

It is to be noted that urea and phosphates are major types of fertilizers, and this guideline is expected to serve for urea and phosphate plants, as well as some other chemical fertilizer plants.

1.1 Major Categories of Fertilizers in Nigeria

The fertilizer industry (including phosphates and urea) is categorized majorly into three– nitrogen (N), phosphorus (P), and potassium (K) fertilizers – based on the essential macro-nutrients for plants.

- Nitrogen fertilizers are produced mainly from ammonia gas. Manufacturers compress the gas into liquid forms, such as anhydrous ammonia and aqua ammonia, which may be applied directly to the soil. Ammonia can also used in producing solid fertilizers, such as ammonium sulphate, ammonium nitrate, ammonium phosphate, and an organic compound called **UREA**. Each of these fertilizers provides the soil with large amounts of nitrogen. Some, including ammonium sulphate and ammonium phosphate, furnish other elements as well as nitrogen.
- Phosphorus fertilizers also called **PHOSPHATES** are made from the mineral apatite. Finely ground apatite may be applied to soil as a solid fertilizer called rock phosphate which is a major source of phosphorus for the production of Mono-ammonium phosphate (MAP) and Di-ammonium phosphate (DAP). Apatite also may be treated with sulphuric acid or phosphoric acid to make liquid fertilizers

called super-phosphates single super phosphates (SSP) and triple super phosphate (TSP).

- Potassium fertilizers come largely from deposits of potassium chloride. Manufacturers mine the deposits or extract them with water and produce such fertilizers as potassium chloride, potassium nitrate, and potassium sulphate.
- Other inorganic fertilizers provide soil with various elements. Those containing gypsum, for example, supply sulphur. Manufacturers also produce fertilizers that provide specific micro-nutrients.

Based on the nutrient(s) present in fertilizer they are categorized as straight fertilizers (single nutrient) or complex fertilizer (more than one nutrient).

1. Straight fertilizers can be further categorized into:

- Straight nitrogenous fertilizers like urea and ammonium salts (ammonium chloride, ammonium sulphate and calcium ammonium nitrate (CAN) and
- Straight phosphate fertilizers which are the SSP.

2. The complex fertilizers include the NP/NPK fertilizers based on mixed acid route, e.g. DAP or the NP/NPK fertilizers based on nitro-phosphate route, e.g. Ammonium Nitro Phosphate (ANP).

This guideline will cover the production of fertilizers, urea and phosphates irrespective of the capacity; metric tonnes per day (MTPD) and related off-site and utility facilities.

2.0 Project Justification

A proponent shall provide necessary and adequate information on the justification for the project. This shall include a summary of the report of the Project's feasibility study; the need, value and sustainability (social, cultural and economic) of the Project. Such justification shall expressly define the benefits of the project to its intended end-users and indicate the over-riding advantages or positive impact of the project over its anticipated environmental impacts. The justification may also include the rationale for selecting the project amongst various available options or alternatives and any socio-economic factor's justifying the project.

3.0 Project Description

The project description should detail the features of the fertilizer, urea or phosphate plant with respect to plant configuration, raw material requirement, utilities and services, infrastructural facilities and sources of waste generation, their quantity, treatment and safe disposal of the waste. A flow diagram of the production process and a layout of the facility should be detailed.

The EIA study should report a description of the development in relation to the local environment as follows:

- Description of development type with physical characteristics, scale and design.
- An estimate of quantities and types of materials needed during construction and operation phase of the project.
- Description of the main characteristics of the production process with diagrams, plans and maps.
- A description of indication of the physical presence and appearance of completed development within the receiving environment.
- The nature of the production processes intended to be employed and expected production rate.
- The land area taken by the development with its location clearly defined on a map.
- The uses to which the land will be put should be described.
- The estimated duration of the construction phase, operational phase and where appropriate, decommission phase should be given.
- The numbers of workers and/or visitors entering the site during construction and operation should be estimated. The access to the site and likely means of transport should be given.
- The means of transporting raw materials and products to and from the site and the approximate quantities involved should be described.
- An estimate, by type and quantity, of expected residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation, etc.) resulting

from operation of the proposed project.

Emphasis should however be given to those components with the most potential for significant short and long term environmental impacts.

4.0 Description of the Environment/ Baseline Data

The area and location of the environment likely to be affected by the development should be described in the EIA Report. The environment expected to be affected by the project should be presented with a suitable map of the area. Description of the existing environment should include the natural (physical and biological environment) and human (cultural, socio-economic) systems and their inter-relationships.

The baseline conditions: a description of the affected environment as it is currently, and as it could be expected to develop if the project were not to proceed, should be presented. The important components of the affected environments should be identified and described. The methods and investigations undertaken for this purpose should be disclosed and be appropriate to the size and magnitude of the project. Secondary data of significance can be sourced for useful utilization including local plans.

Table 1: Environmental Components and Indicators of Existing Environment

Environmental Components	Indicators
Climatic variables	Rainfall – Pattern, amount, trend Temperature- patterns Climatic zone Climate variability and Extreme events Climate change projections Prevailing wind – direction (speed)
Topography	Drainage pattern, elevation and slopes {this can be presented with a digital elevation model}, Specific landform types, etc.
Coastal dynamics and morphology	Wave patterns Currents

	Shoreline morphology – near shore, foreshore Sediment – characteristics and transport, etc.
Soil	Type, properties and characteristics
Water	Availability and abundance Water quality (pH, Ammoniacal Nitrogen, Total Nitrogen, Free Ammoniacal Nitrogen, Nitrate Nitrogen, Cyanide, Vanadium, Arsenic, Suspended Solids, Oil and Grease, Cr as Cr^{+6}, Total Chromium, etc.) Surface water (rivers, lakes, ponds, gullies) – quality, water depths, flooding areas, etc. Ground water – water table, local aquifer storage capacity, specific yield, water level depths and fluctuations, etc. Coastal Floodplains Wastewater discharges Waste discharges, etc.
Air	Ambient air quality (for gaseous and particulate pollutants) Stack and fugitive emissions for PM_{10}, $PM_{2.5}$, Urea dust, NH_3, SO_2, NO_x etc. Air shed 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.
Biological	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.

Land Use	Land use pattern, actual and projected, specially designated areas, man-made features, incompatible land use attributes (e.g. public water supply, tourism site, , etc.), ESAs – sensitivity (distance, area and significance).
Socio-Economic Factors	Demography details of all project affected communities, economy (employment rate, income distribution), services (types, capacity, adequacy), housing, etc. cultural

5.0 Associated and Potential Environmental Impacts

The identification, prediction and evaluation of potential impacts of the project on the environment should be investigated and described. The impacts should be broadly defined to cover all potential effects on the environment.

(a) A description of direct impact and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative impact of the project should be addressed.

(b) The types of impact in (1) above should be described with regards to human beings, flora and fauna, soil, water, air, climate, land, cultural and interactions amongst them.

(c) Impacts during construction and operation phases should be considered including impacts that might arise from non-standard operating conditions, accidents e.t.c.

(d) Predicted impacts should be derived from baseline conditions as to prevail as a consequence of the project.

(e) Identification of impacts should be by a systematic methodology such as project specific checklists, matrices, overlays, Ad-hoc, networks, geographic information system (GIS), expert opinion, Delphi technique e.t.c.

(f) A brief description of the impact identification method should be described and the rational for using it.

(g) The significance of impacts should be assessed, taking into account appropriate national and international standards where available. consideration should also be made for magnitude, location and duration of the impacts. The choice of significance assessment should be justified and any contrary opinion elaborated upon.

(h) The EIA study for fertilizer, Urea and Phosphates projects should also consider the cumulative impacts that could arise from a combination of the impacts due to other projects with those of other existing or planned projects in the surrounding area and including residual impacts.

6.0 Mitigation Measures / Alternatives

(a) For ensuring a thorough site selection process, alternative sites should have been considered where practicable with primary advantages and disadvantages and reasons for the final choice detailed. Including alternative processes, designs, and operating conditions.

(b) Mitigations of all significant adverse impacts for the project type should be considered. Any residual or unmitigated impacts should be justified.

(c) The extent of effectiveness of mitigations measures when implemented should be described.

(d) Mitigation methods considered should include modification of project, compensation and the provision of alternative facilities as well as pollution control.

(e) Details of how the mitigation measures will be implemented and function over the time span for which they are necessary should be highlighted.

(f) Mitigation measure should be described with respect to the impact of significances to which it relates and the conditions under which it is required (for example, continuously or in the event of contingencies). These should also be cross-referenced to the project design and operating procedures which elaborate on the technical aspects of implementing the various measures.

6.1 Mitigation Alternatives

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

(a) avoiding environmental sensitive areas (ESAs)

(b) adjusting work schedules to minimize disturbance

(c) engineered structures such as berms and noise attenuation barriers

(d) pollution control devices such as scrubbers and electrostatic precipitators

(e) changes in fuel feed, manufacturing, process, technology use, or waste management practices, such as substituting a hazardous chemical with a non-hazardous one, or the re-cycling or re-use of waste materials, etc.

Figure 1 below gives an indication of the mitigation procedure.

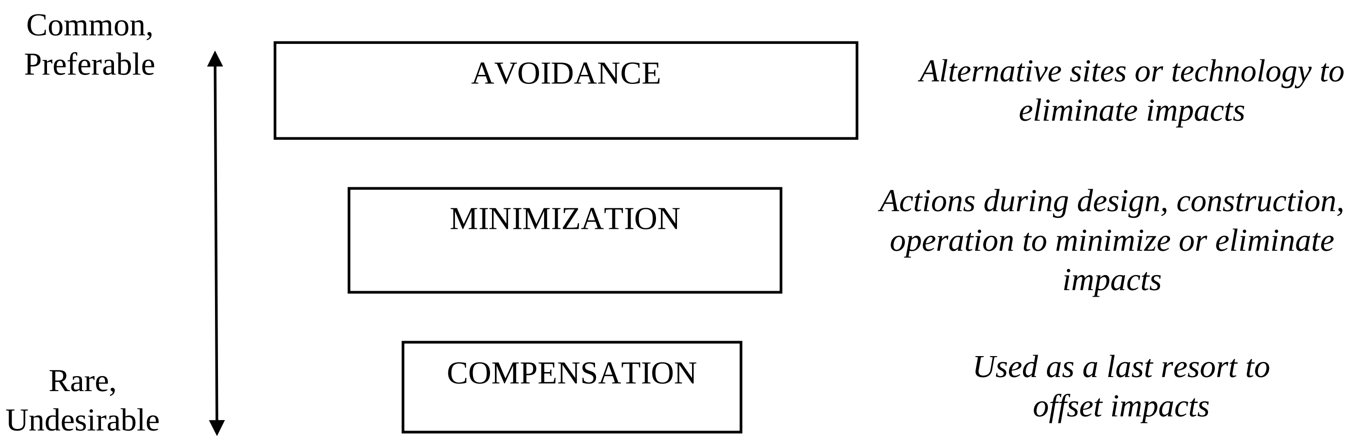

Figure 1: Hierarchy of elements of mitigation plan

7.0 Environmental Management Plan (EMP)

The Environmental Management Plan (EMP) outlines the mitigation, monitoring and institutional measures to be taken during project implementation and operation to avoid or control adverse environmental impacts, and the actions needed to implement the measures.

(a) The EMP for the for projects in the fertilizer (including phosphates and urea) industry should be site-specific, focused and logical with a clear framework for management of key environmental impacts that could arise from the project.

(b) The EMP should be prepared with involvement of key stakeholders (proponent, regulators and local community).

(c) The EMP should cover all areas of the environment (human beings, flora and fauna, air, soil, water, land, cultural heritage, waste management, traffic and transport, noise and vibration) e.t.c.

(d) The EMP should also outline the following; be composed of the following; summary of potential impacts of the project; description of recommended mitigation measures; description of monitoring programme to ensure compliance with relevant standards and residual impacts; allocation of resources and responsibilities for plan implementation; implementation schedule and reporting procedures and contingency plans and disaster management plan.

8.0 Remediation Plans After Decommissioning

The Decommissioning and Remediation Plans should provide a framework for the implementation of decommissioning and rehabilitation activities in the closure phase of the Project. The plan should be in line with the FMEnv guidelines for decommissioning and best international practices. A remediation plan should be drawn by the proponent and approved by all concerned (regulators and stakeholders) before execution. Both beneficial and adverse environmental effects of the decommissioning or closure should be scrupulously stated. Mitigation measures should be prescribed to ensure health of workers and environmental safeguards and to minimize the risk of possible incidental events during decommissioning phase. Decommissioning an remediation must be aimed at restoring environmental conditions existing before the realization of the fertilizer Plant.

9.0 Approach to the EIA Study for Fertilizer, Urea and Phosphate Projects

9.1 Introduction

Any material – organic, inorganic, natural or synthetic – which supplies one or more chemical elements required for the plant growth is considered as a fertilizer. These chemical elements are called nutrients since they are essential for plant growth. Fertilizers provide three primary nutrients: Nitrogen (N), Phosphorus (P) and Potassium (K). Nitrogen supports vegetative growth. Phosphorus improves roots and flowering. Potassium strengthens resistance to environmental assaults, from extreme temperatures to pest attacks. Urea (NH_2CONH_2) is of great importance to the agriculture industry in Nigeria. It is the most important nitrogenous fertilizer in the Nigerian market, with the highest Nitrogen content (about 46 percent). It is a white crystalline organic chemical compound. Urea is neutral in pH and can adapt to almost all kinds of soils.

Di-Ammonium phosphate (DAP) is a most widely used Phosphorus fertilizer. It is made from two common constituents in the fertilizer industry – Nitrogen (N) and Phosphorus (P). It is relatively high in nutrient content and its excellent physical properties make it a popular choice in farming and other industries.

The structure below serves as a guide to understand the scope for conducting an EIA study for all fertilizer projects in Nigeria.

9.2 The development of a fertilizer facility

1. For the development of a fertilizer facility, the proponent should have a clear understanding of the methods, techniques of production process to be employed and should have conducted a feasibility study encompassing project location, raw material source and usage, transportation, energy use e.t.c.
2. Upon having a mandate to conduct an EIA for a fertilizer facility a consultant should understand the environmental aspects of the fertilizer(s) for production and ancillary infrastructures required for its operations.

3. The consultant should consider if there are intermediates required for the production of nitrogenous and phosphatic fertilizers such as Ammonia, Sulphuric acid (H_2SO_4), Phosphoric acid (H_3PO_4) and Nitric acid (HNO_3).
4. In addition to feedstock, raw materials and intermediates required for fertilizer production, other details to be considered include: de-mineralized water, power and steam usually produced in captive plants located in the same premises of the fertilizer plants.
5. The fertilizer production plant can generally be a complex of many facilities/features based on the type and capacity of main production plant, a consultant should be furnished with adequate information in other to ensure a thorough EIA study.

9.3 Composition of an EIA Report for Fertilizer, Urea and Phosphate Project

9.3.1 An introduction and background of the project, the proponent of the project, type and size/capacity of the project. The objectives of the EIA in relation to the project, Terms of Reference (ToR) and a legal, administrative and policy framework for the project.

9.3.2 A justification or the project should be detailed and should address the need for the project, value of the project, project alternatives and envisaged sustainability of the project.

9.3.3 A project and or process description should be discussed extensively and should include;

- **Justification for selecting the proposed unit size.**
- Land requirement for the project including its layout for various purposes, its availability and optimization.
- Details of proposed layout clearly demarcating various units within the plant.
- Complete process flow diagram describing each unit, its processes and operations, along with material and energy inputs and outputs (material and energy balance).
- Details on requirement of raw materials, its source and storage at the plant.
- Details on requirement of energy and water along with its source.

- Groundwater management; management of total dissolved solid from Demineralization plant.
- Details on water balance including quantity of effluent generated, recycled and reused. Efforts to minimize effluent discharge and to maintain quality of receiving water body.
- Details of 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.
- Details of the proposed methods of water conservation and recharging.
- Details of proposed source-specific pollution control schemes and equipments to meet the national standards.
- Details of fluorine recovery system in case of phosphoric acid plants to recover fluorine as hydrofluorosilicic acid (H_2SiF_6) and its uses. Sources of secondary emissions, its control and monitoring.
- Management plan for solid/hazardous waste generation, storage, utilization and disposal. Disposal of by-products viz., chalk, spent catalyst, hydrofluorosilicic acid and phosphogypsum, sulphur muck, etc.
- Adoption of measures taken to achieve zero discharge in case of complex fertilizer plant (DAP/NPK excluding acid plants) and also SSP. Adoption of cleaner and energy-efficient technologies. (Higher emphasis on energy efficiency in case of nitrogenous plants and resource conservation in case of complex fertilizer plants).
- For expansion of existing plants, details of the programmes undertaken for the protection of occupational health of the workers.
- Details regarding infrastructure facilities such as administrative, sanitation, warehouse, fuel storage, etc. during construction and operation phase.
- In case of expansion of existing facilities, remediation measures adopted to restore the affected environmental media and a detailed compliance to the environmental clearance/consent conditions.

9.3.4 Description of the Existing Environment

- The study area to include spatial extent of the proposed site for development and areas identified to be likely affected by the developmental phases and operational aspect of the proposed development.
- Location of the project site and nearest habitats with distances from the project site.
- Land use based on satellite imagery including location specific sensitivities including communities and other industries in the study area.
- Demography details of communities/settlements that fall within the study area.
- Topography details of the project area.
- The baseline data to be obtained from the study area with respect to different components of environment; air, soil water, land, and socio-economic. Actual monitoring of baseline environmental components shall be according to the parameters prescribed after screening by the ministry.
- Surface water quality of nearby water sources such as stream, river, etc. and other nearby surface drains.
- Details on ground water quality.
- Details on existing ambient air quality and expected, stack and fugitive emissions for PM10, PM 2.5, Urea dust*, NH_3*, SPM*, SO_2*, NO_x*, HF*, F*, etc.(* - As applicable)
- 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.
- Air dispersion modelling studies for the proposed fertilizer plant.
- Details on noise levels at sensitive receptors.
- Details on existing water quality parameters such as pH, Ammoniacal Nitrogen, Total Kjeldhal Nitrogen, Free Ammoniacal Nitrogen, Nitrate Nitrogen, Cyanide, Vanadium, Arsenic, Suspended Solids, Oil and Grease, Chromium, etc.
- Site-specific micro-meteorological data.
- One or dual season data gathering as prescribed by FMEnv.
- Proposed baseline monitoring network for the consideration and approval of the Ministry.

- Ecological status (terrestrial and aquatic) of the study area such as habitat type and quality, species, diversity etc.

9.3.5 Associated and Potential Impacts of a fertilizer Project

The following set of conditions may be used as a guide for assessing and evaluating impact of the project

- Will there be a large change in environmental conditions?
- Will new features be out-of-scale with the existing environment?
- Will the impact be unusual in the area or particularly complex?
- Will the impact extend over a large area and continue for a long time?
- Will many people be affected?
- What receptors will be impacted?
- Is there a risk that environmental standards will be breached?
- Is there a risk that protected sites, areas, features will be affected?
- Is there a high probability of the impact occurring?
- Will the impact 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 impact?

9.3.6 Mitigation Measures / Alternatives

A Checklists for mitigation of impacts in a fertilizer plant (including phosphates and urea) projects are listed in table 2 below.

Table 2: Typical Impacts of a fertilizer facility and its Mitigation Measures

Impacts	**Typical Mitigation Measures**
Soil	• Installation of drainage ditches • Runoff and retention ponds • Minimize disturbances and scarification of the surface • Usage of appropriate monitoring and control facilities for construction equipment deployed • Methods to reuse earth material generated during excavation
Resources – fuel / construction materials, 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
Water pollution	• Storm water drainage system to collect surface runoff • Treatment of all effluents containing acid/alkali/organic/toxic wastes • Ground water Monitoring • Use of biodegradable or otherwise readily treatable additives • Neutralization and sedimentation of wastewaters, where applicable • Dewatering of sludge and appropriate disposal of solids • Waste oil treatment • Controlling discharge of sanitary sewage and industrial waste into the environment • Avoid activities that increases erosion or that contributes nutrients to water (thus stimulating alga growth) • Treated wastewater (such as sewage, industrial wastes, or stored surface runoffs) can be used as cooling water makeup. • Develop spill prevention plans in case of chemical discharges and spills • Develop traps and containment system to chemically treat discharges on

	site (if any)
Air Pollution	• Periodic check of vehicles and construction machinery to ensure compliance with emission standards • Attenuation of pollution/protection of receptor • Dilution of odourant (dilution can change the nature as well as strength of an 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 periodical wash of construction equipment and transport vehicles to prevent accumulated dust • Ensure vehicles are covered during transportation • Provide dust collection equipment at all possible points • Maintain dust levels within permissible limits • Provision of PPEs such as nose masks e.t.c.
Noise Pollution and Vibrations	• Use of suitable muffler systems/enclosures/sound-proof glass paneling on heavy equipment/pumps/blowers as appropriate • Pumps and blowers may be mounted on rubber pads or any other noise absorbing materials • Proper scheduling of high noise generating activities to minimize noise impacts • Usage of well-maintained construction equipment meeting the regulatory standards • Periodic maintenance of equipment/replacing whenever necessary/lubrication of rotating parts, etc. • By using damping, absorption, dissipation, and deflection methods • Performance specifications for noise represent a way to insure the procured item is controlled
Social	• Health and safety measures for workers

	• Development of traffic plan that minimizes road use by workers • Upgrade of roads and intersections • Ensure public involvement • Exploration of alternative approach routes in consultation with local community and other stakeholders
Occupational Health and Safety	• Provision of worker camps with proper sanitation 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 communicable diseases. • Provide preventive measures for potential 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/minimize the disturbance on surrounding habitats • Initiate traffic density studies
Solid / Hazardous Wastes	• 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 minimize odour, pest and litter impacts • Prohibit burning of refuse onsite.

9.3.7 Environmental Management Plan

- The administrative and technical organizational structure to ensure proposed project monitoring programme for approved mitigation measures are implemented including the involvement of the ministry and other stakeholders.
- The EMP devised to mitigate the adverse impacts of the project should be detailed including allocation of resources and responsibilities for plan implementation.
- Details of the emergency preparedness plan and on-site and off-site disaster management plan should be discussed extensively.
- Environmental Monitoring Program should be detailed to provide specific information on; monitoring pollutants at receiving environment for the appropriate notified parameters – air quality, ground and surface water, land etc during project phases; specific programme to monitor safety and health of workers, appropriate monitoring network has to be designed and proposed, to assess the possible residual impacts on environmental components and details of in-house monitoring capabilities and the recognized Ministry, department and agencies for conducting the monitoring.

9.3.8 Remediation Plans After Decommissioning

- The need to decommission the project (temporarily or permanently) at any point.
- Develop appropriate plan for the restoration of the environment to include soil, air, water, land, vegetation, fauna, socio-economic, cultural and other components.

9.3.9 Additional Studies

1. Details on risk assessment and damage control during different phases of the project and proposed safeguard measures.
2. Details on socio-economic development activities such as commercial property values, generation of jobs, education, social conflicts, cultural status, accidents, etc.
3. Proposed plan to handle the socio-economic influence on the local community. The plan should include quantitative dimension as far as possible.
4. Details on corporate social responsibility (CSR)
5. Addressing pertinent issues identified during scoping.

10.0 General EIA Report Writing Format

The reporting format for EIA of fertilizer plant (including phosphates and urea) projects shall contain the following:

1. Table of Contents
2. List of Maps
3. List of Tables
4. List of Figures
5. List of Abbreviations and Acronyms
6. List of EIA Preparers
7. Executive summary
8. Acknowledgement
9. Introduction – Background information, Administrative and legal framework, Terms of Reference
10. Project Justification
    - need for the project
    - value of the project
    - envisaged sustainability
    - Alternatives to project
11. Project and/or Process Description
    - type
    - input and output of raw materials and products
    - location
    - technological layout
    - Construction process
    - project operation and maintenance
    - project schedule
12. Description of the Environment (baseline data acquisition)
    - study approach
    - geographical location and topographical features
    - field data

- climatic conditions
- air quality/noise/odour assessments
- vegetation cover characteristics
- potential land use and landscape patterns
- ecologically sensitive areas
- terrestrial fauna and wildlife
- soil studies
- aquatic studies, including hydrobiology and fisheries
- groundwater resources
- socio-economic resources
- infrastructural services

13. Associated and Potential Environmental Impacts
    - impact identification and prediction methodology
    - significant positive impacts
    - significant negative impacts
    - site preparation and construction impacts
    - transportation impacts
    - raw material impacts
    - process impacts
    - project specific incremental environmental changes (if any)
    - project specific cumulative effects
    - project specific long/short term effects
    - project specific direct/indirect effects
    - project specific adverse/beneficial effects
    - project specific risk and hazard assessments

14. Mitigation Measure/Alternatives
    - best available technology/best practicable technology
    - liability compensation/resettlement
    - site alternative, location/routes
    - no project option
    - impacts with corresponding mitigation measures

15. Environmental Management Plan
    - Monitoring schedule
    - parameters to be monitored
    - Scope of monitoring
16. Remediation plans after decommissioning/closure
17. Conclusions and Recommendations
18. References and Bibliography
19. Appendices

11.0 Waste Management

11.1 Effluent and Emissions generated from a Fertilizer, Urea and Phosphate Industry

Effluent and emissions generated from fertilizer plants including utilities are outlined in table 3 below:

Table 3: Effluents from Fertilizer Industry

Fertilizer Plants	Liquids	Gases
Ammonia	• Process condensate bearing Ammonia and methanol from steam reformation of natural gas or naphtha. • Oil bearing effluent from pumps and compressor section, leakages and washing of equipment etc. • Effluent bearing absorbent chemicals like K_2CO_3, methanol, DEA MEA, glycerin etc., from carbon dioxide removal section owing to leakage spillage from the system. • Carry over from gasification process using fuel oil, containing suspended carbon, sulphide, vanadium etc.	• Flue gas containing mainly CO_2, SO_2, NO_x and particulate from primary reformer stack. • CO_2 • Purge gas from synthesis gas section. • H_2S from rectisol wash unit.
Urea	• Process condensate containing urea, ammonia and CO_2 from vacuum concentration section. • Effluents containing mainly oil from carbon dioxide compression section, leakages from pumps and washings of equipment.	• Dust from prilling tower and product handling. • Ammonia fumes from the prilling tower and scrubbers.
Sulphuric acid	• Waste heat boiler blow down and acidic wastewater due to spillage, leakage and washing of the plant and equipment.	• Off gases containing acid mist and SO_2 from the absorption tower stack.

Phosphoric acid	• Effluent bearing phosphate and fluoride and suspended solid purged from recycle scrubber. • Hydrofluorosilicic acid containing condensate generated from the vacuum concentration section. • The gypsum pond overflow containing fluoride, phosphate and suspended solids.	• Dust from rock handling and grinding section • Fluoride compounds emitted from fume scrubbers.
Nitric acid	• Small quantity of boiler blow down and acidic wastewater from spillage, leakage and washing of the plant and equipment	• NOx bearing gas emitted from absorption tower stack.
SSP	Effluent bearing phosphate, fluoride and SS (suspended solids) from the scrubber Effluent containing ammonia, nitrate, fluoride, phosphate and SS from scrubber used for controlling emissions. Effluent containing ammonia, nitrate phosphate and SS due to spillage leakage, washing etc.	Emission of fluoride compounds from acidulation of rock phosphate. Dust emission from rock grinding and handling section. During curing of the product, dust and fluoride compounds are released. Rock Phosphate dust from grinding mill. NO_x, F and dust from reaction vessel. NH_3 from calcium nitrate tetrahydrate section, acid neutralization and ammonium nitrate evaporation section, prilling tower / granulator.

		Dust from prilling tower, granulator, product cooling section, drying section etc.
DAP/APS/UAP	Wastewater from draining and washing of equipment; leakages from pump glands.	NH_3 and small quantity of fluoride compounds from neutralization and granulation operation Dust emission from drying, screening and cooling section.
NPK	Wastewater from draining and washing of equipment; leakages from pump glands.	Dust from drying, screening and cooling section. Fluoride compounds and ammonia fumes from neutralization and granulation operation
De-mineralization of Water	Acidic and alkaline effluents arising from regeneration of ion exchangers in DM (de-mineralization) plant	Nil
Steam and Power Generation	Boiler blow down containing high total dissolved solids (TDS) and conditioning chemicals like hydrazine/sodium sulphite, sodium phosphate etc.	Flue gas discharged through the boiler stack; may contain particulate matter, NO_x, SO_2 etc., depending on the fuel used such as, natural gas, fuel oil or naphtha etc.
Cooling Water Treatment System	Blow down bearing phosphates, biocides etc.	Nil

11.2 Processes Adopted for Treating Effluents and Emissions Generated During the Production of Intermediates and Fertilizers

11.2.1 Liquid Effluents

Table 4: Processes for Treating Liquid Effluents

Type	Sources	Aim	Available Technologies
Ammoniacal effluent	A significant quantity from the nitrogenous fertilizer plant	To reduce the ammoniacal nitrogen content before disposing into receiving bodies, thus to avoid pollution and recover ammonia.	Stripping (air and steam) Ion-exchange Reverse osmosis Chlorination Biological nitrification and de-nitrification
Urea plant effluent	Urea plant	To recover urea as ammonia and CO2, as well as pure condensate for reuse.	Urea hydrolysis and Stripping e.g. use of deep hydrolyser stripper.
Oil-bearing effluent	Oil unloading, storage and pumping sections of fertilizer plants, and pumps and compressors bay.	To recover, recondition and reuse oil and grease.	Mechanical gravity type oil separators
Effluent-bearing absorbent	CO_2 absorption processes	To eliminate arsenic-based CO_2 removal process with glycine and	

chemicals from CO_2 removal sections		secondary amine based vetrocoke process or Benfield CO_2 removal process.	
Fluoride and phosphate	NPK and DAP plants	To recover and reuse the flourides and phosphates.	Liming Clariflocculator
Nitro-phosphate effluent	Processes involving phosphates and nitrogen	To remove pollutants	Air stripping Liming Biological de-nitrification

11.2.2 Gaseous Emissions

Table 5: Processes for Treating Gaseous Emissions

Type	**Source**	**Aim**	**Available Technologies**
Prilling tower dust	Urea production	To minimize particulate dust emission to as low as 15 mg/Nm^3 and maximum dust content of 40 mg/nm^3, and to recover the dust (urea dust).	Natural draft prilling tower De-dusting system
Hydrogen sulphide	Ammonia plant based on gasification of fuel oil with high sulphur (2.5 - 4.2%)	To recover H_2S, and convert to elemental sulphur for reuse.	Washing gases with methanol
Sulphur dioxide	Sulphuric acid plant	To improve SO_2 conversion efficiency to about 99.5% and reduce the SO_2 effluent to 500-600 ppm.	Double conversion double absorption (DCDA)
Acid mist	Sulphuric acid plant	To reduce mist to as low as 30 ppm or totally eliminate it.	Electrostatic precipitator Acid mist eliminator DCDA system with a mist eliminator
Oxides of	Nitric acid plant	To reduce NO_x	Absorption and chilling process

nitrogen (NO_x)		concentration in the tail gas and increase acid production.	Selective catalytic reduction
Particulate matter	From various plant operations like grinding, drying, cooling, coal use etc.	To recover and reuse coal dust. To collect the particulate matters	Dust extracting system Wet collectors (gravity spray separator, dynamic precipitator, venture scrubber and wet centrifugal scrubber) Dry collectors (a settling chamber, a centrifugal and inertial separator, a fabric collector and an electrostatic precipitator).
Fluoride emission	Acidification of rock phosphate	To absorb over 99% of the fluoride.	Multi-stage scrubbers

11.2.3 Solid Wastes

Table 6: Processes for Treating Solid Wastes

Type	Sources	Aim	Available Technologies
Spent Catalyst	Manufacture of ammonia, synthesis of sulphuric acid.	To use new generation catalysts (with longer life span) To sell spent catalyst to authorized waste processes for metal recovery and reuse. To send unbought catalysts to treatment storage disposal facility (TSDF).	Recovery
Carbon Slurry	Ammonia plants based on partial oxidation of fuel oil or coal, gasification of oil.	To discourage fuel oil and use gas	Gas
Waste Oil	Spillages, leakages and washings from oil unloading, storage, pumping section, pumps and compressor bays	To recover and reuse waste oil	Recovery
Acid / Alkaline Waste	Demineralization plants and acid plants		
ETP Sludge	ETP	To treate sludge for use as manure	Reuse
Sulphur Sludge	Sulphuric acid plant	To recover and reuse sulphur as filler in the complex fertilizer plants and SSP plants since sulphur is secondary nutrient.	Recovery
Hydrofl uorosilic	Manufacture of phosphoric acid and	To reuse H_2SiF_6 for acidulation of rock phosphate, (sulphuric acid is saved).	Recovery

ic Acid (H_2SiF_6)	SSP	To convert H_2SiF_6 to AlF_3, cryolite / fluoride chemicals.	
Phospho gypsum	Manufacture of phosphoric acid	To sell to cement manufacturers, to farmers as soil conditioner and for making gypsum board / panel etc.	Recovery
Chalk	Nitro phosphate plants	To be used for making CAN or sold as chalk.	Recovery
Other Wastes like Silica, Scrap, Lime sludge	Solid waste like silica generated in the fluorine scrubbing system	To be used as filler	Recovery

12.0 Team Composition for Conducting EIA for a Fertilizer, Urea and Phosphate Project

The consultant for the EIA study activities should be a multidisciplinary team to carry out the studies holistically. The professional team identified for the EIA study should consist of qualified and experienced professionals from various disciplines in order to address the critical aspects identified for the project. Based on the nature of the project, the following professionals may be identified for EIA studies of fertilizers, Urea and Phosphate projects amongst others;

- Environmental management specialist
- Air quality expert
- Waste management expert
- Noise expert
- Climatologist
- Ecologist
- Socio-economist
- Agronomist
- Chemical engineer
- Civil engineer
- Health safety and environment specialist
- Geologist
- GIS expert
- Transportation expert
- Data analyst

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