

**EGYPTIAN INDIAN
POLYESTER COMPANY
(EIPET)**

**ESIA for PET Plant
in Sokhna Area**

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Executive Summary

1- Background

Egyptian Indian Polyester Company is planning to establish a facility for manufacturing Polyethylene Terephthalate (PET), which is used in manufacturing food grade bottles. The facility will be located at Plot # 2, Southern Part of the Economical and Industrial Zone in Eldorado Industrial Zone. The zone extends north- west of the Suez Gulf, in Ain El-Sokhna, Suez Governorate.

Within the framework of site assessment, a committee has been formalized of ECHEM and EEAA represented by Head of the Central EIA Department Dr. Fatma Abu Shouk and a site visit was conducted on 17/5/2010, the committee has examined the site and its adequacy for the project. The committee has issued its approval on June 6/6/2010, ref 2930, regarding suitability of the project site. PET project would produce 525,000 MTA of bottle grade PET (Polyethylene Terephthalate) resin.

Prior to the currently proposed site, it was decided to establish the PET project inside the industrial zone south of Port Said Governorate. An ESIA Study for PET project has been approved by EEAA in 2009. Due to the obstacles in obtaining permits from the Ministry of Defense regarding the buildings and stack heights, it was decided to relocate the project to Sokhna area, in an industrial zone having a prior approval for the heights. In this context, the current site at Eldorado Industrial Zone, Sokhna was selected.

Egyptian Indian Polyester Company is a joint venture between South Asian Petrochem Ltd., India (SAPL), where Egyptian Petrochemicals Holding Co. (ECHEM) 23%, Engineering for the Petroleum and Process Industry (ENPPI), 7% and SAPL remaining 70% equity in the project.

About 80% of the product is intended for export while about 20% would be directed to the local market. The main inputs involve Mono Ethylene Glycol (MEG), Pure Terephthalic Acid (PTA) and Pure Iso-Phthalic Acid (PIA). All operational chemicals will be imported from the global markets as they are not available / produced in Egypt.

Within the framework of Law 4/1994 and its executive ER, the company assigned Environics consultancy firm to develop an environmental and social impact assessment study (ESIA) for the proposed project. Results of the ESIA study were integrated within the project design and layout of its main components. The ESIA report was reviewed by the Environmental Consultancy Center in Suez Canal University, Ismailia Branch in June 2010.

The study covers the different aspects related to the construction and operation phases encompassing:

- The PET Project construction and operation within the facility premises
- The Effluent Treatment Plant (ETP) plant and the discharge of treated wastewater
- The raw material / product storage

2- Project Location

The proposed project site is located inside Eldorado Industrial Zone at the entrance of Sokhna City. The site will occupy a land of dimensions 300m x 470 m with the following coordinates as shown in the following Figure:

Latitude: 29° 39' 38.37" N to 29° 39' 54.6" N

Longitude: 32° 18' 19" E to 32° 18' 25.1" E

Surrounding the project site the following facilities:

- **North:** 470m bordered by the plot of land allocated to the Egyptian Chinese joint Venture Company
- **South:** Cleopatra ceramic company chemical Store and carpentry workshop away from EIPET border about 40 meter
- **East:** Under construction temporary dwelling for the third shift's workers away from EIPET border about 200 meter and then Suez – Sokhna highway
- **West:** 300m bordered by a vacant plot of land owned by Ceramica Cleopatra Group
- **Sokhna Port:** 1 km to the east of the project site
- **El-Wadi Resort:** 2 km to the east of the project site

3- Process Description

The proposed PET facility uses Purified Terephthalic Acid (PTA), Monoethylene Glycol (MEG) and Purified Isophthalic Acid (IPA or PIA) to produce bottle grade Polyethylene Terephthalate Polymer (PET). Other raw materials include DEG (Diethylene glycol), catalyst and additives. The industrial process goes into a series of consequent reactions of raw materials. These mainly involve two steps, namely producing amorphous polymer chips followed by final crystalline resin. The production encompasses esterification and poly-condensation reactions followed by solid state poly-condensation to produce a polymer with the required viscosity.

- **Production of amorphous polymer**
The process stages include:
 - **Paste preparation**
The raw materials, PTA, PIA, MEG, DEG and a catalyst are mixed to form homogeneous paste.
 - **The Esterification reaction**
In this stage, esterification reaction takes between MEG, PTA and PIA in presence of a catalyst to produce an esterification product.
 - **Final Poly-condensation**
The low molecular PET is polycondensed to high molecular PET. The desired degree of polymerization of the melt and thus its viscosity is achieved through the final stage of this reaction.
 - **Chip production**
The final polymer melt, from the polycondensation stage, is filtered and transferred to the chip production unit where the molten polymer is cooled down and then cut into chips of uniform size.
- **Production of crystalline PET resin**
This process involves implementing solid state polymerization (SSP) to increase the viscosity and upgrade the amorphous PET produced from the polycondensation stage to high quality bottle grade resin. The process is typically conducted at high temperatures and under inert-gas conditions, such as nitrogen to prevent degradation of the polymer at high temperatures.

4- Utilities

The PET plant uses various service units, which serve either to provide the polycondensation and SSP plants with the required utilities or to handle/treat process effluents.

- **Water**

The water requirement for the plant is about 1700 m³/day for industrial and domestic activities. Part of this water (about 1100m³/d) will be supplied through the water network of the industrial zone, and the remaining part (620m³/d) will be provided through recycling of the treated wastewater.

- **Effluent treatment plant (ETP)**

Wastewater is treated through two stages as follows:

- Streams of the process wastewater are directed to the ETP. The involved streams are generated from esterification, poly-condensation processes and the filter cleaning process. The adopted treatment method includes Anaerobic- Aerobic Biocarbon techniques (AABC).
- The resulted wastewater from AABC is then routed- along with the WW streams from the utilities (cooling tower, demineralization unit and boiler) which do not contain any organic contents- to another treatment stage which uses advanced RO technology.

After treatment, about 620 m³/d of water is recycled and reused as make-up water in the cooling tower. Water generated from the RO unit amounts for 124 m³/d. It will be used to irrigate the green areas inside the industrial zone according to Decree 44/2000 modifying the executive regulations of Law 93/1962.

The generated sludge from ETP will be recycled for reuse in the treatment as an activated sludge.

- **Electricity**

The electricity requirements will be about 10 MW.

- **Fuel**

The facility uses Natural Gas as fuel, with a consumption rate of 5000- 6000 m³/hr. It will be used in heating operations. However, in case of natural gas shortage the company will use diesel as alternative fuel.

5- Outputs, Wastes and Emissions

- **Air Emissions**

Emissions are generated from stack of the heaters. The following table gives levels of the different parameters involved in stack emissions. Levels given in the table indicates that the emissions are below the allowable limits of Law 4/1994 and IFC permissible limits as well.

Typical Stack Emissions from the Stack

Parameter	Concentration (mg/m ³)	Max. Limits of Law 4/1994 (mg/m ³)	IFC Limits (mg/m ³)
NO _x	200	300	300
CO	80	250	--
SO ₂	< 1	1500	500
Particulates	10	200	--

- **Wastewater and Liquid Wastes**

- **Domestic Wastewater**

The generated domestic wastewater (about 24m³/d) will be directed to the ETP plant.

- **Industrial Wastewater**

- Process WW is treated through the AABC stages of the ETP.
- Treated process WW together with WW from the service units are treated in the RO stage
- About 620 m³/d of treated WW is recycled for reuse as a make-up water in the cooling tower
- Treated WW is reused in irrigating the green areas in the industrial zone

- **Solid and Hazardous Waste**

- **Hazardous Wastes**

These include:

- Spent catalyst containing platinum used in SSP reactors. It is returned to the suppliers for regeneration.
- Spent oils are delivered to a specialized company licensed by EGPC according to the Egyptian system for spent oils management.

- **Non-Hazardous Waste**

Include the following:

- Off-spec product
- Off-spec packaging bags
- Empty raw material bags
- Domestic wastes (food, glass, plastics, cardboard, etc.).

6- Environmental and Social Impact Assessment

6.1 Environmental Baseline

The environmental baseline for the project area was investigated through desk studies and field surveys in the project area and its surrounding potentially influenced environment. The surveys included investigating the air quality and noise level. The environmental components include physical, biological and socio-economic environment.

6.1.1 Physical Environment

- **Climate**

The climate in Sokhna is generally characterized by warm and dry weather during most of the year.

- **Lithology and Soil**

The project is located at Wadi Ghweiba area where the main outcropping rock unit is represented by Undifferentiated Quaternary deposits of gravel and sands. The Quaternary Alluvium wadi deposits lie at the northwest and south eastern parts of the project site. The Undifferentiated Pliocene sediments, exposed at the eastern parts of the project site, consisting of limestone and shale.

- **Topography**

The Sokhna area is a structurally controlled area with horsts and depressions (grabbens). Variations in elevations are noticeable in a number of areas on the horst structures. Highest elevations occur within southern parts where the escarpment of El-Galala El-Bahariya lies. The maximum elevation in the area (1272 meters) lies at the extreme southeastern corner of El-Galala El-Bahariya, and there are many other peaks with elevations ranging from 1000 and 1270 meter.

The site lies in an approximately flat, low lying area with an approximate elevation low than 20m above mean sea level (MSL).

- **Groundwater Resources**

The Aquifer unit at the project area is represented by the local and moderately to low productive aquifer of the Oligo-Miocene sands and gravels. This Aquifer unit receives insignificant surface recharge, with limited sub-surface recharge, and the main type of recharge is through inter-aquifer recharge. The Aquifer unit composed primarily of sands and gravels, siltstones.

- **Air Quality and Noise**

Baseline air quality and noise monitoring was carried out within and surrounding the proposed PET location. The measured air quality parameters were found within acceptable limits in accordance to Law 4/94 as well as the IFC maximum limits for ambient air quality. Regarding ambient noise levels, results indicate that all baseline noise measurements were below the allowable

limits of the amended executive regulations of Law 4/94 as well as those of the IFC.

6.1.2 Biological Environment

The specific project location is mostly void of fauna and flora.

6.1.3 Social and Economic baseline

Apart from Suez city, there are no other major settlements near the proposed facility location. There are a few tourist resorts, of which the closest is the Wadi resort, and the Stella resort, and camps of workers of the industrial area. There is also a Local Community settlement south of the proposed facility location, at more than 5km south of the site. The Local Community settlement consists of approximately 1500 inhabitants, according to one of the older Local Community of the tribe. The PET project will contribute to the development and improvement of living levels of the local community. This will be achieved through provision of job opportunities during construction and operation phases.

6.2 Impact Assessment

Potential impacts of the proposed project were identified through studying the involved processes and baseline environment to identify the interactions between PET project and the environmental receptors. In addition scoping meetings were conducted with key stakeholder in the area to introduce the project and incorporate their comments within the ESIA.

6.2.1 Positive impacts

It is estimated that the construction phase of the project would provide direct labour force in the average of 1000 skilled and unskilled persons. This number would reach 2000 job by achieving the peak of construction activities. During operation the project is expected to provide about 450 direct and indirect job opportunities. The project will be a growth in the local and national economy. In addition, the project will contribute to the attraction of supporting industries which will consequently generate additional job opportunities in the local community. The project will additionally aid in the technology transfer as well as contribute to more local and abroad training opportunities.

6.2.2 Scoped out impacts

The different activities related to PET production will have no contact with Sea water since the company will not discharge any of generated waste streams (liquid or solid) into the marine environment. The generated wastewater will be recycled within the facility with minimal quantity reused in irrigating the green areas inside the industrial zone.

6.2.3 Potential Negative Impacts

Potentially significant impacts and their mitigation measures as well as the EMP and monitoring plan are summarized in the following tables:

Table 1: potential impacts during construction

Potential impacts	Mitigation measures	Environmental management plan	Environmental monitoring
Air quality - Dust and emissions from construction activities	Contractors will be obligated with the following: - Dust suppression measures at the site - Maintaining machinery and vehicles in good working conditions - Frequent inspection of all construction equipment	<u>H&S measures:</u> - Construct a fence around the site - Establish an on-site office to manage the construction activities. - Provide personal protective equipment (PPE) - Install fire extinguishers in designated places throughout the site. - Implement all applicable occupational health and safety measures	• Air quality • Noise levels • Workplace environment
Noise during construction	- Ensure that workers use personal protective equipment (PPE) - Periodic maintenance for noise generating equipment	<u>Emissions control measures:</u> - Periodic maintenance of used trucks, vehicles and machines - Dust suppression by water spraying	
Occupational health	Implementation of proper occupational health measures and provide workers with the necessary PPEs	<u>Waste management:</u> - Waste from temporary construction facilities will be disposed of to the locations specified by Suez Governorate.	

Potential impacts	Mitigation measures	Environmental management plan	Environmental monitoring
Social impacts - Potential tensions can arise between the two groups (locals and foreigners) in terms of culture	- The contractor will be required to use local employees as much as possible - The foreign workers will be instructed to respect the local culture		

Table 2: potential impacts during operation

Potential impacts	Mitigation measures	Environmental management plan	Environmental monitoring
Air quality - Emissions from burning of natural gas in the HTM heaters - Dust emissions in workplace from material handling	- Use of NG fuel in HTM heaters and accordingly the generated emissions will be free of SO_x - Bag filters are installed to prevent dust emissions during PTA/PIA charging - Install Cyclones for collection of dust in SSP - Mechanical seals for all transfer pumps - Installation of automatic bagging systems for the products - Achieve optimum operational efficiency through installation of controlling instrumentation	- Good house keeping measures - Periodic maintenance - Spill prevention plans - Solid and hazardous waste management plans - Firefighting plans - Employees training and awareness - Contractors and supplies awareness - Health and safety	- Air quality - Noise levels - Self monitoring (stacks and ETP) - Equipment and machinery maintenance programs - Inspection of emergency equipment - PPEs
Noise from compressors, blowers and cutters	- The project is not considered a heavy industry generating high noise levels - Machinery and equipment designed according to standard specifications - Acoustic enclosures are installed for casings of all noise generating equipment - Provide workers with PPEs		
Workplace Health and Safety, during operation from noise and heat stress	- The use of hearing PPE would be enforced actively on/ near machines generating high noise levels.		

Potential impacts	Mitigation measures	Environmental management plan	Environmental monitoring
Impact on public health	- Dispersion modeling of atmospheric emissions was conducted for the PET facility, in addition the cumulative impact of the PET emissions indicated that the impact on the surrounding community is insignificant		
Potential pool fire risk from spills of MEG	Based on the QRA results, it is evident that there is virtually no off-site risk to the surrounding population. The risk to the onsite labor is extremely low and can be further mitigated with the implementation of proper mitigation measures.		

7- Conclusion

Significant impacts of the PET project- located inside Eldorado Industrial Zone, Sokhna- have been identified and mitigated through integrating the environmental control tools and measures within the project design. In addition, mitigation is achieved through adopting an efficient EMP to be performed throughout all phases of the project.

As clarified in the above summary, the project has been designed to fully comply with National and IFC environmental requirements and standards.

1. Introduction

Background

Egyptian Indian Polyester Company (EIPET) is planning to establish a facility for manufacturing PET in The Eldorado Integrated Development and Free Zone S.A.E Company site, which is at Sector-2 of the Southern Region of the Economic and Industrial Zone, North West of the Suez Gulf at Ain Sokhna. The facility would produce 525, 000 MTA of bottle grade PET (Polyethylene Terephthalate) resin. The Project was intended to be established in South of Port Said Industrial zone – Port Said Governorate and was granted EEAA approval in 2009. However, due to obstacles in obtaining permits for building and stack heights from the Ministry of Defense, the EIPET has decided to change the project location to Sokhna area where they have prior approval from the Ministry of Defense for the building and stack heights.

Egyptian Indian Polyester Company is a joint venture between South Asian Petrochem Ltd., India (SAPL), where Egyptian Petrochemicals Holding Co. (ECHEM) 23%, Engineering for the Petroleum and Process Industry (ENPPI), 7% and SAPL remaining 70% equity in the project.

About 80% of the product is intended for export while about 20% would be directed to the local market. The main raw materials for production include Monoethylene Glycol (MEG) and Purified Terephthalic acid (PTA) and Isophthalic Acid (IPA). All raw materials will be imported from the global market.

South Asian Petrochem Limited, India's second largest manufacturer of Polyethylene Terephthalate (PET), is amongst the largest and the most modern in the region. SAPL uses the latest state of the art PET resin manufacturing technology, to efficiently produce high quality packaging products. The state of the art plant has been designed and built with the most modern technology from Zimmer AG Germany. The Company received quality certifications from renowned national and international agencies such as the USFDA, EC, Japanese and Canadian Food and Health Bodies and ITRC. Received ISO 9001:2000 certification from TUVNORD in 2006-07, endorsing its quality commitment. The company is also ISO 14001: 2004 and BS OHSAS 18001: 2007 certified. In the year 2007, SAPL Company was one of four companies awarded the Environment Excellence Award 2007 by the West Bengal Cleaner Production Centre WBCPC), a collaborative effort of the West Bengal Pollution Control Board (WBPCB) and the Indian Chamber of Commerce (ICC) to recognize and encourage such proactive institutional efforts for betterment of the environment.

Outline of ESIA study

This ESIA report includes:

- **Chapter 1:** Introduction and Background on the project is developed as well as the scope and objectives of the ESIA study.
- **Chapter 2:** Description of the local regulatory framework applicable to the company activities.
- **Chapter 3:** Description of the intended production process and the expected emissions and waste
- **Chapter 4:** Description of the baseline environment in the project area
- **Chapter 5:** Discussion of alternatives for different project components, such as location and production technology.
- **Chapter 6:** Assessment of the potential environmental impacts and their mitigation measures.
- **Chapter 7:** The environmental management and monitoring plan for the PET plant
- **Chapter 8:** The results of the PC meetings with the concerned stakeholders.

Objective of the ESIA

The objective of the ESIA is to ensure that the project is environmentally and socially sound and sustainable, and that any potential negative environmental impacts are recognized early in the project cycle and taken into account before project implementation. Furthermore, it is also intended to satisfy the environmental legal requirements of the Egyptian Environmental Law 4 of 1994 amended by Law 4/2009 and its executive regulations No. 338 of 1995 modified by Prime Minister Decree no. 1741/ 2005 and EEAA (Egyptian Environmental Affairs Agency) guidelines for EIAs as well as those of the International Finance Corporation (IFC).

Scope of Work

The ESIA of the proposed project would evaluate the project's potential environmental impacts in its area of influence; identify ways of improving project environmental performance during its different stages by preventing, minimizing or mitigating potential adverse environmental impacts and enhancing positive impacts. The ESIA will cover the different components of the plant at the different phases of site preparation, construction, startup and operation.

The scope of work covers the specific "terrestrial" impacts of the plant, where no marine components are involved in the study as there will be no contact with the different activities and the marine environment. Thus, the ESIA report covers the components within the facility premises, which includes the following project components:

- The PET production process
- The (Effluent Treatment Plant) ETP plant and the discharge of treated wastewater
- The raw material/product on-site storage.

2. Policy, Legal and Administrative Framework

This section summarizes the environmental legislation and regulations that are of relevance to the project, which include Egyptian regulations as well as those of the IFC. The relevant regulations were identified according to the geographic location of the proposed facility, its manufacturing processes (described in detail in the next chapter 3) and the expected emissions. Consideration is first given to the national legislations pertaining to the execution of the ESIA, followed by a review of the national and the International Finance Corporation (IFC) environmental regulations relevant to the project (*IFC Environmental, Health, and Safety General Guidelines, 2007 and Environmental, Health, and Safety Guidelines Petroleum-Based Polymers Manufacturing, 2007*).

2.1 National Legislation Pertaining to EIA

Law 4/1994, Law of the Environment, amended by Law 4/2009 and its executive regulations (ERs), modified in 2005 is Egypt's first modern and comprehensive law regulating the environment as a whole. Law 4/1994 regulates air, water, earth, biodiversity and the anthropogenic activities which may impact upon these resources and receptors. According to Law 4, the project proponent must prepare an Environmental Impact Assessment (EIA) with the application for license of new projects and/or extension of existing facilities. Accordingly, environmental requirements are integrated into the existing licensing system.

According to the Egyptian Guidelines for EIA (EEAA, 1996), proposed developments are classified into three categories according to the severity of potential impacts. They reflect the increasing level of environmental impact assessment. The three categories are:

- **Category A:** projects with minor environmental impacts
- **Category B:** projects with substantial impacts
- **Category C:** projects with high potential impacts requiring full EIA

According to the national EIA guidelines, petrochemical projects are classified as category C projects. Thus the proposed PET plant requires a full EIA to include construction and operation phases. Moreover, it is worth mentioning that the EEAA has upgraded the Egyptian EIA system to capitalize on higher levels of environmental and social impact assessment and analysis of alternatives, elements of the environmental management plan as well as principles of public consultation and disclosure. These modifications have rendered the, already highly developed, Egyptian EIA system compatible with the EIA systems of the different international entities. The modified guidelines were issued on January 2009 and will be applicable as of July 2009.

According to law4/1994 and its ER, the EIA will be submitted to the Competent Administrative Authority (CAA), under which jurisdiction the project falls. For The PET plant, the CAA is the Egyptian Petrochemical Company (ECHEM). The CAA would send the EIA to EEAA to issue its

response within 30 days. If no response is received beyond this period, the assessment shall be deemed approved. The project may accordingly commence its activity during its license period; otherwise the environmental approval shall be disregarded

2.2 Guidelines of the International Financing Corporation (IFC)

In addition to Law 4/1994, this ESIA is prepared according to The International Finance Corporation (IFC) requirements for projects proposed for financing. The International Finance Corporation is a member of the World Bank Group. The IFC fosters sustainable economic growth in developing countries by financing private sector investment, mobilizing capital in the international financial markets, and providing advisory services to businesses and governments. The IFC helps companies and financial institutions in emerging markets create jobs, generate tax revenues, improve corporate governance and environmental performance, and contribute to their local communities.

In this context, the IFC requires the projects to abide by its Performance Standards to ensure that they are environmentally sound and sustainable. Performance Standards (PS) are applied to manage social and environmental risks and impacts. The performance standards define clients' roles and responsibilities for managing their projects and the requirements for receiving and retaining IFC support. The standards also include requirements to disclose information. The IFC PS are:

- ***Performance Standard 1: Social and Environmental Assessment and Management System***
Establishes the importance of: (i) integrated assessment to identify the social and environmental impacts, risks, and opportunities of projects; (ii) effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and (iii) the client's management of social and environmental performance throughout the life of the project.
This performance standard is relevant to most projects and applies to the current one.
- ***Performance Standard 2: Labor and Working Conditions***
Recognizes that the economic growth through employment creation and income generation should balance with protection for basic rights of workers. The requirements set out in this PS have been in part guided by a number of international conventions negotiated through the international Labour Organization (ILO) and the United Nation (UN).
This ESIA addresses the aspects requirements of employment during the different project phases.
- ***Performance Standard 3: Pollution Prevention and Abatement***
Recognizes that industrial activities often generate increased levels of pollution to air, water and land, which can have potential adverse impact on the surrounding environment.

The ESIA investigates the emissions and wastes (solid and liquid) from different sources during construction and operation phases and their potential impacts. It will also investigate relevant mitigation measures to minimize potentially significant impacts of pollutants.

- ***Performance Standard 4: Community Health, Safety and Security***
Recognizes that the project activities and infrastructure can increase the potential for community exposure to risks and impacts arising from equipment accidents, structural failure and releases of hazardous materials. Impacts may also arise from exposure to diseases and the use of safety and security personnel.
The potential impacts on the community during operation, represented in air emissions, noise and risks, are addressed in this ESIA through air dispersion modeling, and quantitative risk assessment. Potential impacts on the work force are addressed during all project phases.
- ***Performance Standard 5: Land Acquisition and Involuntary Resettlement***
Recognizes that the project design minimizes economic and physical displacement, balancing social environmental and financial costs and benefits. The location of the proposed project has already been allocated for industrial activities and is within an existing industrial zone, thus no involuntary resettlement for this specific project or change in current land use would take place.
Provisions of this PS do not apply to the proposed project since the activities will not involve any involuntary resettlement or change in the land use.
- ***Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management***
This PS addresses how clients can avoid or mitigate threats to biodiversity arising from their operations as well as sustainably manage renewable natural resources.
As a main activity of the ESIA, the biological baseline in the project area is investigated..
- ***Performance Standard 7: Indigenous Peoples***
This PS aims at preventing adverse impacts of the projects on communities of Indigenous peoples and to provide opportunities for development benefits.
Provisions of this PS do not apply to the proposed project since there are no indigenous communities in the area.
- ***Performance Standard 8: Cultural Heritage***
The objective of this PS is to protect the cultural heritage from the adverse impacts of the project activities and support its preservation.
The proposed project is located inside The Eldorado Integrated Development and Free Zone, and is designated for industrial activities. Thus, no cultural heritage components are expected.

2.3 Environmental Regulations Pertaining to the Project

2.3.1 Air Quality

Article 40 of Law 4/1994 and article 42 of its modified ERs give the maximum allowable limits for the concentrations of pollutants resulting from burning of fuels.

Article 36 of Law 4/1994 and article 37 of its modified ERs give the maximum allowable limits for exhaust gases from machines, engines and vehicles.

Article 35 of Law 4/1994 and article 34 of its modified ERs give the maximum allowable limits for ambient air pollutants.

Tables (2.1) and (2.2) give the maximum allowable limits for ambient air emissions and stacks emissions. It should be mentioned that the IFC guidelines regarding ambient air quality only apply in case of absence of national limits. (*Section 1.1: IFC General EHS Guidelines for Air Emissions and Ambient Air Quality, 2007.*).

**Table (2.1) Maximum Limits of Ambient Air Pollutants
According to Annex (5) of the Modified ERs of Law 4/1994 and the IFC
guidelines**

Pollutant	Exposure Period	Maximum limit	IFC guidelines
Sulfur Dioxide ($\mu\text{g}/\text{m}^3$)	1 hr	350	
	24 hrs	150	20
	1 year	60	
Carbon Monoxide (mg/m^3)	1 hr	30	
	8 hrs	10	
Nitrogen Dioxide ($\mu\text{g}/\text{m}^3$)	1 hr	400	200
	24 hrs	150	
Total Suspended Particles ($\mu\text{g}/\text{m}^3$)	24 hrs	230	
	1 year	90	
PM ₁₀ ($\mu\text{g}/\text{m}^3$)	24 hrs	150	50
	1 year	70	20

Table (2.2) Maximum Limits of Gaseous Emissions from Stacks According to Annex (6) of the Modified ERs of Law 4/1994 and the IFC guidelines

Pollutant (mg/m³)	Maximum limit	IFC guidelines*
Aldehydes (as formaldehyde)	20	0.15
Sulfur Dioxide	1500	500
Carbon Monoxide	250	
Nitrogen Oxides	300	300
Total Suspended Particles	200	

*IFC Environmental, Health, and Safety Guidelines for Petroleum Based Polymers, 2007

2.3.2 Solid Wastes

Articles 37 of the Law 4/1994 and articles 38 and 39 of the modified executive regulations are concerned with the collection and transportation of solid wastes.

Article 39 of Law 4/1994 and article 41 of its modified ERs set the precautions to be taken during digging, construction, demolition or transport of resulting waste and dust so as to avoid wafting.

Law 38/1967 concerning cleanliness and sanitation and its executive regulations (decree 134/1968) regulates the collection, transportation, storage and disposal of solid waste.

2.3.3 Noise

Article 42 of Law 4/1994 and article 44 of its modified executive regulations give the maximum allowable limits for sound intensity. Tables (2.3 and 2.4) present the maximum allowable sound levels for different activities and the period of exposure in case of increasing noise level intensity over 90 dB (A). Table (2.5) shows the maximum limits for noise levels in the different zones in the workplace.

Table (2.3) Maximum Allowable Noise Levels in Workplace According to Annex (7) of ERs of Law 4/1994 and the IFC guidelines

Type of Place/Activity	Maximum Allowable Sound Level (decibel (A))	IFC guidelines*
Work place with up to 8 hour shifts and aiming to limit noise hazards on hearing	90	85
Work place where acoustic signals	80	

and good audibility are required		
Work rooms for the follow up, measurement and adjustment of high performance operations	65	
Work rooms for computers, typewriters or similar equipment	70	
Work rooms for activities requiring routine mental concentration	60	

*IFC General EHS Guidelines, 2007- Section 2.3, Physical Hazard

Table (2.4) Period of Workplace Exposure in case of Noise Level Intensity over 90 dB (A) According to Annex (7) of the Modified ERs of Law 4/1994

Noise intensity level dB (A)	95	100	105	110	115
Period of exposure (hour)	4	2	1	1/2	1/4

Table (2.5) Maximum Limit Permissible for Noise Level in the Different Zones According to Annex (7) of the Modified ERs of Law 4/1994 and the IFC guidelines

Type of zone	Permissible limit for noise level, dB (A)			IFC guidelines*	
	Day time 7 am – 6 pm	Evening 6 pm – 10 pm	Night 10 pm – 7 am	Daytime 7 am – 10 pm	Night 10 pm – 7 am
Industrial zones (Heavy Industries)	70	65	60	70	70

*IFC General EHS Guidelines, 2007- Section 1.7, Noise Management

2.3.4 Protection of Water Resources

Article 69 of Law 4/1994 prohibits the discharge or disposal of any untreated substances, wastes or liquids, which may cause pollution along the Egyptian seashores or adjoining waters.

Law 93/1962 sets the conditions for discharging wastewater to public sewers. Decree 44/2000 of the Ministry of Housing modified the executive regulations of Law 93/1962 concerning the conditions for discharge of wastewater to public sewers. Besides, Article 15 of Decree 44/2000 sets the requirements for using treated wastewater in irrigation.

The following Table describes maximum limits of treated wastewater that could be used for irrigation. Article 15 also provides the types of plants to be irrigated with each of the identified groups.

Table 2.6: Maximum Limits for use of treated Industrial Wastewater for irrigation

Item	Maximum limits for use of secondary treated wastewater for irrigation
Biochemical Oxygen Demand (BOD)	40 ppm
Chemical Oxygen Demand (COD) dichromate	80 ppm
Total Suspended Solids (TSS)	40 ppm
Oil and Greases	10 ppm
No. of enteric Nematoda cells or eggs (No./Liter)	1
No. of faecal coliform cells (every 100/mL)	1000
Maximum limits for total dissolved salts	up to 2000 ppm
Sodium adsorption ratio	20%
Chlorides concentration	300 ppm
Boron concentration	up to 3 ppm
Cadmium	0.01 ppm
Lead	5 ppm
Copper	0.2 ppm
Nickel	0.2 ppm
Zinc	2 ppm
Arsenic	Not determined
Chromium	Not determined
Molybdenum (for green fodder only)	0.01 ppm
Manganous	0.2 ppm
Iron	5 ppm
cobalt	0.05 ppm

2.3.5 Hazardous Substances and Wastes

Article 33 of Law 4/1994 specifies that all precautions must be taken when handling hazardous material either gaseous, liquid, or solid form to avoid any environmental damage. Articles 25, 26 and 27 of the modified executive regulations obligate facilities using hazardous substances to obtain a license from the competent authority. These articles also stated the licensing procedures to be followed by the facility.

2.3.6 Work Environment

The Egyptian Labour Law number 12/2003 organizes working conditions and management of worker relationship. The national labour law in its different Books addresses the individual labour contracts, terms of employment, wages and leaves, collective negotiations and collective labour agreements and litigations as well as vocational training are addressed in Books one to four. The occupational health and safety requirements are addressed in Book five. A number of explanatory notes and ministerial decrees have been issued detailing the different stipulations of the law.

Chapter 3 of Book 5 of the labor law number 12/2003, articles 208 through 215, address the responsibility of companies to protect workers against risks resulting from handling of gaseous, liquid and solid chemical substances. The Ministerial Decree 134/2003 requires that organizations hiring more than 50 employees establish an occupational health and safety department to be responsible for the workplace and employees' safety and provide the necessary equipment for measuring and monitoring pollution in the work environment. Besides, Ministerial Decree 211/2003 of the Ministry of Manpower also addresses the requirements to prevent adverse physical, chemical, biological and mechanical hazards in the workplace as well as keeping medical surveillance records for the employees

According to articles 43 and 45 of Law 4/1994 and articles 44, 45, 46 and 47 of its executive regulations, the facility owner must provide the protective equipment and all necessary safety measures for the workers against noise, heat stress and gaseous emissions inside the work place. In addition, it is the responsibility of the facility's owner to provide all closed and semi-closed places with efficient ventilation system. Moreover, the facility owner, according to the requirements of the labour law 12/2003, must ensure that exposure limits and periods for pollutants, inside the work environment, are within the maximum allowable limits.

2.3.7 Environmental and Other Registers

Article 22 of Law 4/1994 and article 17 of its modified executive regulations stipulates that establishments should maintain an environmental register for its activities. Article 17 and Annex (3) of the ER provides the content of the environmental register and state that the owner of the facility must inform EEAA with any non-compliances.

Furthermore, articles 26, 28 and 29 of the modified executive regulations are concerned with the rules and procedures of hazardous substances and waste

management. Accordingly, a register for the hazardous waste should be maintained as well as record for the hazardous substances used.

In addition, article 211 of the Labour Law 12/2003 and article 34 of the Decree of the Minister of Labour and Manpower no. 211/2003 regarding requirements to prevent adverse physical, chemical, biological and mechanical hazards in the workplace, stipulates that companies should prepare, records/reports/register for chemical safety.

2.3.8 International Agreements

Since 1936, Egypt has been party to many regional and international conventions, treaties and agreements addressing environmental protection as well as labor standards. Such regulations have also been incorporated in the different national laws. Relevant legislation to the project in hand includes the following:

- Work Environment (Air Pollution, Noise and Vibration) Convention, 1977
- Worst Forms of Child Labor Convention, 1999
- Basel Convention on Trans-boundary Movements of Waste (1995).
- The Convention on Conservation of Migratory Animals, Bonn, 1979

3. Project Description

This chapter describes the industrial processes taking place at the proposed facility. It also illustrates the expected types and amounts of emissions, which will be assessed and evaluated in light of the relevant laws and regulations as well as in relation to potential sensitive receptors that exist in the project area. Identifications of sensitive receptors will be presented in the next chapter (4) which is concerned with describing the environmental settings of the project area.

3.1 Location and Layout

3.1.1 Location

The proposed project site is located at The Eldorado Integrated Development and Free Zone S.A.E Company site, which is at Sector-2 of the Southern Region of the Economic and Industrial Zone, North West of the Suez Gulf at Ain Sokhna.

3.1.2 Surrounding Landuse

Figure 3.1 presents the location of the project and the surrounding area.

- **To the North:** 470m bordered by the plot of land allocated to the Egyptian Chinese joint Venture Company.
- **To the South:** Cleopatra ceramic company chemical Store and carpentry workshop away from EIPET border about 40 meter.
- **To the East:** Under construction worker temporary dwelling to be used by the workers of the third shift rotatingly at about 200m northeast of EIPET fence line and then Suez – Sokhna highway.
- **To the West:** 300m bordered by a vacant plot of land owned by Ceramica Cleopatra Group.

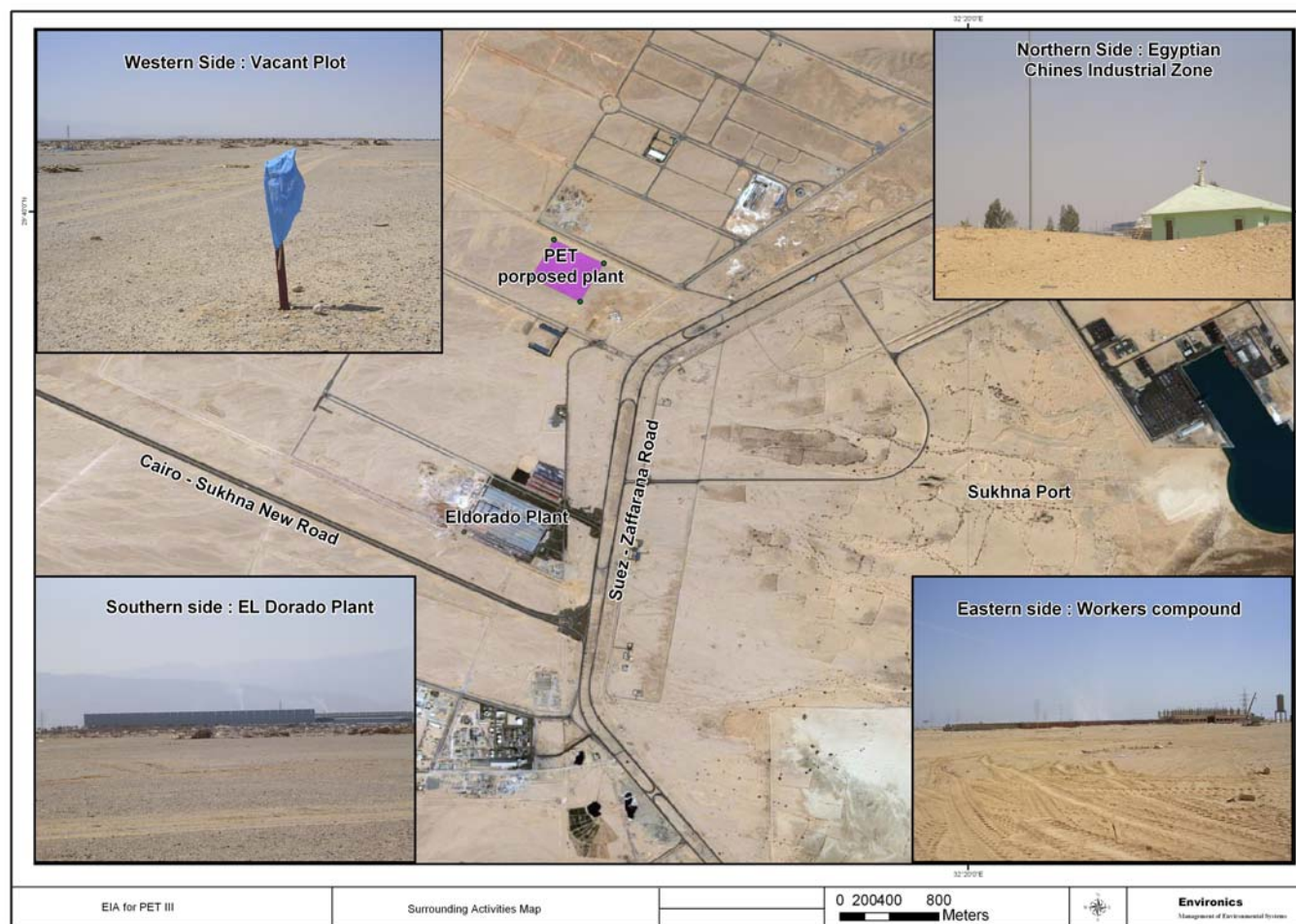


Figure (3.1): The Location and Surrounding Area of PET Project

3.2 Process/Plant Description

The proposed PET facility uses Purified Terephthalic Acid (PTA), Monoethylene Glycol (MEG) and Purified Isophthalic Acid (IPA or PIA) to produce bottle grade Polyethylene Terephthalate Polymer (PET). Other raw materials include DEG (Diethylene glycol), catalyst and additives. The production process is performed in two steps, namely producing amorphous polymer chips followed by final crystalline resin. The production encompasses esterification and polycondensation reactions followed by solid state polycondensation to produce a polymer with the required viscosity. The production process is described in detail in the following sections.

3.2.1 Production of amorphous polymer

The plant is designed for the continuous production of PET. The process stages include:

- Paste preparation
- Esterification
- Pre-polycondensation
- Final polycondensation
- Chip production

- ***Paste preparation***

The raw materials, PTA and IPA, in powder form, are conveyed into the paste preparation tank via storage/feed silos. MEG and DEG, in liquid form, and the catalyst dissolved in MEG are mixed with PTA and IPA in the paste preparation tank at a particular mole ratio. The prepared paste is fed to the esterification reactor.

Handling of PTA is carried out in closed environment and under inert conditions, thus preventing the emissions of raw material dust and particulates into the atmosphere.

MEG and DEG are provided in liquid form, and the catalyst in powder form. The solution is prepared by metering the MEG and adding it to the paste preparation tank. Additives, such as phosphoric acid and cobalt acetate are also added to the mixture after dissolving in MEG. All materials are mixed with an agitator forming a paste. The prepared paste is fed directly to the esterification reactor via a transfer pump.

- ***The Esterification reaction***

In this stage, esterification reaction takes place between MEG, PTA and IPA in presence of a catalyst to produce an esterification product. As result of the esterification reaction, water is generated as by-product in addition to the excess MEG. The MEG is recycled back to the process and water, contaminated with organic constituents, is transferred to the on-site Effluent Treatment Plant (ETP).

- **Polycondensation reaction**

The polycondensation reaction takes place in two steps i.e. pre and final polycondensation, under vacuum at high temperature (about 280 – 290°C). Pre-polymer melt is transferred to the polycondensation reactor via pre-polymer gear pumps. The low molecular weight PET is polycondensed to high molecular weight PET in the final reactor. The desired degree of polymerization of the melt and thus its viscosity is achieved through this reaction. MEG vapor liberated during these reactions is condensed and recycled back for paste preparation. The separated water is directed to the ETP.

The resulting polymer melt is filtered before transfer to the chip production unit to remove the potentially generated bulks from the melt to ensure its homogeneity.

- **Chip production**

The final polymer melt from the polycondensation stage, with higher molecular weight is filtered and transferred to the chip production units where the molten polymer is cooled down by means of a loop of demineralized water then cut into chips of uniform size. The resulting amorphous PET chips are subsequently dried and screened for removing over-size and fines then sent to intermediate storage silos prior to being fed to the SSP unit. The used demineralized water is filtered, cooled and recycled.

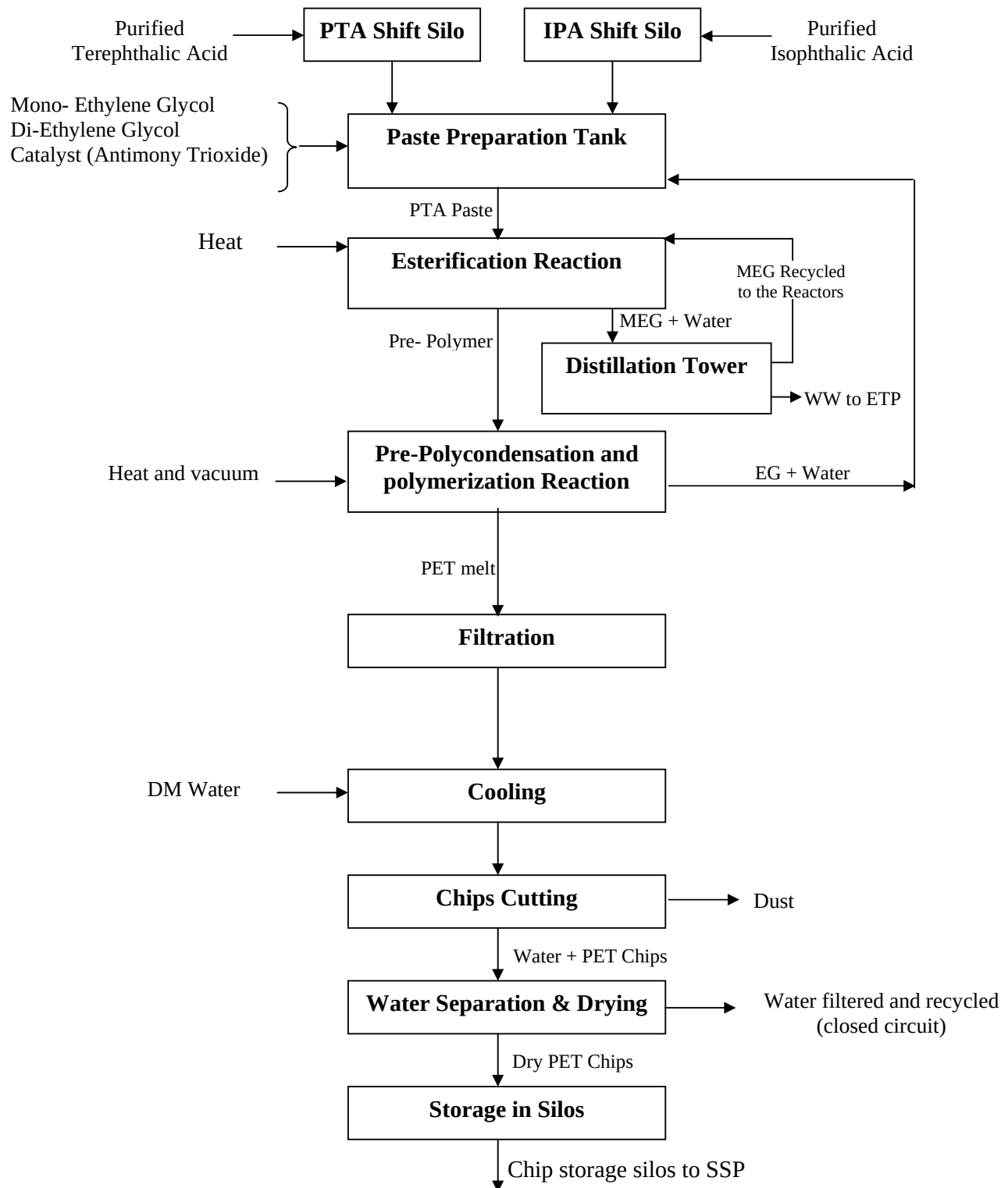


Figure (3.2): Block Flow Diagram for Polycondensation Unit

Production of crystalline PET resin

This process involves implementing solid state polymerization (SSP) to upgrade the amorphous PET produced from the polycondensation stage to high quality bottle grade resin. The chips, having an amorphous molecular structure, have the tendency to stick together or agglomerate if directly polymerized at high temperatures. Therefore, pre-crystallization is carried out to prevent agglomeration. The main parameters affecting the process are temperature and residence time. The SSP is accomplished by heating the PET chips at temperatures below their melting point. The process is typically conducted in an inert-gas environment, namely nitrogen to prevent degradation of the polymer at high temperatures. The SSP stage includes:

- Crystallization
- Annealing
- SSP
- Nitrogen purification
- Polymer cooling
- Packaging

- ***Crystallization (pre-crystallization)***

In the precrystallizer the adsorbed moisture on chips is removed by passing hot nitrogen counter currently. The pre-crystallizer also performs a dedusting operation to remove the fine PET particulates, if any, from the surface of the chips. The dust generated during fluidization process is separated by cyclone separators.

- ***Annealing (crystallization)***

This is similar to pre-crystallization where the chips are heated up to the required temperature in an inert environment, hot nitrogen, which prevents thermal and oxidative degradation of the chips. Nitrogen flows countercurrent to the flow of chips to remove moisture, acetaldehyde and other volatile organic compounds released during heating and crystallization. Contaminated nitrogen stream is directed to the nitrogen purification unit, where organic constituents are oxidized to carbon dioxide and water by catalytic oxidation. Chips are continuously agitated using an agitator to prevent chips agglomeration.

- ***SSP reaction***

The crystallized polymer needs conditioning in order to reach the required specification. This is carried out in the SSP reactor where sufficient residence time, about 10 -12 hours, is given to polymer in the reactor to build up the polymer chain. This is achieved by passing hot N₂ counter currently for driving out reaction byproducts such as aldehydes. The contaminated hot N₂ is taken to NPU (Nitrogen Purification Unit) for regeneration.

The product from SSP Reactor is taken to de-duster for cooling, sieved for removing dust before conveying to storage silos.

- **Polymer cooling**

The solid-stated resin needs to be cooled for storage and packaging. The maximum temperature for packaging is typically less than 60°C. Since the polymer temperature exiting the reactor is below 180°C the cooling can be performed in an air environment. Polymer dust generated during SSP and cooling operations is removed at this stage before sending for packing of the product.

- **Nitrogen Purification System**

As discussed above, the nitrogen, providing inert conditions in the crystallization and SSP reactors, is contaminated with volatile organic hydrocarbons such as acetaldehyde, MEG, oligomer dust and water. The circulated gas needs to be purified to maintain reaction efficiency and minimize nitrogen make up. The nitrogen purification system consists of catalytic oxidation reaction where the contaminants are oxidized to carbon dioxide and water. The wet nitrogen is dried by adsorption of water in drying desiccant beds.

- **Packaging**

The final product is packed in 1 MT jumbo bags in preparation for export or distribution in the local market. Provision will be made to pack the product in 25 kg bags for local market purpose, if required

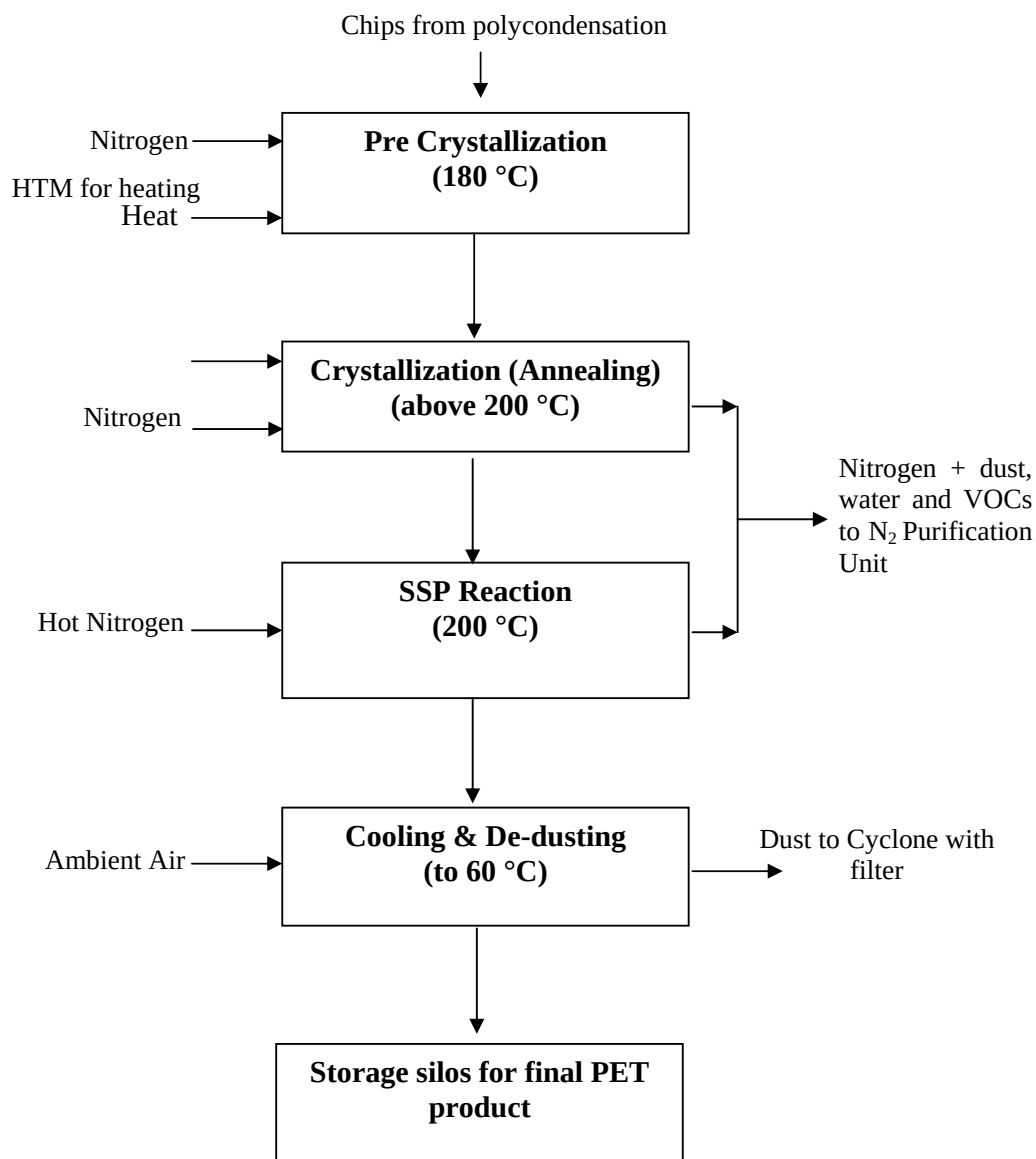


Figure (3.3): Block Flow Diagram for SSP Reaction Unit

3.3 Utilities

The PET plant uses various utility units, which serve either to provide the polycondensation and SSP plants with the required utilities or to handle/treat process effluents.

3.3.1 Water

The overall water requirement for the plant is about **1700 m³/day** for industrial and domestic activities of which 1100 m³/day fresh water which will be provided through public water network within the industrial zone and the rest 620 m³/day will be provided through recycling of treated industrial wastewater. The process water is distributed as follows for the different plant activities:

- **Cooling System:** Cooling system consists mainly of a cooling tower and auxiliary pumps, which circulate the cooling water to the piping system. The cooling water is used as cooling media for the different heat exchangers. The hot water is recycled to the cooling tower, where it is cooled by evaporation. The cooling water quality is adjusted by chemical dosing, blow down and fresh water addition (make-up water). The quantity for make-up is about 1500 m³/day, of which about 880m³/d is provided from the fresh water consumption and about 620 m³/d through recycling of the treated industrial wastewater.

The added chemicals include the following:

- Corrosion inhibitors, to protect the cooling system from corrosion
- Biocides, to destroy micro organisms
- Acid to adjust the pH

In order to reduce salt build up in the cooling tower, a continuous side stream is discharged from the cooling tower about 314 m³/day. The blow down is characterized by high TDS content of about 2000 ppm.

- **RO Unit:** is a desalination unit using Reverse Osmosis Technology (RO) to produce demineralized water for chips cooling and filter cleaning. Water is filtered through semi permeable membranes at a pressure greater than the osmotic pressure. The reject from the RO backwash is characterized by high TDS content, about 2000 ppm, which is directed to non-contaminated effluent stream collection tank.
- **Chiller**
It is used to remove heat from liquids via vapour absorption. For cases it is required to maintain water temperatures between 7-13⁰C, chillers are used. No Freon related refrigerant is used.
- **Softener/MB**
Softeners/MB with resins, are used to remove the salts from the water used at DM unit. The outlet water has hardness between 6-8 ppm
- **Domestic water requirements:** the daily requirements is about 24 m³/day.

Figure (3.4) below presents the facility water balance.

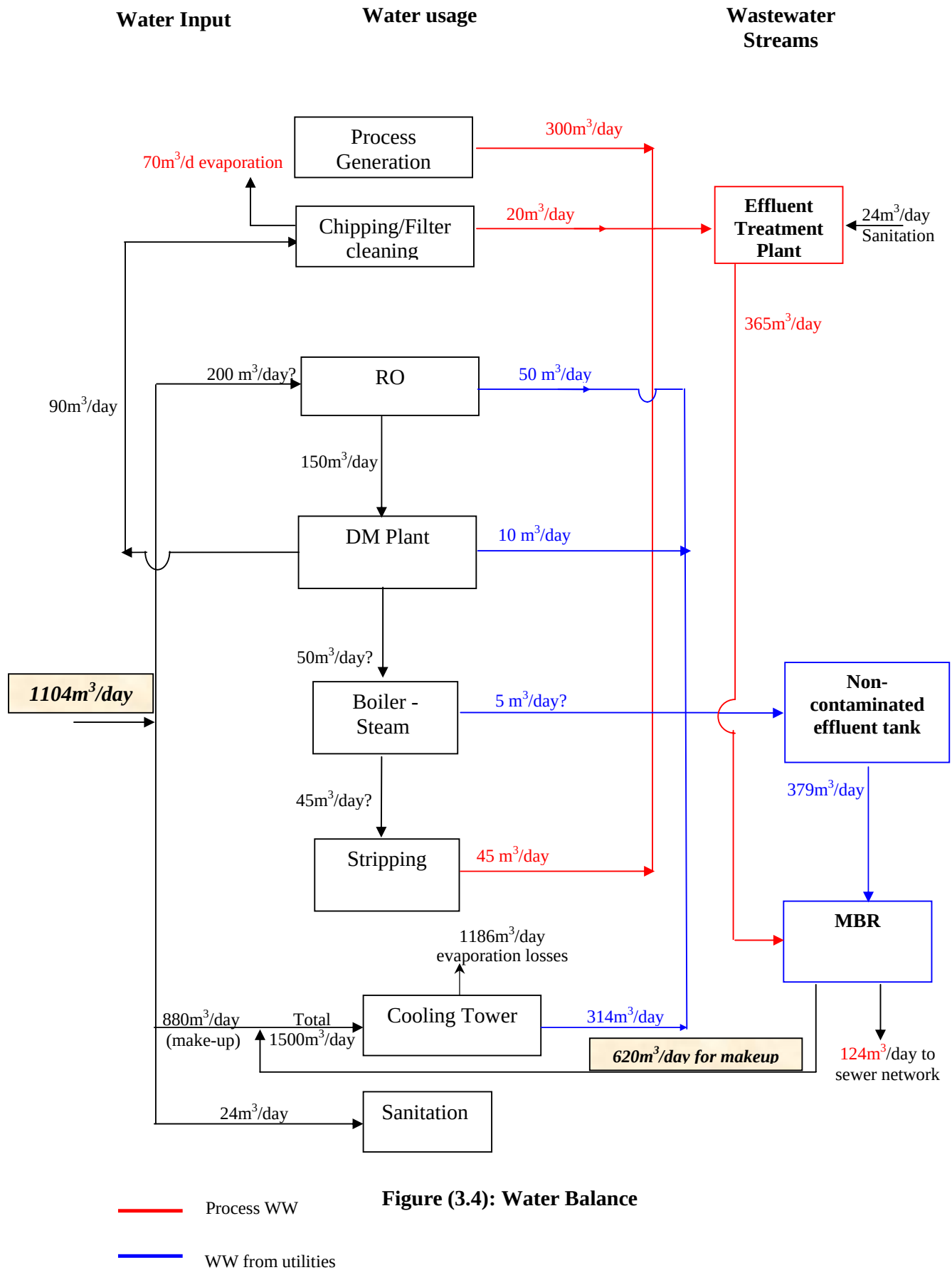


Figure (3.4): Water Balance

3.3.2 Wastewater streams treatment

Wastewater streams directed to the ETP consist of reaction water from the esterification and polycondensation reactions and water from filter cleaning process.

- **Wastewater stripper system**

The process water streams from esterification flow through a stripper column. Low pressure steam is blown counter current in the column resulting in stripping the volatile organics, such as aldehydes, into gaseous phase. The resulting process water is pumped as reflux to the process column of the esterification line and the remaining process water is directed to the ETP plant. The treated wastewater is used as makeup for the cooling tower. Off-gases containing organic constituents are directed to HTM heater to be burned with natural gas resulting in carbon dioxide and water vapor

- **Effluent Treatment Plant (ETP)**

The facility uses Anaerobic-Aerobic-Bio-Carbon (AABC) effluent treatment process. AABC is an innovative technology of higher efficiency than the conventional physical-chemical or the biochemical processes. The principle for treatment depends on degradation of the organic components in the wastewater under anaerobic conditions, with hydrolyzation and acidification of macromolecules. The organic components are further decomposed under aerobic conditions. The treatment conditions allow for digestion of the bio-sludge resulting from the decomposition of organics. Bio-carbon stage ensures that the treated water meets the requirements to use as makeup for the cooling tower. The sludge generated from the ETP is recycled as digested sludge for wastewater treatment.

- **MBR**

The treated water from the ETP plant and the non-contaminated effluent is directed to a Membrane Bed Recovery (MBR). The MBR is an advanced form of reverse osmosis systems. The MBR unit removes the salts and traces of inorganic material from the influent water. The resulting treated water, about 620m³/day is recycled to be used as make-up water for the cooling tower. Reject from the MBR unit, about 124m³/day will be used for greenery within the industrial zone.

Figure (3.5) below schematically presents the AABC treatment plant

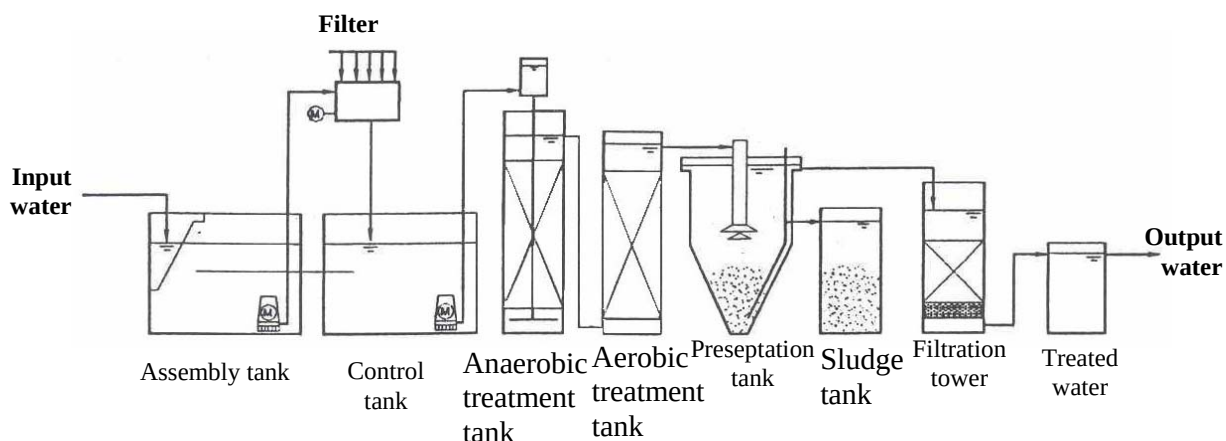


Figure (3.5) Effluent Treatment Plant

3.3.3 Filter cleaning

The filters used for filtering the final polycondensation melt are changed at regular intervals. The contaminated filters are cleaned for reuse. The cleaning principle depends on hydrolysis of the polymer. Superheated steam melts the polymer from filter candles at temperatures of 350-400°C. Hydrolysis results in splitting the polymer into terephthalic acid and ethylene glycol resulting in a liquid containing organic constituent. The resulting liquid effluent is directed to the ETP for treatment.

All filter parts are then washed with demineralized water. After several cleaning batches, the water is discharged into collection vessels then directed to ETP for treatment. The resulting solids from filter cleaning, about 10 kg/day (containing organic material), is collected and stored prior to disposal.

3.3.4 The HTM System/steam generation

The facility uses high and low pressure steam for filter cleaning and off gases stripping. The different steam requirements are generated through the heat exchange in the HTM heaters or from the wastewater evaporation unit.

The HTM System provides the different units in the facility with the necessary thermal energy by means of fluid heat transfer medium. HTM pumps are used to circulate the HTM (Therminol 66) in a closed system to the different heaters. Four heaters are available at the PET facility, one stand-by and three operating. HTM is maintained at a constant outlet temperature (320 - 330°C) by means of natural gas used as fuel in the heaters.

In order to balance out the increase in volume of the HTM as a result of high temperature, an expansion vessel is installed at the highest point of the system. A discharge tank is installed underground /aboveground to collect the drained HTM. The drained HTM is recycled in the system.

3.3.5 Catalyst Preparation

A series of catalysts and stabilizing materials are used in the polycondensation process including Antimony trioxide and cobalt acetate. The catalysts provided in powder form are fed into the catalyst preparation tank and mixed with MEG to form a catalyst solution. The solution is filtered and fed into a storage tank then sent to the paste preparation tank. The used catalyst filters, mainly consisting of Polypropylene or cotton, with traces of catalyst and MEG and is disposed off as hazardous waste.

3.3.6 Tank Farm

- **MEG storage Tanks**

The imported liquid MEG is pumped from the ship/tank from Ain Sokhna port by installing a suitable pipeline or unloaded from the tank trucks in case of tank lorry transportation at the tank farm to the MEG storage tanks at EIPET site. There are four tanks each of capacity of about 6000 m³. The stored MEG is pumped to the different processes in the polymerization plant as per the process demand. MEG is stored under atmospheric pressure. The tanks are located at eastern side of the facility. The construction material is stainless steel and include dyke wall for containment of any potential leakages.

- **The DEG storage Tank**

The facility uses liquid DEG as raw material. It is stored in a storage tank of capacity of about 200 m³ under atmospheric pressure. The construction material is stainless steel and includes dyke wall for containment of any potential leakages.

- **The SEG storage Tank**

Spent EG tank with 200 m³ capacity will be installed to take care of the spent EG coming from the process, which will be recycled back to the process.

- **The Diesel storage Tank**

A tank with 600 m³ capacity will be installed for the storage of diesel, which will be used as a fuel at power generating sets (for emergency use only).

3.3.7 Other Utilities

- **Buildings for Administration, Laboratories, Workshops**

Separate buildings will be provided around the site including administration, change rooms, maintenance, warehouse, chemical storage, process control and quality control laboratory. The buildings will conform to local regulations and requirements.

- **Fire Fighting System**

The fire fighting system consists of a water storage tank of 3000m³ capacity and three pumps for maintaining system pressure. Two pumps will be equipped with electric motor and one with diesel engine. Also three pumps will be available for handling foam system. In addition, a hydrant

fire fighting system will be installed within the facility at the MEG storage tanks.

- **Standby Diesel Generator**

The company will install a standby diesel generator as a 100% backup in case of total power failure.

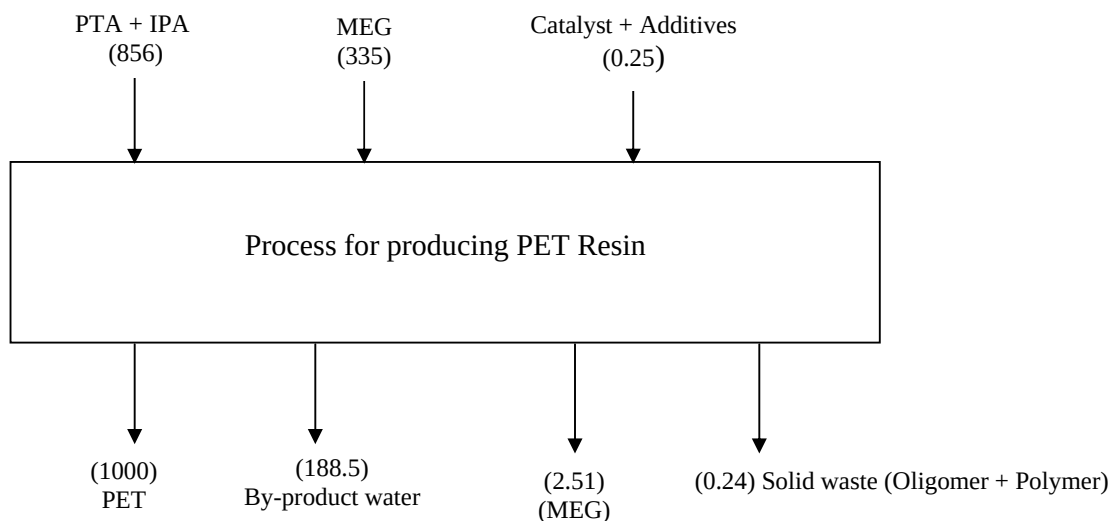
3.4 Input Materials

The facility uses several inputs including main raw material, catalysts, chemicals, water, electricity and fuel. All input materials are summarized in Table (3.1).

Table (3.1) Facility Inputs

Input	Annual Consumption (t/yr)	Usage and source	
Main Inputs			
PTA @0.856	449,400	Continuous polymerization	Imported from abroad
MEG @0.335	175,875	Continuous polymerization	
IPA @2% of PTA	8988	Continuous polymerization	
DEG @1.5% of MEG	2638	Continuous polymerization	
Antimony trioxide@ 189 ppm of PTA	85	Continuous polymerization	
Nitrogen, Nm ³ /day	16,500 (688 / hr)	For blanketing to ensure oxygen free environment and prevent color formation	Plant will be installed for air separation
Utilities			
Water	1100 m ³ /day	Used for cooling. Provided from the public water system	
Electricity	10 MW	Used for driving electrical equipment and is Provided by the National Grid	
Natural Gas	6000 m ³ /hr	Used as fuel in the HTM heaters and is provided by the national gas Network	
Chemicals			
Chemicals for Water treatment/resin regeneration	HCl - 45 NaOH - 90	Supplied from the local market	

Annex (1) presents the MSDS for the used raw materials as well as the PET product.

MATERIALS BALANCE FOR 1000 kg PRODUCT AT EIPET PLANT

Input Material (kg)		Output Material (kg)	
PTA + IPA	856	PET Resin	1000
MEG	335	Byproduct water	188.5
Catalyst + Additives	0.25	MEG	2.51
		Solid waste	0.24
Total	1190.25	Total	1190.25

Figure (3.6): Input and Output

3.5 Outputs, Wastes and Emissions

This section presents the facility outputs (products and by-products) and the generated wastes and emissions.

3.5.1 Outputs (Products and by-products products)

The PET plant produces bottle grade PET resin. The design capacity of the facility is 525,000 TPA. Table (3.2) presents all product types and their production rates.

Table (3.2) Products and By-products of PET plant

Product/ By-product	Estimated Maximum Annual Production TPA	Notes
PET dust – off spec polymer	500	By-product
Crystallized PET pellets (Product)	525000	Final product

3.5.2 Wastes and Emissions

This section addresses the different emissions and wastes generated during operation activities taking into account normal operation.

- **Air Emissions**
1- Point Source emissions

These are released from two sources inside the facility, namely the HTM stacks. As previously mentioned in the above section, the facility uses Natural Gas as fuel in all the HTM heaters. In addition, the organic off gases from stripper are also burned with NG in the HTM heaters. These will be broken to carbon dioxide and water vapour. Therefore, exhaust gases from stacks are expected to be minimally polluted.

The expected parameters in the stacks' emissions include CO, NO_x as a result of burning NG and off gases. Emission characteristics from the process heaters are given in Table (3.3) below.

Table (3.3) Specifications of emissions from point sources

Source	Pollution Parameters (mg/m ³)	
HTM heaters	CO	80
	NO _x	200
	SO ₂	<1
	PM ₁₀	10

To ensure compliance with allowable limits of Law 4/1994, exhaust gas quality will be periodically monitored as well as to combustion efficiency as described in details in the following chapter 7.

2- Fugitive Emissions

The different processes take place in a completely closed system. All process reactors, tanks and piping system material handling activities are sealed and controlled. Thus, fugitive emissions are not expected to be generated from the processes.

However, all production reactors, pipelines and material handling systems are periodically maintained and monitored to ensure that no fugitive emissions are generated. The monitoring and maintenance plans will be presented and discussed in detail in chapter 7.

- **Wastewater and Liquid Wastes**

1- Domestic Wastewater

During operation, the expected domestic wastewater is about 24 m³/day. The generated domestic wastewater will be directed to the ETP plant.

2- Industrial Wastewater

Two types of industrial wastewater are generated from the facility. These involve the following:

a) Process wastewater

Process wastewater containing organic constituents is generated from the polycondensation plant, with a total flow rate of about 365 m³/day, as a result of the following streams:

- Process water from polycondensation plant 300 m³/day.
- Process filter cleaning 20 m³/day
- Stripping 45 m³/day

b) Wastewater from utilities

Utilities generating wastewater including relatively high concentration of TDS:

- Cooling tower blow down 314 m³/day
- Backwash effluent from DM system 10 m³/day
- RO unit 50 m³/day
- Boiler blow down 5 m³/day

The process water and filter cleaning water will be treated in the ETP. Other wastewater streams from utilities are collected in a non-contaminated effluent collection tank. Both streams will be further treated in the MBR unit to be used as make-up for the cooling tower. The reject from the MBR will be used for greenery within the industrial zone.

Specifications	Specifications before treatment	Specifications after treatment (mg/ l)
pH	3-5	6-9
Temperature	45	35
BOD	3000 (mg/ l)	<30(mg/ l)
COD	18000 (mg/ l)	<100(mg/ l)

- **Workplace Pollutants**

Chemical and Physical pollutants are potentially to impact the workplace environment, as described in the following section:

1- Air Emissions

Particulates are potentially generated from the following sources:

- Catalyst preparation
- PTA/IPA charging system
- PET Product packaging
- Filter cleaning system

Accordingly, handling and storage of chemicals and product will be carried out according to the instructions provided in their MSDS (Material Safety Data Sheet) and the relevant chemical management sections of the Labour Law 12/2003 and Law 4/1994.

2- Noise

Noise during operation potentially results from a number of sources including, air blowers in the SSP unit and cutters and air compressors in the CP unit.

3- Heat Stress

Sources of heat stress include:

- Polycondensation and SSP Reactors
- HTM heaters

Measures for management of workplace environment will be discussed in chapter 7, the environmental management plan (EMP) of the facility, including outline for the health and safety procedures. The management measures implemented will be in accordance to the requirements for workplace protection of the national labour law 12/2003 as well as the IFC EHS guidelines (IFC Environmental, Health, and Safety General Guidelines, and Environmental, Health, and Safety Guidelines Petroleum-Based Polymers Manufacturing,).

- **Solid and Hazardous Waste**

1- Hazardous Wastes

Hazardous waste is identified according to the hazardous waste list issued by the Ministry of Industry. These include:

- Spent catalyst containing platinum used in SSP reactors
- Used machinery oils

2- Non-Hazardous Waste

The main types of non-hazardous solid wastes generated from the facility involve the following:

- Off-spec product
- Packaging bags
- Empty raw material bags
- Domestic wastes (food, glass, plastics, cardboard, etc.).

The facility's management plans regarding handling and disposal of all hazardous and non-hazardous wastes is described in Chapter (7) of the current ESIA report.

3.6 Construction Activities

3.6.1 Description of Main Activities and Construction Schedule

The construction phase comprises 2 stages, the first includes the planning and design and the other is the actual construction activities. Following are descriptions of the different activities to be carried out in both stages:

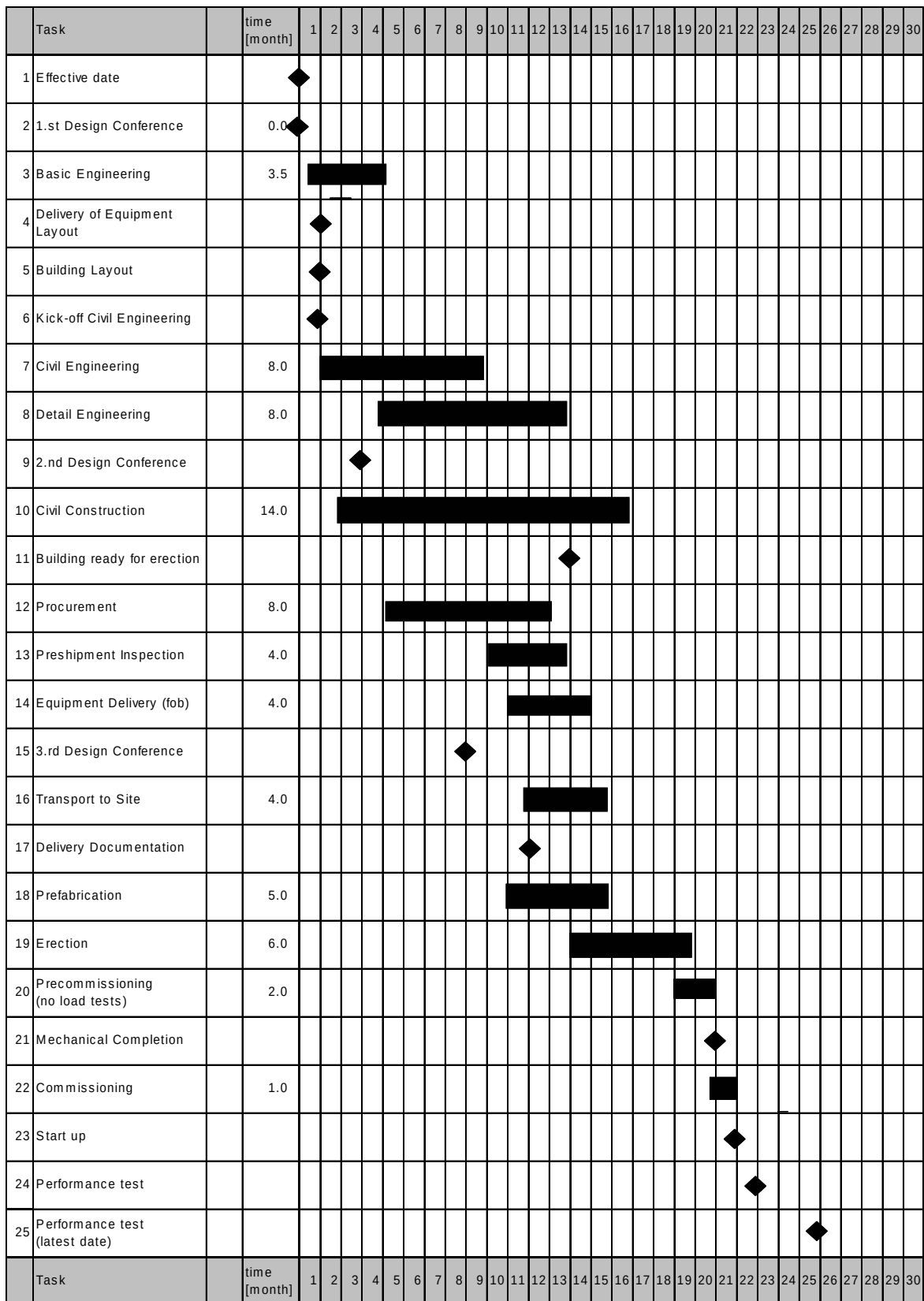
Design and Planning Stage:

The following activities would take place:

- Site leveling
- Performing piling works
- Performing civil works
- Structural Steel erection
- Utilities equipment and tanks erection
- Pipe work erection
- Electrical and Instrumentation works
- Mechanical works
- Pre-commissioning
- Commissioning

Table (3.4) below provides details of the execution time schedule

Table (3.4): Execution Time Schedule



3.6.2 Sources of Construction Material

The majority of construction materials to be preferably provided from the local market in Suez and Sokhna area.

3.6.3 Construction Equipment

The major construction equipment includes:

- Cranes of various capacities
- Trucks
- Bulldozers
- Forklifts
- Dumpers
- Trailers
- Scaffolding material
- Welding, grinding and cutting machines
- Concrete vibrators
- Concrete mixers
- Rigging tools and tackles

The number of above construction equipment at specific times used will depend on the contractor and project progress.

3.6.4 Construction emissions and wastes

The construction operations may generate gaseous emissions, liquid effluents, noise and solid waste. However, it is expected that the construction phase will have minimal impacts on the surrounding environment, due to the relatively short construction period and distance from any sensitive areas. Following are the potential impacts from the construction activities.

- **Noise**
The predominant noise generation during construction will be as a result of the use of heavy equipment, piling activities, grinding and cutting machines and vehicle movement.
- **Air Emissions**
Air emissions during construction phase include smoke, fumes, exhaust gases and dust resulting from site clearance, excavations and filling and transportation of construction materials.
- **Wastewater**
This includes wastewater containing suspended and dissolved solids from workshops, sewage from construction site etc.
- **Solid Waste**
Consist mainly of non-hazardous solid waste, they will include the following:
 - Packaging and wood scrap waste
 - Unused construction materials, off-cuts from piping and cabling bulks;

- Civil wastes such as sand, cement, brick, aggregates, steel parts, aluminum, etc.
- Municipal solid and liquid waste from construction camp

Chapter 6 below addresses the potential impacts from the construction activities and their mitigation measures. Moreover, Chapter 7, the environmental management plan, addresses the measures to be implemented for proper management of the different aspects of the construction phase.

3.7 Number and Source of Labour and Accommodation

According to the company employment policy, priority for selection of workers will be given to the surrounding local workforce with a percentage of foreign experts not exceeding 10 %. In order to ensure the implementation of its policy, the company will encourage through its contracts with the implementing contractors the use of local labor from Ain Sokhna and Suez areas. Skilled workers will be mostly from all around Egypt. However, in the case of similar qualifications, preference will be given to Suez governorate residents. Very few skilled workers will be from outside Egypt. Moreover, the project will provide work opportunities for the local community in the neighborhood, where qualified local community will be trained and hired as workers.

Number of labor

During construction: The labour force required for the project construction will be in the average of 1000 skilled and unskilled persons, might increase to 2000 at peak of construction phase for a period of 2 years.

During operation: about 450 workers direct employment including technical staff and operators to work at the different operation stages as well as the administrative staff. Accommodation for skilled labour from outside Egypt will be in Sokhna, Suez and Cairo.

4. Description of the Environment

4.1 Physical Environment

4.1.1 Geographic location

The site of the Egyptian Indian PET is located within the industrial area of “El-Dorado” at the entrance of Sokhna city. The site is almost rectangular in shape with dimensions approximately 300 x 470 m. The proposed site has the following coordinates: E 32° 18' 19" to 32° 18' 25.1", North 29° 39' 38.37" to 29° 39' 54.6", the location of the site is presented in Figure 4-1.

Surroundings of the site are as follows:

- North: 470m bordered by the plot of land allocated to the Egyptian Chinese joint Venture Company.
- South: Cleopatra ceramic company chemical Store and carpentry workshop away from EIPET border about 40 meter.
- East: Under construction temporary dwelling for the third shift's workers away from EIPET border about 200 meter and then Suez – Sokhna highway.
- West: 300m bordered by a vacant plot of land owned by Ceramica Cleopatra Group.

The closest sensitive receptor to the project site includes a workers' dwellings approximately 200m northeast of the site. Sokhna Port is located in the far eastern part of the site.

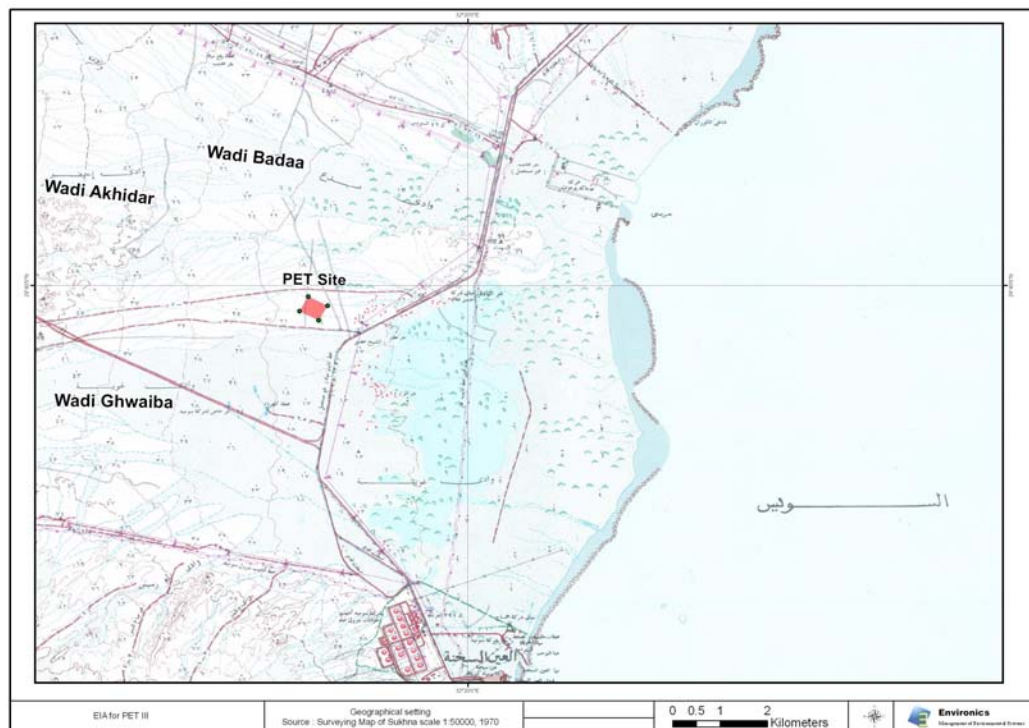


Figure 4-1: Location of the proposed site of EIPET

4.1.2 Metrological data:

Climate

The climate in Sokhna is generally characterized by warm and dry weather during most of the year. This section provides information pertaining to wind speed and direction, maximum and minimum air temperature, rainfall and relative humidity. The source of the data presented herein is the Suez meteorological monitoring station No.450, which is the closest station to the industrial zone, located at N 29° 25' and E 32° 28', approximately 31 km from the site.

The climatic data presented herein was extracted from the "Climatic Atlas of Egypt", issued by the Egyptian Meteorological Authority (EMA, 1996). The climatic data is an average of 30 years (1968-1996) covering a complete climatic cycle which includes successive wet and drought periods. It should be mentioned that the latest available Climatic Atlas was prepared in 1996.

a. Wind

Wind data was extracted from the "Climatic Atlas of Egypt, issued by the Egyptian Meteorological Authority (EMA, 1996). Monthly wind roses were extracted from the Atlas and are provided in Figure 4-, hereafter.

The wind roses indicate that the prevailing wind direction is North and Northwestern almost throughout the year.

The prevailing wind direction is North and Northwestern during most of the year.

Hot dust-laden wind often blows, especially during the months of April and May (Khamasin winds). These winds are of south-east direction and cause an increase in temperature. Visibility during these storms is substantially reduced.

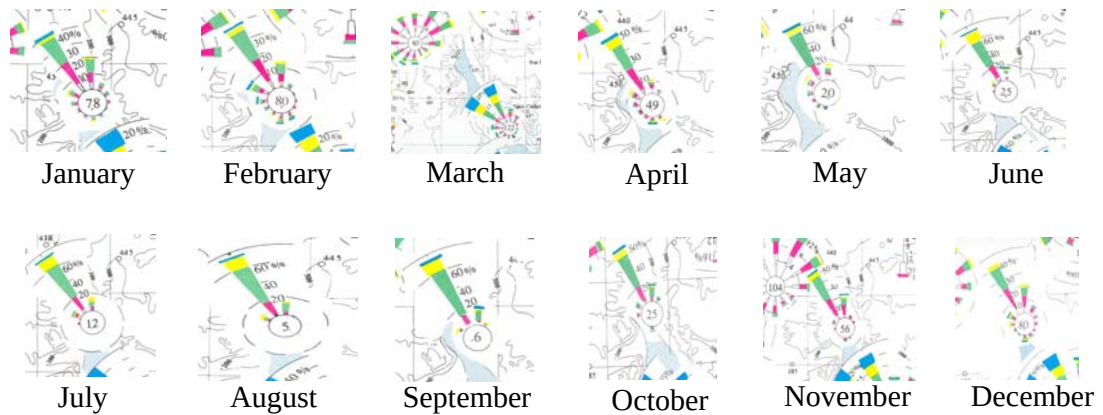


Figure 4-2: Monthly Wind Roses of the Project Area

b. Temperature

The highest maximum air temperatures occur during the month of July, while the lowest minimum temperatures take place in February, as shown in Table

Table 4-1: Maximum and Minimum Monthly Air Temperatures

Air Temperature	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Maximum (°C)	20	21	24	28	32	35	36	36	33	32	26	21
Average Minimum (°C)	9	10	12	15	18	21	22	23	21	19	15	11

Source: <http://www.weatherbase.com>

Latitude: 30°20'N, Longitude: 32°16'E, Elevation: 21.3 m, Distance: 20.52 km

	Unit	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average temperature over 11 years	°C	22	14	15	17	21	25	27	29	29	27	25	20	16
Average high temperature over 11 years	°C	28	20	21	23	28	32	35	36	36	33	31	26	21
Average low temperature over 11 years	°C	16	9	10	12	15	18	21	22	23	21	19	15	11
Highest recorded temperature over 11 years	°C	43	26	30	37	42	43	42	42	41	40	38	33	27
Lowest recorded temperature over 11 years	°C	3	3	5	7	8	12	16	20	20	16	13	7	3
Average number of rainy days over 11 years	days	2.7	0.4	0.4	0.3	0.4	-	0.1	-	-	-	0.3	0.5	0.3
Average number of days above 27°C over 11 years	days	153.4	-	-	1	5.5	16.5	27.3	30.7	31	25.3	14	2.1	-
Average precipitation over 11 years	cm	1.8	0.3	0.3	0.3	0.3	-	-	-	-	-	0.3	0.5	0.3
Average relative humidity over 7 years	%	43	73	55	49	30	19	20	24	26	33	39	64	81
Average dew point over 12 years	°C	6	9	5	5	1	-2	0	4	5	7	8	12	12

Source: <http://www.weatherreports.com/Egypt/El-suez/>

c. Rainfall

Rain in Sokhna is both localized and episodic, and may often result in flashfloods. As shown in Table 4-2, maximum rainfall occurs in the months of January through March, followed by the months of April, November and December. The weather is mostly dry throughout the rest of the year.

Table 4-2: Mean Rainfall/month (mm/month) in the Sokhna Area

Rainfall	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(mm/month)	5	2	3	1	1	0	0	0	0	2	1	2

d. Relative Humidity

Relative humidity reaches its maximum value in December, while the minimum value takes place in April and May.

Table 4-3: Average Relative Humidity (%)

Parameter	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Relative Humidity (%)	55	53	49	44	44	51	49	51	53	53	53	56

Air Quality and Noise Levels

Baseline air quality and noise measurements were carried out on Monday April, 12th 2010 at a number of locations within and surrounding the proposed project site. This section provides a description of the measurement locations as well as the acquired results.

Air Quality

Air quality measurements were carried out at the proposed site and the neighbouring sensitive receptors. Most land use activities surrounding the site within “El Dorado” industrial zone are empty plots not yet designated for certain activities. In this respect it was decided that the ambient air quality measurements to be taken throughout a typical weekday would be representative of the ambient air quality of the area. The measurements were taken over time intervals to represent the whole working day. Two air quality measurement locations were identified for the purpose of this project. During such measurement CO, NO₂, SO₂, PM₁₀ levels were measured within and surrounding the site.

Ambient air concentrations of SO₂ CO were measured using 205A Series Miran Sapphire portable air analyzer. CENTURY OVA 108. A dust meter type Personal/DATARAM was used to detect PM₁₀. NO₂ was measured using Nitrogen Dioxide Analyzer, Model ML 8840– Monitor Lab. Inc. USA. (EPA reference method RFNA 0280-042)

The locations presented in are as follows:

- Location (1): this location within the proposed project plot is selected to represent the actual current air quality situation within the site.
 - Location (2): This location is selected near to the near sensitive receptors.
- The following table provides the average of readings measured at all the locations.

Table 4-4: Results of Air Quality Monitoring

Location No.	GPS Position	PM ₁₀ µg m ⁻³	CO µg m ⁻³	SO ₂ µg m ⁻³	NO ₂ µg m ⁻³	Compliance status
1	Inside PET Site	45	350	60	33	Complying-
2	In front El Wadi Resort	85	800	70	43	Complying-
Law 4/1994 maximum limits - µg/m ³		No limits for one hour*	30000 (one hour)	350 (one hour)	400 (one hour)	
IFC maximum limits - µg/m ³		No limits for one hour	No limits for one hour	No limits for one hour	200 (one hour)	

PM10 measurements were compared to Egyptian limits for 24 hour limits (150 µg/m³) since there are no limits for one hour measurements³. PM10 levels were found well below the limits, at all locations.

Measurements for the different parameters were found below national and international limits..

Ambient Noise

Noise measurement were carried out at the two locations of air quality measurements, which represented the major sources of noise and main receptors, inside the work place and in the surrounding ambient area. Type 1 SOLO sound level meter, which complies with the international standard (IEC 61672-1) was used. Measurements were carried out, for sufficient intervals to provide meaningful averages, during three periods; daytime (7 am to 6 pm), evening (6 pm to 10 pm).

The noise level measurement results carried out in the two measurement events are provided in

Table 4-.

Table 4-5: Noise Measurements

Location	Measured Noise Level (dB)	Law 4/94 ^{2,3,4, 22, 33, 44}	IFC Guidelines
Day time			
1	45	Comply	Comply
2	67		
Evening time			
1-	48	Comply	Comply
2	55		

- IFC limits for Residential; institutional; educational: (55 dB at day time 7 am-22pm and 45dB at nighttime 22pm-7am) - Industrial Zones: 70 dB (during daytime and nighttime)

³ 1 hour limits are generally higher than 24 hour limits, in the absence on 1 hour limits, the readings were compared to 24 hour limits, which are more conservative, and were found complying.

From the above table it could be concluded that the background noise measurements carried out at all locations, in both measurement events, indicate that the study area is a quiet environment with little disturbance. Highly intrusive noise, such as aircrafts, trains, etc... was generally not experienced during the field measurements.

4.1.3 Geology, Structural geology, Geomorphology:

A. Geology:

i. *Lithology and soil:*

General:

The exposed lithological units of Al-Sokhna area are mainly of sedimentary origin and belong age-wise to the Paleozoic-Mesozoic-Tertiary with local outcrops of Quaternary represented mainly by Wadi deposits. The Paleozoic outcrops are represented by Permian, whereas the Mesozoic are represented by Jurassic and lower to upper cretaceous rocks. Tertiary section is composed of deposits having a long time period extending throughout the Geologic time units of the Eocene, Oligocene, Miocene, Pliocene (Sadic 1959, Said 1962, Conoco Coral 1987). The following is a brief description of the composite stratigraphic column of Al-Sokhna area and its vicinity:

- 1- **Permian Rocks** cover the low-lying expanse of foothills extending along the eastern escarpment of El Galala El Bahariya. These rocks consist of alternating beds of dark colored sandstone, siltstone and shale with subordinate limestone.
- 2- **Jurassic Rocks** are of limited stretch and are exposed only at Gebel Khashm El Galala, which is located at the extreme northeastern end of El-Galala El-Bahariya. The Jurassic sequence is differentiated into cross bedded sandstone at the bottom overlain by fossiliferous marls and dolomite bands. The upper part of this sequence consists of siltstone and sandstone intercalations⁴.
- 3- **Cretaceous Rocks** cropping out along the eastern and southern scarp faces of Gebel Ataqa massif, and the eastern cliff of El-Galala El Bahariya as well as the escarpment of Khashm El Galala. These rocks are distinguished into lower and upper Cretaceous. At the base is a sequence of well-bedded green shales and marls with inter-bedded sandstone. The upper part composed of grayish white limestone and marl capped with thick massive dolomite and dolomite limestone.

⁴ The intrusion of a bed or layer between other layers; interbed

- 4- **Lower and Middle Eocene Rocks** are composed predominantly of a sequence of thick-bedded limestone with subordinate marl (calcium carbonate or lime-rich mud or mudstone) and local chert (fine-grained silica-rich crypto-crystalline sedimentary rock that may contain small fossils). They built up the surface cap and topmost part of cliffs of the topographic highs (El Galala El Bahariya, Ataqa, El Qatamiya, Kahaliya, Akheidar, Mokattam and Iweibid).
- 5- **Upper Eocene Rocks** cropping out mostly in the lowlands between highlands, where they are downthrown against the middle Eocene limestone beds. Also, they form the bulk of some blocks (Gebels Nasuri and Anqabiya). The upper Eocene deposits composed of shale and limestone with occasional sandstone beds.
- 6- **Oligocene Rocks** are represented by the highly-colored loose sands and gravels, more or less cemented. The Oligocene sands and gravels form dark colored low hills, covered by large gravels left behind after the deflation of the fine sands. In Ataqa-El Galala El Bahariya depression, the Oligocene sands and gravels cover small patches, which overlies uncomfortably the upper Eocene beds.
- 7- **Miocene Rocks** are mainly represented in the Ataqa-El Galala El Bahariya depression by marls and sandy limestones. This outcrop follows faults, that border the eastern side of Gebel Ataqa massif, and covers large areas in Wadi Hagul and Wadi Bedaa. They composed of grits, gravels and sands.
- 8- **Pliocene Rocks** are of limited extent and are restricted to the Ataqa-El Galala El Bahariya depression. They have a patchy distribution and made up of gravels and sands.
- 9- **Quaternary Deposits** are the youngest beds in the area, and represented by terraces of pebbles and gravels, Wadi deposits and fan-glomerates.

Lithology at the project location:

The main outcropping rock unit at the project site is represented by Undifferentiated Quaternary deposits of gravel and sands. The Quaternary Alluvium wadi deposits lie at the northwest and south eastern parts of the project site. The Undifferentiated Pliocene sediments, exposed at the eastern parts of the project site, consisting of limestone and shale. Figure shows the exposed rock units at the project site.

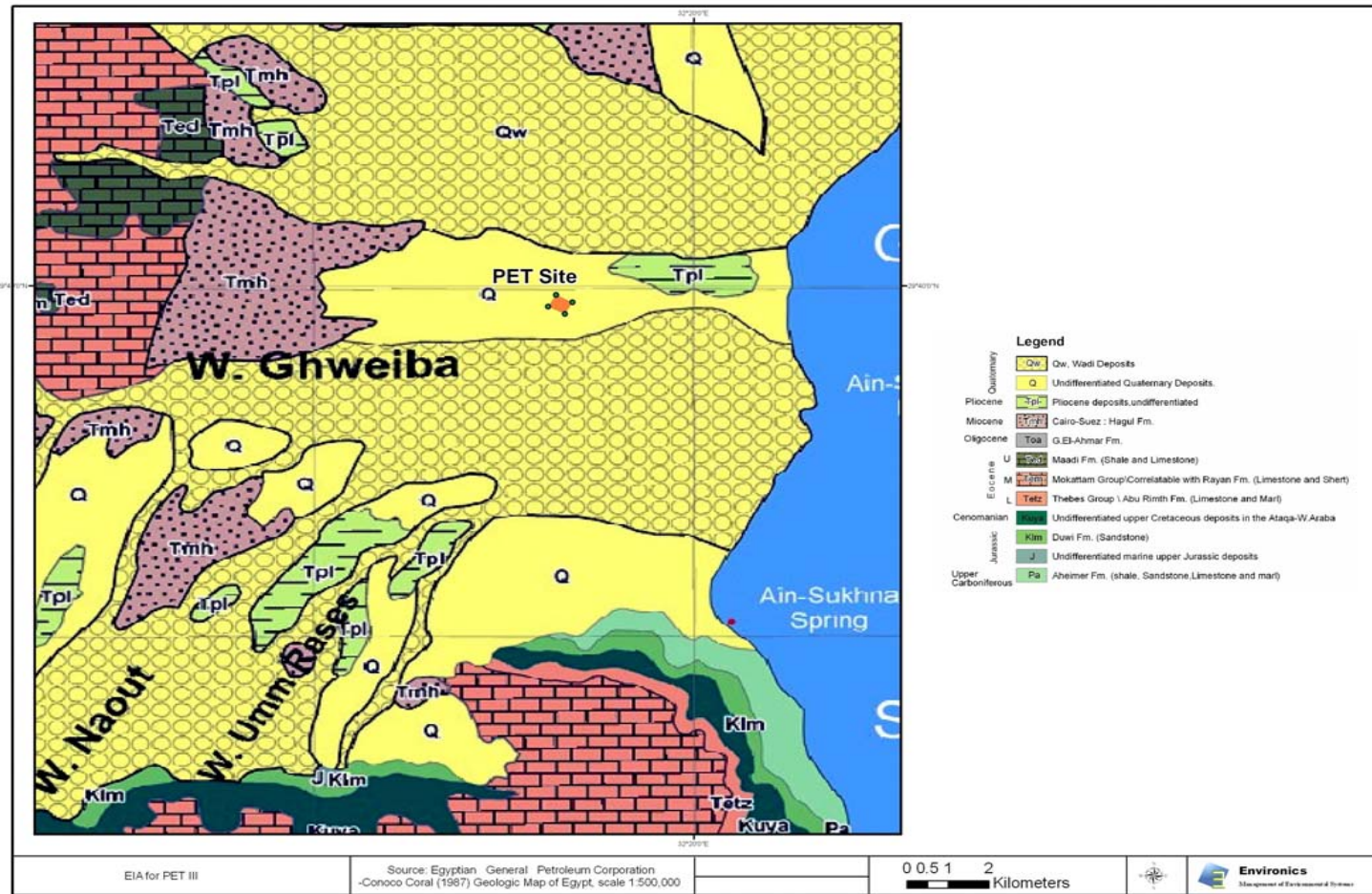


Figure 4-3: Geological Map of Ain Sokhna Area (after Conoco Coral 1987) showing the project site

Soils at the project location:

The main type of soil units exposed at the project site is represented by gravelly and gravelly sand soils (sometimes with rock outcrops).

Figure 4-4 shows soil associations at the project site.

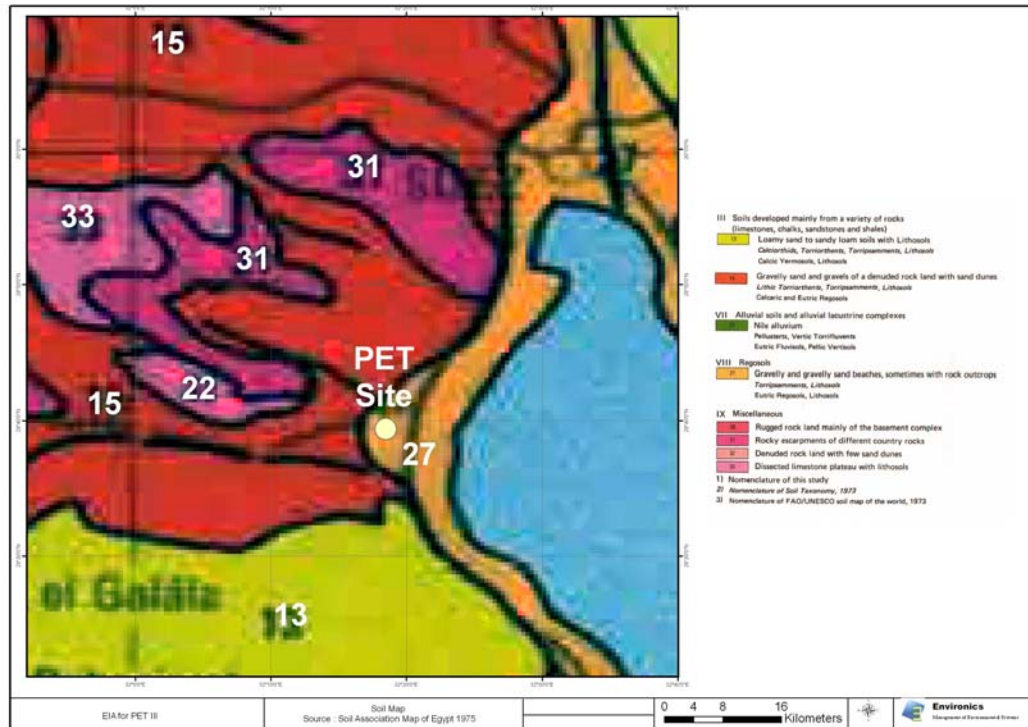


Figure 4-4: Soil association at the project site

ii. Topography: General

The Sokhna area is a structurally controlled area with horsts and depressions (grabbens). Variations in elevations are noticeable in a number of areas on the horst structures. Highest elevations occur within southern parts where the escarpment of El-Galala El-Bahariya lies. The maximum elevation in the area (1272 meters) lies at the extreme southeastern corner of El-Galala El-Bahariya, and there are many other peaks with elevations ranging from 1000 and 1270 meter.

Proposed Project Location:

The site lies in an approximately flat, low lying area with an approximate elevation low than 20m above mean sea level (MSL). **Figure 4-5** represents the topographic map at the proposed project location.

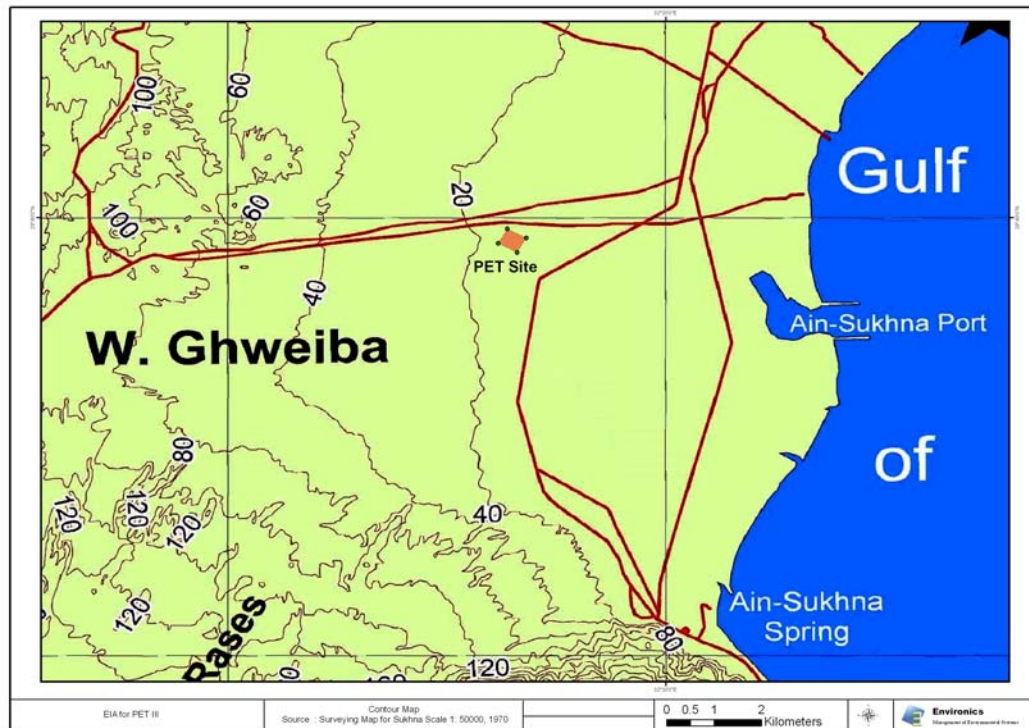


Figure 4-5: Contour map of Ain Sokhna, showing the location of the proposed facility

B. Structural Setting

General

The structural features in Ain Sokhna area are represented by faulting and folding:

- 1- **Faulting.** Two sets of faults are well recognized trending in a NW-SE and E-W orientation. A third set of minor importance has a NE-SW orientation. Faults of the northwest set are the longest and have the largest amounts of throw compared to those of the other two sets. Faults of E-W orientations form the northern and southern margins of both negative and positive blocks. The east-northeast transverse faults are basically more pronounced in the vicinity of the Gulf of Suez and die out westward.

The west-northwest faults divide the Gebel Huf-Gebel Ataq plateau into transverse blocks. These positive blocks are separated by Wadi Degla-Wadi Garaba and Wadi Hagul NW structural lows. The structural pattern of Wadi Ghweiba is a graben, bounded by well-defined transverse faults forming an E-W longitudinal topographic depression (Abdel-Rahman and El-Etr 1979, Abd-Alla 1988).

- 2- **Folding.** Syrian arc folding systems strongly affects Al-Sokhna area. It is represented by structural highs of Gebel Ataqa and Gebel Akheidar anticlines.

Project Site

Because of the damping (weak) effect of the unconsolidated sediments of alluvial fans and the coastal plain sediments, the effect of these deep structures (faults) on the proposed facility is virtually insignificant.

C. Geomorphology

General:

Sokhna area is a structurally controlled area that is divided into three major provincial geomorphologic units; the **Plateaus**, **Depressions** and the **Coastal Plain**.

The main **Plateau** areas within Sokhna province are El-Galala El-Bahariya, El Qatamiya-Gebel Ataqa plateau, El Qatamiya-Gebel Ataqa plateau consists of a series of alternating smaller graben and horst structures, which are mainly controlled by northwest to north-northwest oriented faults, that divide the plateau into three subunits; El Qatamiya-Gebel Akheider, Gebel Kahaliya-Gebel Umm Zeita, and Gebel Ataqa.

Depressions are represented by grabens between the faulted blocks; Wadi Ghweiba, Wadi Gharaba, Wadi Bada, and Wadi Hagul are the main structural depressions. The ridges of Gebel Kahaliya-Gebel Umm Zeita ridge, and Gebel El Nuqra-Gebel Akheider divide the graben structure bounded between them into three main Wadis, namely; Wadi Hagul, Wadi Badaa and Wadi Ghweiba (from north to south).

The Coastal plain is limited and very narrow due to the vicinity of the structural platforms to the shoreline of the Gulf. The scarps bordering the eastern sides of the plateaus terminate abruptly against the Gulf leaving a very narrow coastal plain. The coastal plain is covered with fine sediments and gravel. Some parts are covered by sediments of Sabkha.

Proposed Project Location:

The project site lies within the major provincial unit of depressions. The alluvial flood plain of Wadi Ghweiba with its well-developed alluvial fan that debouches into the Gulf of Suez lies at the southeastern part of the project site.

Wadi Ghweiba and the wider project area are affected by the provincial geomorphologic characteristics of Sokhna area, where the Wadi is surrounded by the high plateaus of El-Galala El-Bahariya from south, G.Akheidar from North West, and Gabal Kahaliya-Umm Zeita-Attaqa stretch from north, which flood into that basin, it is therefore considered the main basin in the area. This basin is formed of seven large sub-basins. Southern sub-basins are carved into the middle Eocene limestone of El-Galala El-Bahariya plateau, and their main streams follow the southeast-northwest direction. These sub-basins are very large in area and

elongated in shape. Their tributaries are long, narrow, highly meandering and ranked as high-order wadis.

Wadi Ghweiba depression measures about 40 km from north to south and 50 km in an E-W direction. It rises gradually westward until it merges into the great plateau of Eocene limestone. The total area of Wadi Ghweiba is 2950 km² and perimeter reaches 243.5 km. The geo-morphological unit of the alluvial fan at Wadi Ghweiba generally has a conical surface and form a plain at the coastal area, the middle of that fan is covered with sand with well-rounded limestone fragments and gravels.

Wadi Ghweiba forms a plain at the coastal area where margins of this plain are covered by ill sorted alluvial deposits of very fine sediments. The heterogeneity of the composition of W. Ghweiba alluvial fan leads to the development of braided channels.

4.1.4 Geologic risks

4.1.4.1 Earthquakes

General

The Gulf of Suez is controlled by rift structure extending northwest into the African plate from the junction of the Red Sea rift and the Levant transform fault (Robson, 1971). Suez rift is a tectonically active structure that is considered to be a sub-plate formed as relict of the early opening of the Red Sea. **Figure 4-8** shows the distribution of earthquakes' activity trends (Kebeasy, 1990). Seismic activities along Gulf of Suez are low and occur mainly as small events. The largest earthquake of 5.3 on the Richter scale⁵, which was considered of medium scale, occurred in June 12th, 1983. Seismic activity in the Gulf of Suez is scattered and does not have any distinct trend, but there are three active zones; at the entrance of the Gulf (triple junction between Africa, Arabia and Sinai), at the central and northern parts. The activity decreases from south to north.

The Proposed Project Location

The proposed project location lies within the northern Red Sea-Gulf of Suez-Cairo-Alexandria-Clysmic trend, where the nearest earthquake epicenter to the project area lies at Wadi Hagul which represents seismically active area with small number of local micro-earthquakes. An earthquake occurred in March 1984 in Wadi Hagul with a magnitude of 4.7. Seismic activities in this area are very local with estimated focal depth of about 10 km (Kebeasy, 1990). The project site lies southeast of Wadi Hagul epicenter where seismic activities are mainly attributed to active faulting of the Wadi and the Red Sea rifting.

⁵ Used for classification of earthquake magnitude, with value "1" being the lowest and "9" the highest

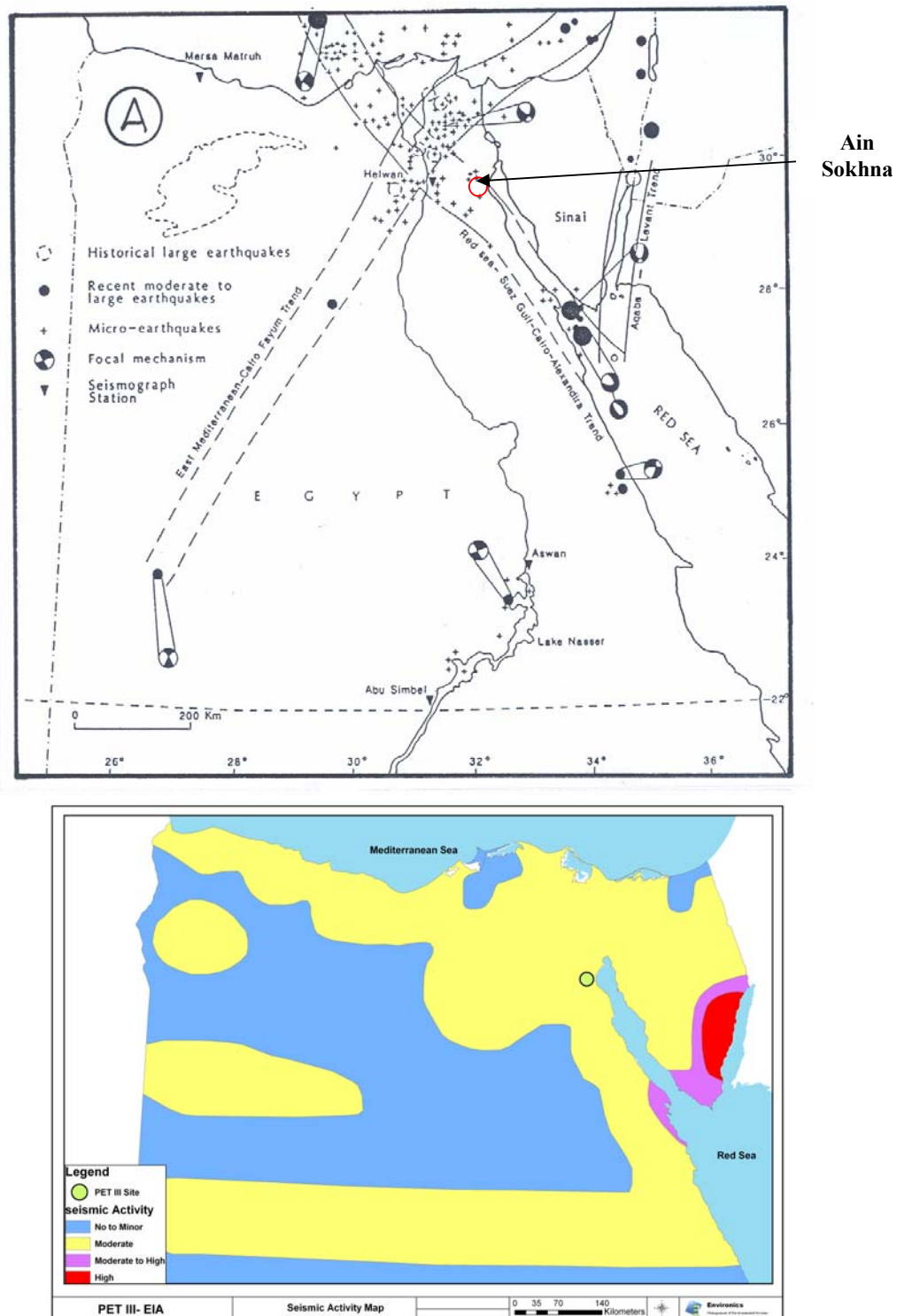


Figure 4-6: Epicentral distribution of all earthquakes, focal mechanism of principal earthquakes and active seismic trend (A) and enlarged map showing the distribution of the microearthquakes (+), Helwan Seismograph Station (▼) and Sokhna area.

4.1.4.2 Drainage Network

General

The general drainage pattern in El-Sokhna area is controlled by a number of flood basins that are from north to south Wadi Hagul, Wadi Bada, and Wadi Ghweiba.

Wadi Bada is a circular basin, which lies to the north of Wadi Ghweiba and debouches into the Gulf of Suez mega basin (El-Shazly et al., 1991). It is an elongated basin trending northwest. It has a large area (625 km²) and wide main trunk with tributaries following the northwest trend, whereas, they follow the east-west trend in its middle part. Streams order for Bada basin has a fifth stream order (medium ranking order).

Wadi Ghweiba a large, elongated basin lying south of Wadi Bada, and has a total area of 2950 km² and a perimeter reaching 243.501 km (Horton 1945). This basin is formed of seven large sub-basins. The southern sub-basins are carved in the middle Eocene limestone of El-Galala El-Bahriya plateau surface and their main streams follow the southeast-northwest direction. These sub-basins are very large in area and elongated in shape. Their tributaries are long, narrow, highly meandering and rank as high-order wadis. The northern sub-basins are also carving in middle Eocene limestone of G. Akheider and G. Abu Treifiya. They cover small areas and have low-order wadis.

Wadi Ghweiba outlet is affected by major east-west structures forming the low topography in which the main channel of the main trunk follows. The northeastern part of Wadi Ghweiba fan shows the main numbers of the braded channels and grading in slope westwards from 43 m to 7 m. The southeastern part shows few numbers of the braded channels and grading in slope westwards from 74 m to 9 m.

The Proposed Project Location

The proposed project is located at the extreme northeastern part of Wadi Ghweiba alluvial fan, at the northern sub-basins.

The heterogeneity of the composition of W. Ghweiba alluvial fan leads to the development of braided water channels which cut their way eastwards to the Gulf via the Ain Sokhna Port area.

According to the studies prepared by the Ministry of Water Resources, 1998 and 1999, for protection of the northern and southern economic zones west of Gulf of Suez from flash flood hazards. Retardation structures (dykes) have been constructed across the narrow parts of the trunks of Wadi Ghweiba **Figure 4-7**. These dykes are distributed well in the area and are of good design. They are composed of cobbles of chert nodules and siliceous limestone fragments filling plastic gabions. Some of the dykes are aligned in series of two or more to support one another (**Figure 4-8 & Figure 4-9**).

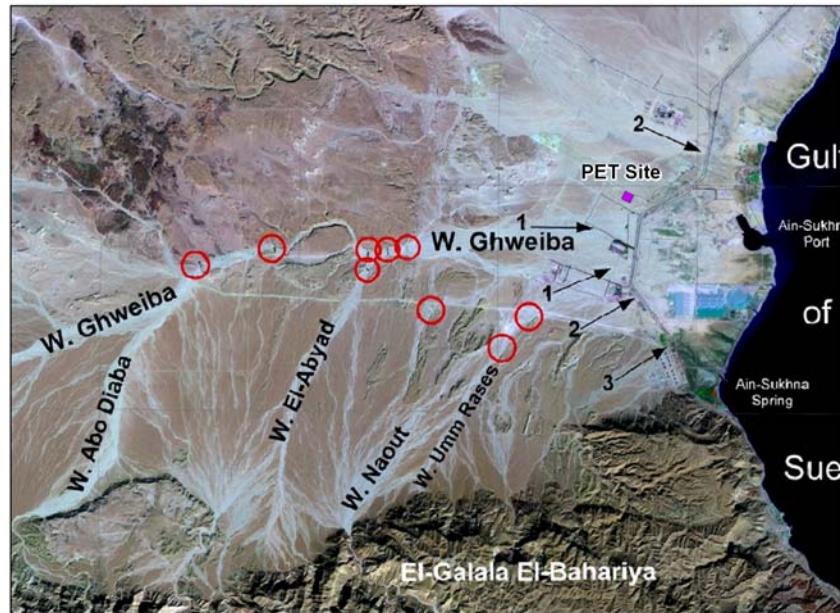


Figure 4-7: Risk assessment in enhanced TM + image showing location of the proposed EIPET facility and the flood risks (1= high vulnerable, 2=moderately vulnerable and 3= low vulnerable)
Vulnerability of flash floods and distribution of the constructed retardation dykes



Figure 4-8: Two successive retardation dykes supporting one another, constructed at the narrow trunk of Wadi Ghweiba for flashflood protection



Figure 4-9: Structure of retardation dyke, composed of stone-contained gabions

Accordingly, it is expected that the site is protected from flash flood impact from Wadi Ghweiba, which is the main contributing basin.

4.1.5 Ground Water Resources

General

Groundwater studies identified five main aquifers (water bearing formations) in El-Sokhna area namely; the Plio-Pleistocene, the Miocene, the Oligocene, the Eocene and Nubian aquifers of lower Cretaceous (Diab, 1984). However these aquifers are of variable degrees of importance depending upon thickness, extension, lithology and chemistry of the groundwater.

The most favorable water-bearing formations are:

1. The Pleistocene water-bearing formation.
2. The Miocene water-bearing formation.
3. The Oligocene fluvial water-bearing formation.
4. The Eocene calcareous water-bearing formation.
5. The Cretaceous (Nubian) water-bearing formation.

The above mentioned formations are of tested water potentialities and the water-bearing and water confining formations are based on the available data collected from; natural springs, drilled wells, dug wells and boreholes (Diab, 1984, Misak et al. 1989, El-Gindy et al., 1999).

The Pleistocene deposits are of narrow extension and directly overlie either the Miocene, Oligocene or Eocene strata. The water occurrences are very limited and can be considered of non-economic importance even for small projects (Diab, 1984).

The depth to Miocene water-bearing formation is about 100 m and the thickness of the Miocene aquifer is about 20 m. It is composed of sands, sandstones, gravels with green marl interbeds (Diab, 1984). The salinity of Miocene water is tested to be very high (35 gm/liter).

The Eocene aquifer is manifested in the area at the foot of Gebel Ataqa near Suez town. However, the aquifer was encountered at a relatively great depth (in Habashi well), where it is tapped at a depth of 635m (Abdel Daïem, 1971).

Hot springs in Egypt are confined to the areas adjacent to the Gulf of Suez (Swanberg et al. 1976) and represent deep circulating groundwater, mixed with sea water during its migration to the surface (Ain Sokhna Spring).

The Nubian aquifer in Ain Sokhna is under artesian pressure (Diab; 1969, Abdel Daïem, 1971). However, the groundwater of Ain Sokhna is of mixed origin and is not pure Nubian water.

Proposed Project Location

From the hydrological point of view, the Aquifer unit at the project area is represented by the local and moderately to low productive aquifer of the Oligo-Miocene sands and gravels interpreted from the hydrogeological map of Egypt (scale 1: 2,000,000).

This Aquifer unit receives insignificant surface recharge, with limited sub-surface recharge, and the main type of recharge is through inter-aquifer recharge. The Aquifer unit composed primarily of sands and gravels, siltstones

Figure 4-10 shows the hydrological settings at the project site.

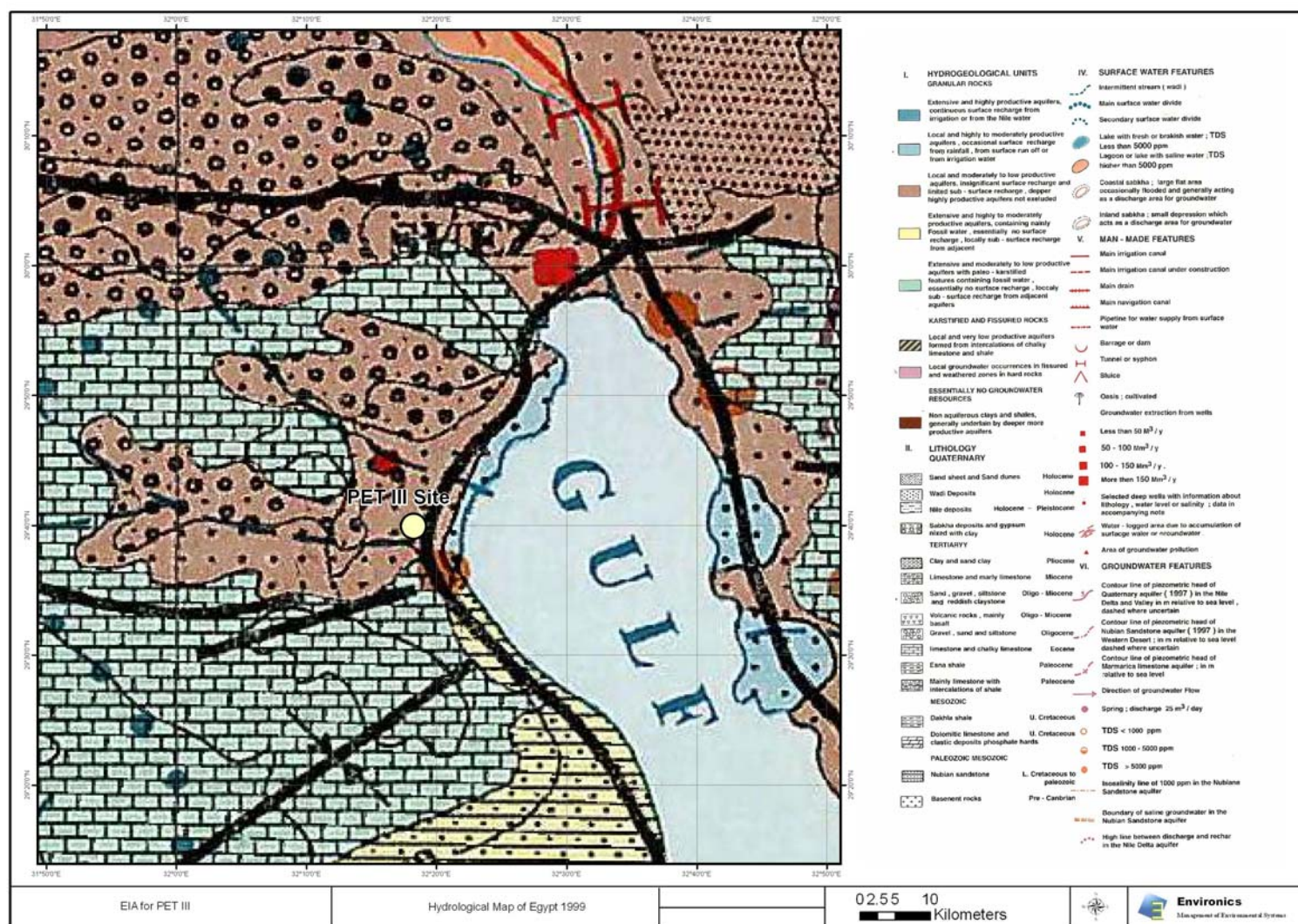


Figure 4-10: Hydrogeological map of Egypt (scale 1: 2,000,000).

4.2 Biological Environment

4.2.1 Ecology of the Project Hinterland

Ain Sokhna is located at the northeastern foot of Gebel El Galala El Baharya (1274 m) overlooking the Gulf of Suez. However, the name traditionally designates a much larger region encompassing the wide coastal plain wedged between Gebel Ataqa (871 m) in the north and Gebel El Galala El Baharya in the south, and including the coastal portion of the latter mountain range (Baha El Din, 1999).

An extensive walk-over survey of approximately 60 km along a north-south segment of the study area was carried out by Environics (2005) for a previous project located in the port industrial zone. According to this survey and literature review, the terrestrial environment of the region may be organized into four principal ecosystems, namely the littoral belt, littoral salt marshes, coastal desert plains and adjoining mountains and hills (Figure 4-11). Thus, a description of these systems and their most representative floral and faunal communities in the Gulf of Suez area is here presented. Identification of floral species of the hinterland was based on visual identification (performed during the survey), complemented with literature review; while faunal description is entirely based on literature.

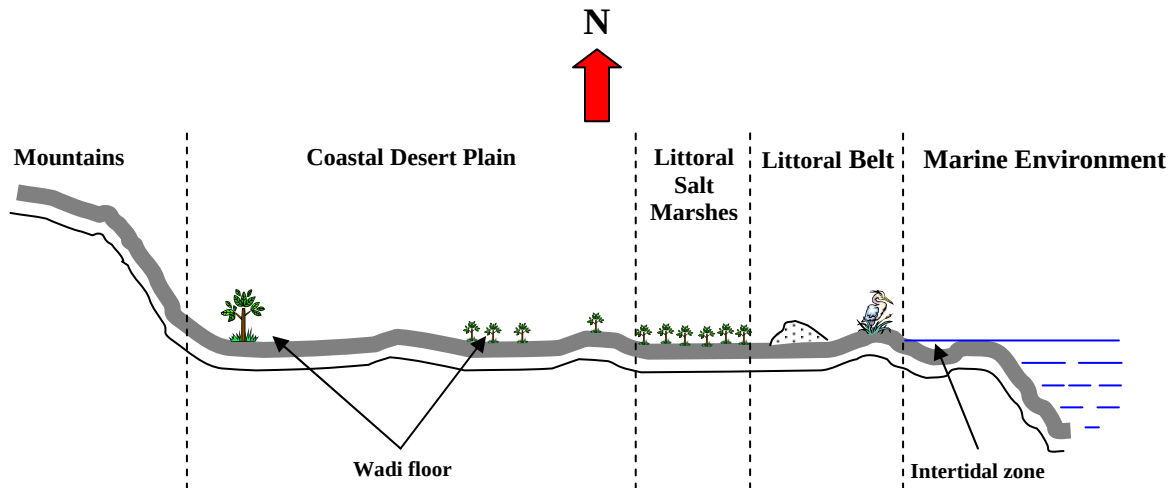


Figure 4-11: Schematic representation of the ecological zones of the study area

a. The Littoral Belt

Sandy and rocky beaches forming the littoral shore were recognized during the field survey (Figure 4-12). The survey also showed that an almost continuous succession of tourist resorts is located along the coast, northwards and southwards of the study area, on the seaward side of the Ain Sokhna/Suez Road.



Figure Error! No text of specified style in document.-12: Sandy beach in the study area

Flora

Beaches are devoid of vegetation, while tourist resorts are characterized by the presence of man-planted ornamental vegetation, alien to the region.

Fauna

Several seagulls were noticed along the coast and on sea ridges. According to Baha El Din (1999), prominent water birds include Slender-billed Gull (*Larus genei*), Lesser Black-backed Gull (*L. fuscus*), Armenian Gull (*L. armenicus*) and Yellow-legged Gull (*L. cachinnans*), all of which are migrant or winter visitors. Besides, small numbers of the protected White-eyed Gull (*L. leucophtalmus*), which is endemic to the Red Sea, are regularly seen offshore in the Gulf of Suez.

Artificial habitats along the coast attract several commensal and/or opportunistic species of birds, mice, lizards and geckos.

b. Littoral Salt Marshes

The littoral belt includes the coastal salt marshes and a few other associated habitat types (Figure 4-13). The marshes comprise areas of land bordering the sea and subject to periodic inundation by tides of high waves.

Littoral salt marshes may be conceived as the seaward fringes of inland desert, their landward border is set by the desert conditions. The width of the littoral salt marsh may be a narrow strip of coast within the reach of salt spray, a few hundred meters wide; or it may extend inland for several kilometers (EEAA/UNEP, 1993).



Figure Error! No text of specified style in document.-13: Littoral salt marshes of the

Flora

Juncus rigidus community type is typical of Ain Sokhna salt marshes, while *Nitraria retusa* and *Tamarix nilotica* form the main vegetation cover (Baha El Din, 1999).

Fauna

There is little information on the herpetofauna of the littoral salt marshes. The few observations suggest that some species such as the gecko *Tropiocolotes steudneri*, the lacertid lizard *Mesalina guttulata* and the Shokari Sand Snake *Psammophis schokari schokari* may be found at or near littoral salt marshes.

Salt marshes are frequented by a large variety of migratory birds during both the autumn and spring passages. On the other hand, most of these species are closely related to mangrove trees (absent in the study area). Characteristic resident birds of the area include the Striped Heron (*Ardeola striata*), the Reef Heron (*Egretta gularis*) and the Common Spoonbill (*Platalea leucordia*).

It is not clear if there are any mammals specifically associated with this type of habitat. The Cape Hare (*Lepus capensis*), Sundevall's Jird (*Meriones crassus*), the Lesser Egyptian Gerbil (*Gerbillus gerbillus*), the Fat Sand Rat (*Psammomys obesus*) and Rüppell's Fox (*Vulpes rueppelli*) have been recorded at or near littoral salt marshes (EEAA/UNEP, 1993; Hoath, 2003; EEAA/DANIDA/Governorate of Suez, 2004). The House Mouse is found mainly in human settlements along the Red Sea coast, but also in beaches, salt marshes, meadows and canal banks (Hoath, 2003).

c. Coastal Desert Plain

The coastal desert plain extends between the littoral belt on the seaward side and the coastal range of hills and mountains on the inland side (Figure 4-14). The coastal plain is non-saline as it lies above sea level and far from the reach of the tidal water. It is essentially a gravel-covered plain traversed by the main wadis and their tributaries. The large plain at Ain Sokhna is composed of sand and gravel, extending to the north and west and is intersected by large shallow wadis (Baha El Din, 1999).



**Figure Error! No text of specified style in document.-
14: Vegetated desert plain extending to the shoreline**

Flora

According to Zahran and Willis (1992 in Baha El Din, 1999) the plain at Ain Sokhna is characterized by a good vegetation cover dominated by *Hammada elegans*, *Zilla spinosa*, with numerous scattered *Acacia raddiana*, *Tamarix nilotica* and *Calotropis procera*. During the walk-over survey many of these floral species were recorded, particularly *Zilla spinosa* and *Acacia raddiana*.

Fauna

Characteristic species of the area include Bosc's Lizard (*Acanthodactylus boskianus*), the Long-tailed Lizard (*Mesalina guttulata*) and the Turkish Gecko (*Hemidactylus turcicus*). The Fan-footed Gecko (*Ptyodactylus hasselquistii*) may be found in rocky areas of the coastal plains and on buildings of the Red Sea coastal towns (EEAA/UNEP, 1993) while the Pigmy Gecko (*Tropicolotes steudneri*) is usually found under rocks or dry vegetation (Saleh, 1997).

Large birds of prey concentrate in large numbers at Ain Sokhna, particularly in spring. The area also includes several globally threatened species such as the Imperial Eagle (*Aquila heliaca*), Greater Spotted Eagle (*A. clanga*), Lesser Kestrel (*Falco naumanni*) and the Pallid Harrier (*Circus macrourus*) (Tharwat, 1997; Baha El Din, 1999). A significant passage of White Stork (*Ciconia ciconia*) and Common Crane (*Grus grus*) is also known from the area. The latter regularly roosts in large numbers in the wide coastal plain (Baha El Din, 1999).

Vegetated areas of the coastal plains support a variety of mammals, of which *Lepus capensis*, *Gerbillus gerbillus*, *G. henleyi*, *Meriones crassus*, the Lesser Egyptian Jerboa *Jaculus jaculus*, *Vulpes rueppelli* and *Felis margarita* are the most characteristic.

d. Mountains, Hills and Wadis

Mountains of the area include Gebel Ataqa, which bounds the coastal land of the Gulf of Suez and Gebel El Galala El Baharya (Figure 4-15). The influence of the orographic precipitation is hardly noticeable within the coastal mountains of the Gulf of Suez. The limited expanse of water of the Gulf does not seem to feed the dry winds crossing from Sinai with appreciable amounts of moisture.



Figure Error! No text of specified style in document.-15:
Northern foot of Gebel El Galala El Baharya

An extensive system of wadis dissects the Red Sea mountains. Wadis may extend from the foothills to the coastal front or may not reach the coast. The downstream extremities of the main wadis may form deltaic basins. Superimposed on this pattern, aeolian deposits may form sheets, mounds or hills of various size and extent. This complex set up produces a likewise complex set up of habitat conditions.

Within the coastal hills of the Gulf of Suez, the wadi courses are usually well defined in the hill country. Across the coastal plain, the watercourses are defined runnels within the much wider course of the wadi.

Flora

The survey encompassed the northern part of Gebel El Galala El Baharya, which was found devoid of vegetation. The plant growth is, therefore, confined to the drainage system (run-off desert). The central part of the wadi bed is usually devoid of perennial plant cover and vegetation is mostly restricted to the sides. As they support a floral community comparatively richer than the rest of the plain and being easily accessible, wadis are subject to grazing and cutting.

Plant cover varies in obvious relation with the extent of the catchment area and the texture and depth of the bed cover. Several plant communities may be recognized. The dominant species include *Acacia raddiana*, *Tamarix aphylla*, *Launea spinosa*, *Hammada elegans*, *Anabis articulata*, *Panicum turgidum*, *Zilla spinosa* and *Zygophyllum coccineum*.

Plants that characterize the cliffs and dry waterfalls that intercept the courses of the wadis traversing the hills, include: *Capparis spinosa*, *C. sinaica* and *Ficus palmata*.

Fauna

Characteristic reptiles of this habitat type in the Gulf of Suez area include rock dwelling forms such as the Egyptian Gecko (*Tarentola annularis*), the Pale Agama (*Agama agama spinosa*) and the Sinai Agama (*Pseudotrapelus sinaitus*). In the wadi beds, the Egyptian Dabb Lizard (*Uromastyx aegyptius*) and the Horned Viper (*Cerastes cerastes*) are found. Wadis with fine sandy substrates are characterized by the presence of Nidua Lizard (*Acanthodactylus scutellatus*), while Bosc's Lizard (*A. boskianus*) is common in those with coarse sand (EEAA/UNEP, 1993).

Characteristic breeding species of birds include *Neophron percnopterus*, the Sand Partridge (*Ammoperdix heyi*), *Oenanthe lugens*, *Oenanthe monacha*, Scrub Warbler (*Scotecerca inquieta*), Pharaoh Eagle Owl (*Bubo bubo*), Trumpeter Finch (*Rhodopechis githaginea*) and Pale Crag Martin (*Ptyonoprogne obsoleta*). There is a great abundance of migratory birds passing through the wadis and mountains, particularly during the autumn migration.

Rock and mountain dwelling species include the Hyrax (*Procapra capensis*). The Nubian Ibex (*Capra ibex nubiana*) was formerly widespread over much of the rocky mountainous areas and wadis of the Eastern Desert, but today, it has been critically reduced by hunting (Hoath 2003). Typical mammals of wadis include *Lepus capensis*, and *Vulpes rueppelli*. *Psammomys obesus* may be found in wadi beds and, occasionally, on gravel pans depending on the availability of succulent plants on which it feeds. The Cairo Spiny Mouse (*Acomys cahirinus*) is found in rocky wadis, cliff sides and also in human settlements where, according to Osborn and Helmy (1980), it is dominant over the House Mouse (Hoath, 2003). The Red Fox (*Vulpes vulpes*) is not a true desert fox¹ and in some areas the animal seems to have replaced Rüppell's Fox.

4.2.2 Ecology of the Project Site

The site is totally flat and rectangular in shape, with an elevation of approximately 20m above MSL.

The soil at locations is composed mainly of yellowish brown sand with some gravel at the surface layer.

Assessment of flora and fauna was based on a rapid visual inspection as well previous experience with similar situations in the study area. This included an evaluation of the vegetation cover and the examination of signs indicating the potential presence of wildlife (feces, tracks, dens and burrows, nests, etc). Accordingly, fauna potentially occurring within the site boundaries has been inferred based on recorded signs, species range and habitat, as well species ability to colonize human-affected environments.

Flora and Fauna

The site is part of the coastal desert plain and was found to be totally devoid of vegetation as shown in figure (4-16) Accordingly, no signs of wildlife were recorded. Inspection of the site indicated the total absence of animal species.

¹ Red fox is adapted to live near human settlements, where sources of water and food exist; whereas desert foxes have less water requirements and thus are mainly found in remote desert areas.



Figure (4-16) Picture showing the total absence of vegetation cover

4.2.3 Biodiversity Value

The wider area of Ain Sokhna is included among the “Important Bird Areas” (IBAs) of Egypt according to a set of criteria developed by BirdLife International Secretariat as it encompasses three of the four IBAs’ categories, namely Categories A1, A3 and A4.

In fact, Ain Sokhna is situated along a major flyway for Palearctic migrant birds. Large birds of prey (passive flyers) concentrate in significant numbers, particularly in spring. Although no systematic counts have been carried out at Ain Sokhna, numerous single-day counts indicate that the area is a bottleneck where over

IBAs’ Categories Applying to Ain Sokhna Area

Category A1: Globally threatened species

The site regularly holds significant numbers of a globally threatened species, or other species of global conservation concern.

Category A3: Biome-restricted species

The site is known or thought to hold a significant component of the group of species whose distributions are largely or wholly confined to one biome.

Category A4: Congregations

Site known or thought to be a bottleneck where > 20,000 storks (Ciconiidae), pelicans (Pelecanidae), raptors (Accipitridae and Falconidae) or cranes (Gruidae), or a combination thereof, regularly pass during migration.

100,000 large birds of prey may pass through it every year. Also, over 5,000 White Stork and 5,000 Common Crane have been recorded on migration. Besides, the area sustains several globally threatened species and its desert habitats support a good diversity of characteristic Saharo-Sindian species (Baha El Din, 1999).

Figure (4-17) (EEAA/DANIDA/Governorate of Suez, 2004) summarizes the wealth and natural biodiversity in the area of the Gulf of Suez, including the route of migratory birds.

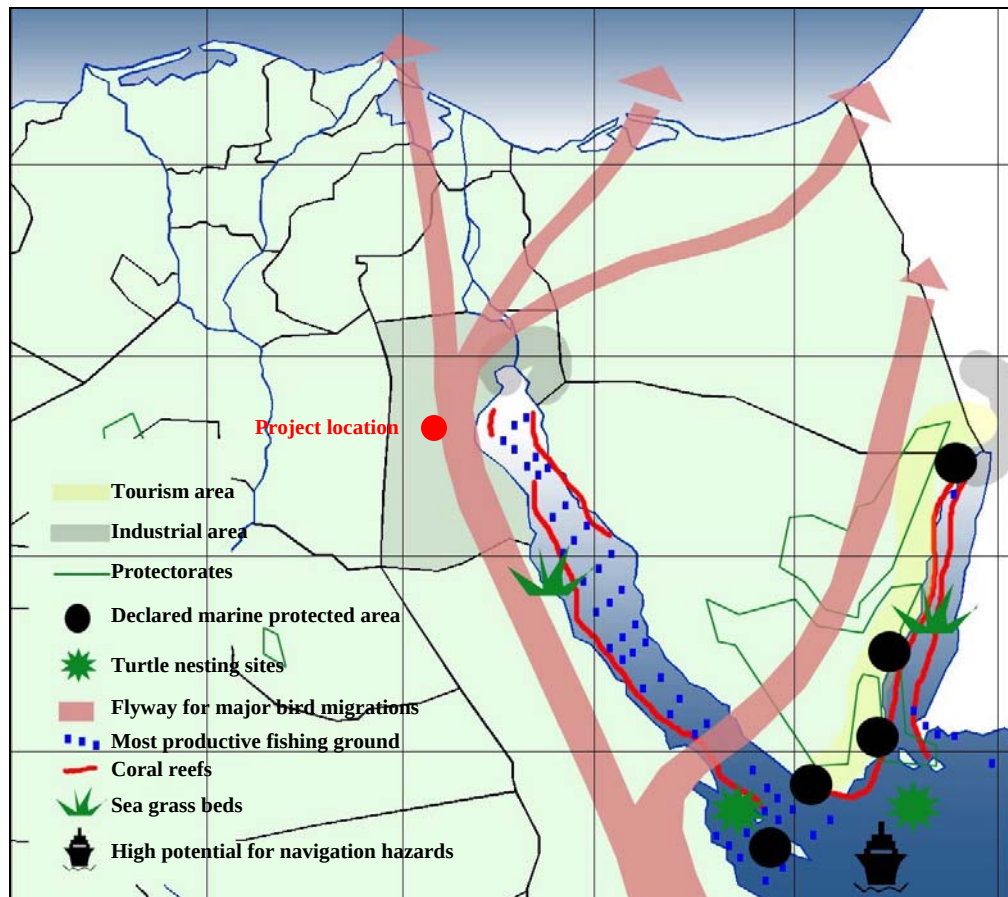


Figure Error! No text of specified style in document.-17: Major birds' migratory routes

As shown in the figure, Ain Sokhna is located along one of the principle flyways of migratory birds in their seasonal voyages between the Euro-Asian Palearctics and the African tropics. The area is also characterized by the presence of coral reefs and productive fishing grounds in its marine environment.

On the other hand, as the project site is totally devoid of vegetation cover, it does not provide shelter and food resources for migrating birds. Therefore, the site is considered of low ecological value.

4.3 Socioeconomic Environment

The Sokhna area is not considered an urban centre with socio-economic activities. Therefore, this section describes the overall socioeconomic environment in Suez governorate focusing on the issues that would be affected by the project particularly employment issues.

4.3.1 General Overview on Suez Governorate

a. Population

Suez, one of the four urban governorates of Egypt, has been witnessing expanding economic development which attracted many migrants from neighboring governorates, especially from Upper Egypt and Cairo. In 1986, the population of Suez reached 328,000, of which 52 % were male. In 1996, the population of the Governorate reached 421,292, with male population representing 51.1 % of the total population (CAPMAS, 1996). In 2006 the total population reached 510,935 (CAPMAS, 2006). The average household size has decreased from 4.7 persons per household in 1986 to 4.3 persons per household in 1996. The annual population growth rate (between 1986 and 1996) was more than two percent per annum, which is higher than the national average. Population distribution shows that only about 1.14 percent of the gross area of the Governorate is inhabited.

Apart from Suez city, there are no other major settlements near the proposed facility location. There are a few tourist resorts, of which the closest is the Wadi resort and the Stella resort, and camps of workers of the industrial area. There is also a Local Community settlement south of the proposed facility location, at more than 5km south of the site. The Local Community settlement consists of approximately 1500 inhabitants, according to one of the older Local Community of the tribe.

b. Education

There are no schools or colleges in the project area, the closest are in Suez. The only option for the Local Community living in the area is to send their children for education either to schools in Suez or in Cairo. However, according to interviews with the Local Community, they consider sending their children to school too costly and far, therefore about only 1% of the Local Community can read and write and the others are completely illiterate. The literacy rate in Suez was estimated in 2004 at 79.9% (UNDP Human Development Report, 2004).

c. Employment

Unemployment rates at Suez were estimated by the UNDP human development report at 17.9%. Employment opportunities in the proposed project area are mainly offered by the port, the tourism sector and the industrial sector. Most Local Community in the area work as guards and/or workers at the industrial facilities surrounding their area (almost 80% of males). They also work in herding sheep and camels.

d. Health services

There are no hospitals or clinics in the proposed project area but some hotels have 24-hour operating clinics with doctors residing in them. The closest clinics to the proposed project location are in Attaka and Suez. There are two main public hospitals in Suez Governorate, one in Hai Suez and one in Hai Al Baldeya³.

e. Infrastructure

According to the Decision Support Center (2006) (Ministry of Housing, Utilities and Urban Communities), the total produced drinking water in 2006 in the Governorate of Suez, including new developments was 79 million m³, while the consumed drinking water in the year 2004 reached 51 million m³.

There are several highways near the project location, including the Suez/Hurghada highway, Old Cairo/Suez highway and the New Cairo/Suez highway. In addition to the presence of a railway which serves the port. Electricity, telephone lines and natural gas are available in the project area. A few solid waste contractors collect wastes from the nearby resorts and factories. However, the area is not connected to a sewerage network and the different facilities have to dispose/treat their sewage individually.

Local Community have one source of water, which is a hose connected to the Koraymat network. Water is filled in tanks from the hose and carried to the Local Community's homes. Furthermore, the Local Community is not connected to electricity services.

f. Economic activity

Economic activity in the governorate varies between the agricultural sector and the mining and industrial sector and tourism sector, where the governorate is considered to be one of the leading governorates in the area of agricultural development for its high agricultural potential. As for the mining and industrial sector; it could be considered one of the major economic sectors in the governorate of Suez, where the most important industries in the Suez in the extraction and refining of oil, in addition to the chemical industry, cement industry and the food industry. Tourism sector is also specifically important; as it provide locals with jobs in the city and around the resorts along the Gulf shoreline.

Fishing and livestock are the main traditional activities in the area. Cultivation is limited due to soil quality and limited amount of fresh water. The specific project is located within the industrial area fronting the Sokhna port. The port provides import/export services, which cover the neighboring industrial area. Industry and tourism also provide employment opportunities. Few fishing boats were observed nearby the port location. A number of shops and restaurants exist on the Suez/Hurghada highway, north of the port. Otherwise, residents purchase the rest of their requirements from Suez or from areas near Cairo.

³ <http://www.mohp.gov.eg/sec/Directories/Hospgovdet1.asp?x=1&i=4>

g. Tourism

The tourism sector is witnessing an unprecedented boom. Various tourist establishments are located at the Gulf of Suez, particularly at Ain Sokhna. The new industrial estate west of the Gulf of Suez has created demand for these services. Egyptian white collar employees prefer hotels in the city, while international experts working for the manufacturing plants prefer resorts.

4.3.2 Local Community in the Project Area

The Local Community in the area is from “Kabilat Al Amreen” tribe. There are approximately 300 families living in the area, with 1,500 inhabitants in total as estimated by Sheikh Salem one of the elder members of the Local Community. The Local Community huts are made of straw, wood and tin sheets. They are bounded by the industrial zone to the north, SUMED tanks to the east and the mountains to the south.

Local Community used to live in the port area and plant olive trees, palm trees, melons and some vegetables depending on flood water for irrigation. Nowadays, the Local Community has moved to an area south west of the port, near the SUMED storage tanks. They currently rely on herding sheep and camels as well as working as guards for the facilities in the area for extra income.

Most Local Community members in the area work as guards and/or workers at the industrial facilities surrounding their area (almost 80% of males). They also work in herding sheep and camels.

Local Community has one source of water, which is a hose connected to the Koraymat network, where it is filled in tanks from the hose and transported to the Local Community’s homes. Furthermore, the Local Community is not connected to electricity or wastewater services. They purchase some goods from the small shops nearby their settlement, while they need to travel to Suez or Cairo for purchasing other essential needs.

The only option for the Local Community living in the area is to send their children for education either to schools in Suez or in Cairo. However, according to interviews with the Local Community, they consider sending their children to school too costly and far, therefore about only 1% of the Local Community can read and write and the others are completely illiterate.

The Local Community in the area was contacted to discuss the proposed project. They were provided with a summary description of the project. They had the following inquiries and comments:

Recycling

- Some of the treated industrial wastewater can be used for irrigation and landscaping.

Health & Safety

- Inquired about health impacts on workers and the surrounding community.

Socio-economic considerations/community development/PC

- Drinking water, Electricity, Education (illiteracy school) and Health unit were proposed for community development projects.
- There is approximately 1500 Local Community in the tribe living in this area.
- 80% of the Local Community members work as guards for the surrounding industrial facilities and the others are either workers in the facilities or are shepherds.
- Literacy rate amongst the Local Community is 1%, where education usually take place in Suez.
- Local Community seeks health services in Suez.

5. Analysis of Alternatives

The analysis of alternatives is based on the evaluation of numerous project alternatives during the conceptual and pre-feasibility design phases.

When evaluating alternatives, particular emphasis was placed on the environmental and social implications of the alternatives to ensure that the option selected is environmentally sound and meets the Egyptian Laws and regulations.

5.1 No Development Alternative

The alternative to not develop the proposed plant was used in this ESIA as the scenario with which to compare the environmental and social impacts of project construction, operation and closure.

The “no development” alternative would deprive Egypt of a source of hard currency from export of the produced PET. It is worth mentioning that the facility is the first of its kind that allows Egypt to compete for the international/regional market of PET. This facility will also contribute to fulfilling the Egyptian market needs in this field. Moreover, the “no development” option will result in the loss of approximately 450 direct job opportunities during operation and about more than thousand direct and indirect jobs during construction.

Should the “no-development” alternative be selected, the land proposed for the development would still be used for other industrial development as it has been designated as an industrial area.

Considering the type and nature of the industry and that the potential impacts of the proposed project will be managed to levels where the environmental impacts will not be detectable, the “no development” alternative has not been given further consideration.

5.2 Alternative Site Locations

The basic criteria for site selection is the proximity to a port since the raw materials required for the process will be imported and the finished product exported. This would contribute to reducing the costs for raw material and for product and material transport. The availability of infrastructure and utilities such as water, electricity and natural gas are also major parameters for site selection. Moreover, an important criteria for selecting the location its relative proximity to the targeted markets, namely Europe and the Mediterranean basin. Therefore, a site located at/close to a Mediterranean port was sought Damietta Port has meet all site the selection, thus the project originally was intended to be established in Damietta. However, due to financial disagreements in Damietta Port the project relocation has been considered. The next best option was Port Said, a location has been considered within the industrial zone C9 south of Port Said. However, due obstacles facing obtaining the approval of the aviation authority for stack and building heights, project

relocation has been considered again, Sokhna area has been one of the areas considered for relocation. Within this context, the following locations were investigated for establishing the project, namely;

- Alexandria
- Industrial area in East of Port Said
- The industrial area in Sokhna

Following are the characteristics of the different locations.

Alexandria area

The location within the industrial area in Wadi El-Kamar in Alexandria near Dekheila Port was considered and use El Dekheila Port for import of raw material and export of products. However, due to the proximity of the proposed location to various heavy industries, petroleum, iron and steel, carbon black and cement, in addition to procedural obstacles for land acquisition, the area has not been investigated further.

Therefore, the Alexandria location was not considered

Industrial area East of Port Said

The industrial area in east Port Said was a potential location for the PET project. However, the area is still developing and currently lacks most infrastructure requirements. Therefore, it was not further investigated.

Therefore, East Port Said area was not considered

Industrial areas in Sokhna

The main constraints as clarified above were the availability of suitable land area and the heights approval. Various locations in different industrial zones have been investigated including SIDC zone (Suez Industrial Development Company), the Egyptian Chinese Industrial zone, Ataka industrial zone and Eldorado industrial zone. The location in Eldorado industrial zone was selected as it has the following characteristics:

- It is located on the Red Sea and at the same time near to the southern entrance of the Suez Canal.
- The location is ideal for import of the raw materials from the global market.
- Ready access to infrastructure and services
- The location is part of a declared industrial zone in Sokhna area
- The area has a prior approval for stack and building heights to about 100m. Annex (2) presents the prior approval for stack and building heights in Eldorado industrial zone

Moreover, ECHEM has formed with EEAA a joint committee for pre-assessment of all ECHEM sites before submitting EIAs for new project. The committee has visited the proposed site on 17/5/2010 and has issued on 6/6/2010 its approval on the site. Annex (3) presents the approval on the site by EEAA-CHECM joint committee.

Having investigated different locations for the project, the Industrial area in Sokhna is selected to establish the PET project.

5.3 Process Design Alternatives

5.3.1 Raw materials alternative

Historically, till the late 1960's, PET productions processes used Di-Methyl Terephthalate (DMT). The DMT has an inherent disadvantage since its estrification reaction of with MEG results in generation of methanol, a highly flammable substance, which requires stringent management practices in order to prevent potential risks. Nowadays, almost all PET production plants use PTA instead.

Due to PTA's excellent quality and its significant advantages over DMT, PET producers made substantial efforts to develop a polymerization technology to directly utilize PTA.

Factors favoring the use of PTA over DMT include:

- PET yields from PTA are reportedly higher on a molar basis than those from DMT, and there are reported savings in ethylene glycol consumption.
- The elimination of special methanol recovery equipment and explosion proof operating environment.
- When processing PTA the lower ethylene glycol requirement during the initial stages of the reaction leads to lower investment costs and energy consumption for the glycol recovery/recycle system.

5.3.2 Alternative Process Technologies

The PET production process involves integration of continuous polycondensation and solid state polymerization processes. There are four leading technologies for SSP in the global PET market.

1. **UOP Sinco Process:** Is a successful technique with over 70 SSP licensed units around the globe. It offers batch and continuous SSP processes for a variety of polymer upgrade applications. The UOP Sinco SSP process is an economical and simple four-step process. Amorphous feed chips originating from a continuous polymerization (CP) process enter the SSP unit's precrystallizer, where the feed material is de-dusted, heated, and crystallized inside a multi-zone fluid bed heat exchanger. The crystallized chips are then fed to the crystallizer, where crystallization is completed (perfected) under process conditions optimized to the behavior of the feed polymer. Crystallization is performed in a moist Nitrogen environment, a key feature of UOP Sinco's flow scheme, to reduce acetaldehyde (AA) in the product.
2. **DuPont's NG3TM Technology:** DuPont and Fluor Daniel launched the NG-3 Technology which uses a continuous polymerization process specifically developed for packaging resin. The technology providers focus mainly on providing the technology to Asia producers. The NG3TM process uses a patent pre-polymerizer to produce a low molecular weight polymer intermediate product, which then passes through solid state polymerization to the desired level of intrinsic viscosity. The system operates in atmosphere of nitrogen and under slight pressure. The propriety particle formation step simultaneously forms and crystallizes the low molecular weight intermediate into robust pellets. The NG3TM approach eliminates

the finisher stage in the conventional melt phase and one crystallization stage in the SSP.

3. **Zimmer SSP process:** Provides process technology operating worldwide in the polymer and synthetic fiber field. Polycondensation take place under increased temperature and increased vacuum. The technology implements the patented EG driven jet to facilitate material recovery and reuse. The produced polymer melt is directed to either fiber/filament or chips production. The crystallization process uses mechanical agitation. The crystallization stage does not encompass a separate annealer prior to final crystallization stage.
4. **Buehler SSP process:** The typical features of the technology are gentle processing of the polymer by using fluid bed and gravity flow reactors, negligible dust generation, narrow residence time and therefore constant product quality as well as sintering resistance process design and low operation and maintenance costs.

The SSP Bühler AG's know-how units for bottle grade production are laid out as commodity production facilities. The benchmarks for these systems are

- Economy of scale
- Constant product quality
- A robust plant operation
- Low utility consumption
- High plant availability

Annex (4) of the ESIA provides additional details of the different technology alternatives

After due consideration of all economic and operational parameters of the different technologies, the facility has selected the Buehler SSP technology for the proposed project. The key advantages of the Buehler technology relative to other processes are summarized as follows:

- The selected technology is well proven where about 60% of the world SSP capacity uses this technology
- No mechanical agitation is used and therefore no pellet deformation and less polymer dust formation
- The crystallization takes place in air environment reducing the nitrogen consumption
- No IV (intrinsic viscosity) drop during crystallization
- Using an annealer avoids sticking of polymer chips in the reactor.

For more details, refer to Annex (4) of the ESIA study.

2. Alternatives for Wastewater disposal

As previously described in chapter 3 above, wastewater streams generated by the facility are categorized as follows:

Stream I: Process wastewater:

- Process water ($\approx 300 \text{ m}^3/\text{day}$) contaminated with organic constituents
- Wastewater from filter cleaning ($\approx 20 \text{ m}^3/\text{day}$) contaminated with organic constituents
- Wastewater from stripper ($\approx 45 \text{ m}^3/\text{day}$) contaminated with organic constituents

Stream2: Wastewater from utilities

- Cooling tower blow down ($\approx 314 \text{ m}^3/\text{day}$)
- Other wastewater (including blowdown from different sources)($\approx 65 \text{ m}^3/\text{day}$) with a TDS $\approx 2500 \text{ ppm}$ maximum

Handling of the different streams of wastewater is as follows:

- Process water and wastewater from filter cleaning is directed to the ETP for treatment.
- Cooling tower blow down and RO and other rejects are high in TDS concentration (not exceeding 2000 ppm) does not contain organic constituents and are directed to non-contaminated stream collection tank.

Both streams, the treated process water and the utility water will be combined, thus minimizing the overall TDS content, then directed to the MBR unit. In light of the above handling measures the following disposal alternatives are addressed.

Disposal into ground water reservoirs

Article 61 of Law 48/1982 stipulates that wastewater discharged into groundwater reservoirs must meet the TDS limit of 800 ppm. The generated wastewater is expected to exceed this limit, and thus does not fulfill article 61 requirements.

This alternative will not be considered for implementation

Disposal into public sewer network

The resulting wastewater will be complying with disposal into public network. However, the public sewer network in the area is not yet fully developed

This alternative will not be considered for implementation

Recycling/reuse of the generated wastewater

Process water

After treatment the treated process water and water from filter cleaning (about $365 \text{ m}^3/\text{day}$) with minimum organic constituents. The blow down from the different utilities will be directed to a non-contaminated wastewater collection tank.

Both streams then to be directed to MBR unit for further treatment. After additional treatment the wastewater will be used for makeup for the cooling tower thus minimizing the requirements for fresh water supply from the public fresh water network and decrease the load on the water demands in the area. The reject from the MBR (about 124m³/day) will be complying with article 15 of decree 44/2000 regarding use of treated industrial wastewater irrigation and landscaping within the industrial zone.

This alternative can be considered for implementation.

The Selected Alternative

This alternative has the following advantages:

- Minimizing fresh water consumption and reducing the load/reliance on the freshwater resources in the area.

6. Impacts Assessment and Mitigation

6.1 Methodology

Environmental assessment was carried out to cover potential impacts of the project on the environment as well as impacts of the environment on the project. The assessment was carried out in three main steps, as follows:

1. Identification of potential impacts
2. Evaluation and assessment of the impacts in terms of their significance
3. Identification/ proposing mitigation measures for minimizing the affects of the significant impacts.

6.1.1 Identification of Potential Environmental Impacts

Potential impacts of the proposed project are identified based on a modification of the Leopold matrix (Table 6.1). The matrix has been designed so that the key potential impacts associated with the project become immediately apparent. The layout of the matrix is arranged as follows:

- The “y” axis of the matrix consists of a list of activities presented according to construction and operation activities. It also consists of the list of aspects associated with each activity or group of activities.
- The “x” axis consists of the resources and receptors susceptible to impacts categorized as physical, biological and socio-economic environment. Identified resources and/or receptors were:
 - Air quality
 - Noise level
 - Soil
 - Marine water quality
 - Surface and Groundwater quality
 - Aquatic life
 - Terrestrial life
 - Public health
 - Employment
 - Workplace health and safety

6.1.2 Evaluation and Assessment of Impacts

Interaction between the different activities and the environmental receptors, identified through the baseline information, was carried out. Such interactions may result in negative or positive impacts. The different types of impacts were identified.

Based on the analysis of the baseline environmental conditions and the nature of the receiving environment, some aspects were found to be irrelevant to specific activities of this particular project. These are identified as "scoped out impacts"

Potential impacts were subject to a process of impact evaluation, based on the analysis of the proposed project components and activities, in order to determine the significance of the different impacts. The evaluation process takes into account the information collected in the field, available in the

literature and/or based on the professional judgment of the consulting team, public consultation as well as environmental modeling activities.

Impact evaluation is based on pre-set criteria including, impact magnitude, duration, built in mitigation measures, regulatory standards and sensitivity of environmental receptors.

6.1.3 Mitigation Measures

Mitigation measures are either incorporated as integral part of the plant design or through environmental management and monitoring measures. By implementing both types of mitigation measures, the residual impacts, which are those potentially remaining after implementing the mitigation measures, will be minimal/insignificant/ acceptable. Based on the impact identification and evaluation process, Irrelevant impacts are scoped out of the assessment process, mitigation measures are proposed for significant impacts, while minor impacts are integrated within the management plans of the facility.

6.2 Impact Identification

6.2.1 Scoped out Impacts

Potential impacts in the Leopold matrix were identified in relation to their effects on potential receptors. This step would facilitate eliminating and scoping out irrelevant impacts taking into consideration the following:

- Type of industry
- Location
- Characteristics of the surrounding environment.
- Receptor sensitivity or importance: depends on its nature, value, scarcity etc. There are three types of receptors:
 - On site receptors encompassing soil and workplace.
 - Receptors surrounding the site such as ambient air, humans, plants and animals.
 - Final sinks/receptors such as surface and groundwater.

Examination of the environmental setting of the area and the production processes has shown that the following impacts are irrelevant:

Impacts on “marine water quality” and “aquatic life”

The different activities related to PET production will have no contact with marine water or marine life.

6.2.2 Positive Impacts

It is estimated that the construction phase of the project would provide direct labour force in the average of 1000 skilled and unskilled persons, this number can increase to reach about 2000 during some phases of construction. During operation the project is expected to provide about 450 direct and indirect job opportunities including management. The majority of the skilled workforce will be from all around Egypt. However, in the case of similar qualifications, preference will be given to Suez residents. This reflects the company hiring policy to hire as much workforce as possible from the skilled labor in Suez governorate. In this regard, the company employment policy will be encouraged through the contracts with construction contractors. This

employment policy will have positive socioeconomic impact on the surrounding local community.

Moreover, the positive impact of the project will reach farther than the employment at the site through sourcing of contractors, building materials and supporting services from the local markets such as wood pallet industries, jumbo bags manufacturing and PP bags manufacturing industries. PET pre-forming, bottles manufacturing, plastic strap production and plastics recycling units can be set up by potential entrepreneurs where company can support technically, wherever possible.

6.2.3 Potential Negative Impacts

After exclusion of the irrelevant impacts and identifying the positive impacts, the remaining “potential negative impacts” were assessed based on the following criteria:

- **Magnitude** of the impact.
- **Duration:** period of time that impact lasts.
- **Mitigation measures;** its availability whether integrated in the project design or implemented as management measures.
- **Adherence to regulatory standards according to Egyptian legal and regulatory framework** (described in Chapter 2).
- **Public concern** and perception

Using the impact identification matrix (Table 6.1), the different types of impacts were identified. The table presents the different types of potentially negative impacts during the construction and operation phases. For each potential negative impact the significance before and after implementing the design integrated measures and/or applying management and monitoring practices determined:

Table (6.1) Potential/ Residual Impacts Matrix

		Environmental Attributes ⁽¹⁾							
Activities (Sources of impacts)	Aspects	Physical Environment				Biological Env.	Socio-economic		
		Air Quality	Noise level	Soil	Groundwater Quality	Terrestrial life	Public Health	Employment	Work place H & S
Construction Phase									
Site leveling	• Labor	NA	NA	NA	NA	NA	NA	+	NA
Piling works	• Dust Emissions	-/I _m	NA	-/I _m	NA	-/I _m	-/I _m	NA	-/I _m
Civil Works	• Emissions (vehicles, equipment & material)	-/I _m	NA	-/I _m	NA	-/I _m	-/I _m	NA	-/I _m
Steel erection	• Noise (vehicles & equipment)	NA	-/I _m	NA	NA	NA	NA	NA	-/I _m
Equipment erection	• Construction Waste (including generation of solid and liquid municipal waste)	NA	NA	-/I _m	-/I _m	NA	NA	+	-/I _m
Piping works	• Accidents (vehicles & equipment)	NA	NA	-/I _m	-/I _m	-/I _m	-/I _m	NA	-/I _m
Electrical and instrumentation	• Spills (vehicles & equipment)	NA	NA	-/I _m	-/I _m	NA	NA	NA	-/I _m
Mechanical completion	• Sewage	NA	NA	-/I _m	-/I _m	NA	NA	NA	NA
Pre-commissioning									
Construction camps									
Operation Phase									
Activities related to Workforce	• Labor	NA	NA	NA	NA	NA	NA	+	NA
	• Municipal Solid Waste	-/I _m	NA	-/I _m	NA	NA	-/I _m	NA	-/I _m
	• Sewage	NA	NA	-/I _m	-/I _m	NA	NA	NA	NA

¹⁾ (-): Negative impact

(+): positive impact

I_d: minor residual impacts acceptable after design integrated mitigation

I_m: minor residual impacts acceptable after mitigation through management

NA: Not applicable

		Environmental Attributes ⁽¹⁾							
Activities (Sources of impacts)	Aspects	Physical Environment				Biological Env.	Socio-economic		
		Air Quality	Noise level	Soil	Groundwater Quality	Terrestrial life	Public Health	Employment	Work place H & S

<i>Production of Amorphous PET chips⁽¹⁾</i>									
Paste preparation	• Particulate matter from raw material handling	-/I _d	NA	NA	NA	NA	NA	NA	-/I _m
	• Noise from transfer pumps and compressors	NA	-/I _{d,m}	NA	NA	NA	NA	NA	-/I _{d,m}
Estrification reactors	• Process water containing organic constituents	NA	NA	-/I _m	-/I _m	NA	NA	NA	NA
	• Noise from pre-polymer gear pumps	NA	-/I _{d,m}	NA	NA	NA	NA	NA	-/I _{d,m}
Polycondensation	• Process water containing organic constituents	NA	NA	-/I _m	-/I _m	NA	NA	NA	NA
Chip production	• Particulate matter from screening	-/I _d	NA	NA	NA	NA	NA	NA	-/I _{d,m}
	• Noise from screening and air cooling fans and cutters	NA	-/I _{d,m}	NA	NA	NA	NA	NA	-/I _{d,m}
<i>Production of crystalline PET resin</i>									
Pre-crystallization	• Particulate matter from dedusting	-/I _{d,m}	NA	NA	NA	NA	NA	NA	-/I _{d,m}
Crystallization	• Air emission from HTM stacks (CO, NO _x , SO ₂)	-/I _m	NA	NA	NA	-/I _m	-/I _m	NA	-/I _m
Polymer cooling	• Particulate matter from final dust removal	-/I _{d,m}	-/I _{d,m}	NA	NA	NA	NA	NA	-/I _{d,m}

¹⁾ (-): Negative impact
 (+): positive impact
 I_d: insignificant impact after design integrated mitigation
 I_m: insignificant impact after mitigation through management
 NA: Not applicable

Activities (Sources of impacts)	Aspects	Environmental Attributes ⁽¹⁾							
		Physical Environment				Biological Env.	Socio-economic		
		Air Quality	Noise level	Soil	Groundwater Quality	Terrestrial life	Public Health	Employment	Work place H & S
SSP	• Hazardous waste: spent platinum/palladium based alumina catalyst	NA	NA	-/I _m	-/I _m	NA	NA	NA	-/I _m
Plant Utilities									
RO	• Wastewater: RO reject	NA	NA	-/I _{d,m}	-/I _{d,m}	NA	NA	NA	NA
Cooling water system	• Wastewater: from blow down	NA	NA	-/I _d	NA	NA	NA	NA	NA
Filter cleaning	• Wastewater from filter washing	NA	NA	-/I _{d,m}	-/I _{d,m}	NA	NA	NA	NA
Steam system: HTM heaters	• Heat stress	NA	NA	NA	NA	NA	NA	NA	-/I _m
Catalyst preparation	• Particulate matter from material handling	NA	NA	NA	NA	NA	NA	NA	-/I _{d,m}
	• Hazardous waste: spent catalyst PP filter containing heavy metals (Antimony)	NA	NA	-/I _m	-/I _m	NA	NA	NA	-/I _m
Instrument/Plant air system	• Noise from compressors	NA	NA	NA	NA	NA	NA	NA	-/I _m
	• Liquid waste: spent lubricating oil	NA	NA	-/I _m	-/I _m	NA	NA	NA	NA
Storage facilities	• Liquid waste: spent lubricating oil	NA	NA	-/I _m	-/I _m	NA	NA	NA	NA
ETP	• Treated effluent to final discharge	NA	NA	-/I _d	-/I _d	NA	NA	NA	NA

(-): Negative impact

(+): positive impact

I_d: minor residual impacts acceptable after design integrated mitigation

I_m: minor residual impacts acceptable after mitigation through management

NA: Not applicable

6.3 Assessment of Potential Negative Impacts

6.3.1 Impact on Physical Environment

6.3.1.1 Air Quality

Construction Phase

Construction activities may result in minor, localized, short term, air quality deterioration in the form of dust/particulate matter, and emissions from soil leveling, construction equipment and transport vehicles. Air Emissions from mechanical construction equipment may result in potential impacts due to the localized increase in concentration of nitrogen oxides, sulphur oxides and carbon monoxide.

Such impacts will occur for relatively short duration and will affect mainly the workplace environment. Impact on public health is unlikely due to the fact that there are no nearby residential areas to the site.

Mitigation Measures

PET facility will ensure that contractors will carry out the necessary measures to minimize impacts. This is to be included in the contractor's scope of work (contract). Possible measures include:

- Dust suppression measures at the site
- Maintaining machinery and vehicles in good working conditions to minimize fugitive emissions
- Frequent inspection of all construction equipment will be carried out to minimize fugitive emissions

Therefore the residual impacts after implementation the management measure are negligible

Operation phase

The proposed PET plant operates inherently "clean" processes due to the improved process design factors. The processing steps and the physical properties of used raw materials and the use of natural gas as clean fuel for the heaters contribute to the clean nature of the industry. However, during operation, air emissions, will be generated from the plant. This section covers the expected emissions from different sources of the proposed facility. Impact on air quality results from two sources, point source emissions and fugitive emissions:

Point source emissions (Stack emissions) are generated from the HTM stack. During combustion operations, potential impacts are caused by NO_x, SO_x, CO and high temperature.

Mitigation Measures for stack emissions:

Design integrated measures:

In order to minimize the potential impacts of air emissions, the facility integrated several mitigation measures in the design, these include the following:

- Natural gas is used as fuel for the HTM heaters. The flue gases will therefore be practically free of SO_x.
- Operation optimization is achieved through the installation of several monitoring and control instruments including:
 - Control fuel/air ratio to reduce CO concentration and smoke which are produced due to incomplete combustion.
 - Off-gases from the stripper containing organic constituents will be burned in the HTM heaters with the natural gas resulting in carbon dioxide and water vapour that are natural components of the atmosphere

Table (6.2) shows the emissions from the stacks compared to the Egyptian maximum allowable limits for ambient air. The table shows that the resulting emissions are well below the national regulatory limits, as well as the IFC guidelines

Table (6.2) Emission Sources

Source	Emission (mg/m ³)		Law 4 Maximum Limits for Emissions from Stacks (in mg/m ³)	IFC guidelines
HTM heater stack	NO _x	200	300	300
	CO	80	250	----
	SO ₂	< 1	1500	500
	PM ₁₀	10	200	20

* VOC from stripper will be burned with natural gas in HTM to produce CO₂ and H₂O

Mitigation Measures for fugitive emissions:

Fugitive emissions As discussed previously in chapter (3) no fugitive emissions are expected from the plant activities. This is mainly because of the effective design measures that prevent such emissions. These measures are:

Design integrated measures:

- Bag filters are installed to prevent dust emissions during PTA/IPA charging in the paste preparation tank
- Cyclones are installed for collection of dust during SSP
- Mechanical seals are provided for all transfer pumps, wherever required
- Installation of automatic bagging systems and efficient ventilation in packaging operations

6.3.1.2 Impacts of PET stack emissions on the sensitive receptors

As shown above, the emissions from the facility are below the permissible limits, however, dispersion modeling of atmospheric emissions for the PET facility was conducted as an integral part of this ESIA with the purpose of predicting potential impacts of the emissions on the surrounding environment. The model was developed for emissions generated from combustion of NG in the HTM heaters. Using this model, it was possible to estimate the impact of such emission on the ground level air quality at the main sensitive receptors in the area, namely the touristic resorts north eastern the proposed site.

The model

For running the air dispersion model, the short-term industrial source complex model (ISC3ST-Prime) has been used. The model is an advanced Gaussian dispersion model approved by the United States Environment Protection Agency (USEPA)¹ which is one of the most widely used regulatory models in the world. The model is used to assess pollutant concentrations from a wide variety of sources associated with an industrial complex. The model takes into account dry and wet deposition and includes mechanisms for determining the effect of terrain and buildings on plume dispersion. The model uses a meteorological file that provides wind speed, wind direction and other dispersion parameters on an hourly basis. The model also has the capacity to take into account emissions that vary in time, or with meteorological conditions. Building downwash parameters are calculated using the Building Profile Input Program Prime (BPIP-PRIME) developed by the US EPA.

The ISC3ST model is applicable to rural and urban areas, flat and complex terrain, surface and elevated releases and multiple sources (including point, area and volume sources). It is a steady state plume model.

The model contains the following modules:

- Meteorological module: uses meteorological data and surface characteristics to calculate boundary layer parameters (e.g. mixing height, friction velocity, etc...)
- Map module: uses grid terrain data for area modeling to calculate a representative terrain-influence height associated with each receptor location.
- Dispersion model: computes concentrations of pollutants considering:
 - Dispersion in both the convective and stable boundary layers
 - Plume rise and buoyancy
 - Plume penetration into elevated inversions
 - Computation of vertical profiles of wind, turbulence and temperature
 - The urban boundary layer
 - The treatment receptors on all types of terrain from surface and above plume height.
- Post processor: generates maps and tables of resulting concentrations

¹ Further information on the ISC3STmodel is available at the USEPA website:
http://www.epa.gov/scram001/dispersion_alt.htm

Modeling results

The results of the dispersion modeling indicated that the emission concentration for the different parameters at the neighboring sensitive receptors are very far below the Egyptian maximum allowable ground level concentrations as well as the limits of IFC emissions guidelines, as shown in table (6.3) below. Therefore, it is concluded that the impact of the PET facility on air quality is insignificant.

Table (6.3): PET Emissions at the surrounding receptors

Parameter	Time	Sensitive receptors		Law 4/ 1994 for ambient air quality	IFC Guidelines* for ambient air quality*
		Touristic Resorts	Temporary Workers dwelling		
CO ($\mu\text{g}/\text{m}^3$)	hourly	2-5	5-10	30000	
	8 hours	<1	1-2	10000	
NO ₂ ($\mu\text{g}/\text{m}^3$)	Hourly	5-10	10-15	400	200
	Daily	<0.8	1-2	150	
PM ₁₀ ($\mu\text{g}/\text{m}^3$)	24 hours	<0.05	0.05-0.1	350	50
	annually	<0.005	0.005-0.01	150	20

IFC Environmental, Health, and Safety Guidelines for Petroleum-based Polymers Manufacturing, 2007

The figures below show the result of the air dispersion model of the PET plant emissions.

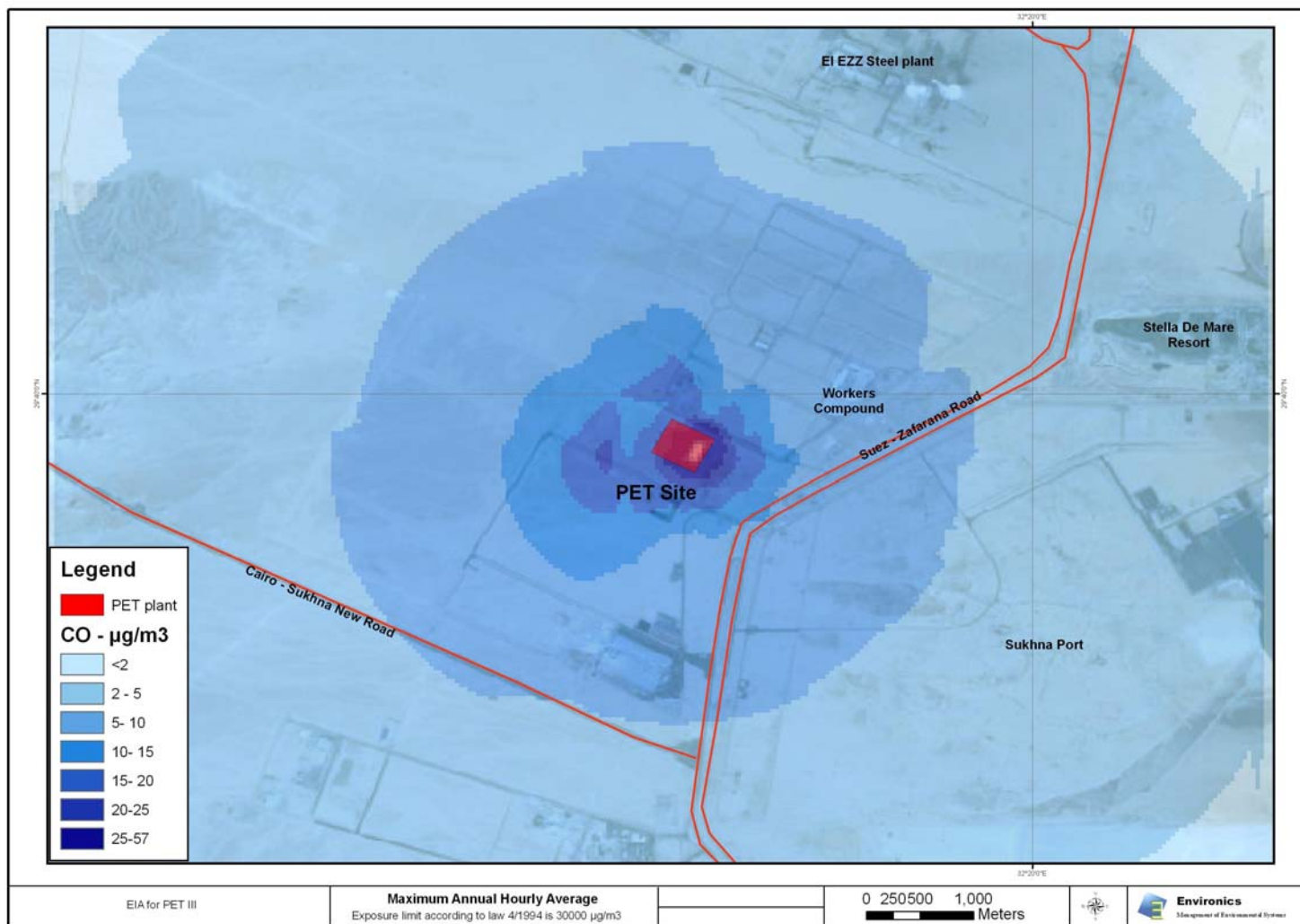


Fig (6.1): Maximum One hour average for Carbon monoxide CO

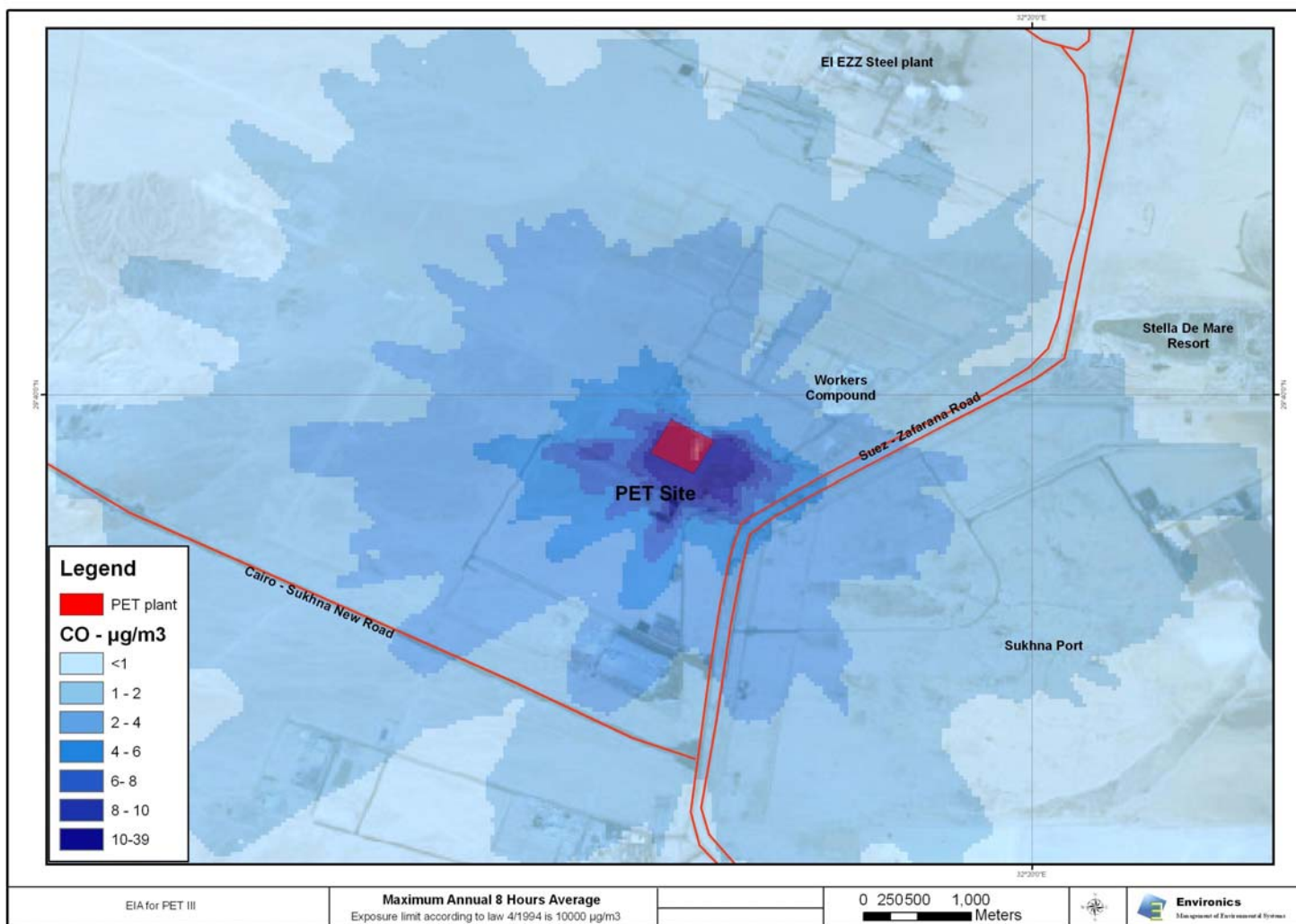


Fig (6.2): Maximum 8 hours average for Carbon monoxide CO

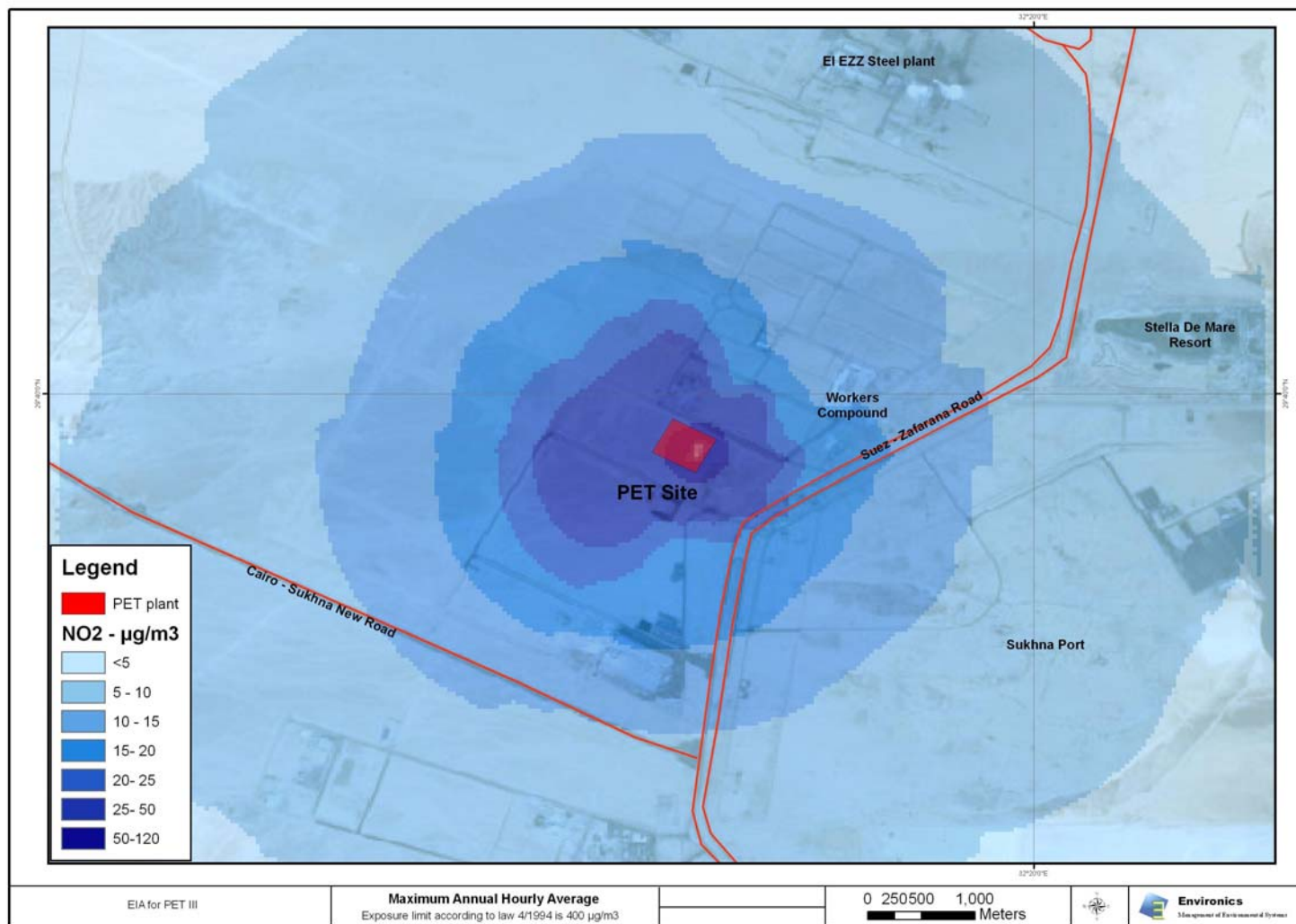


Fig (6.3): Maximum One hour average for Nitrogen dioxide NO₂

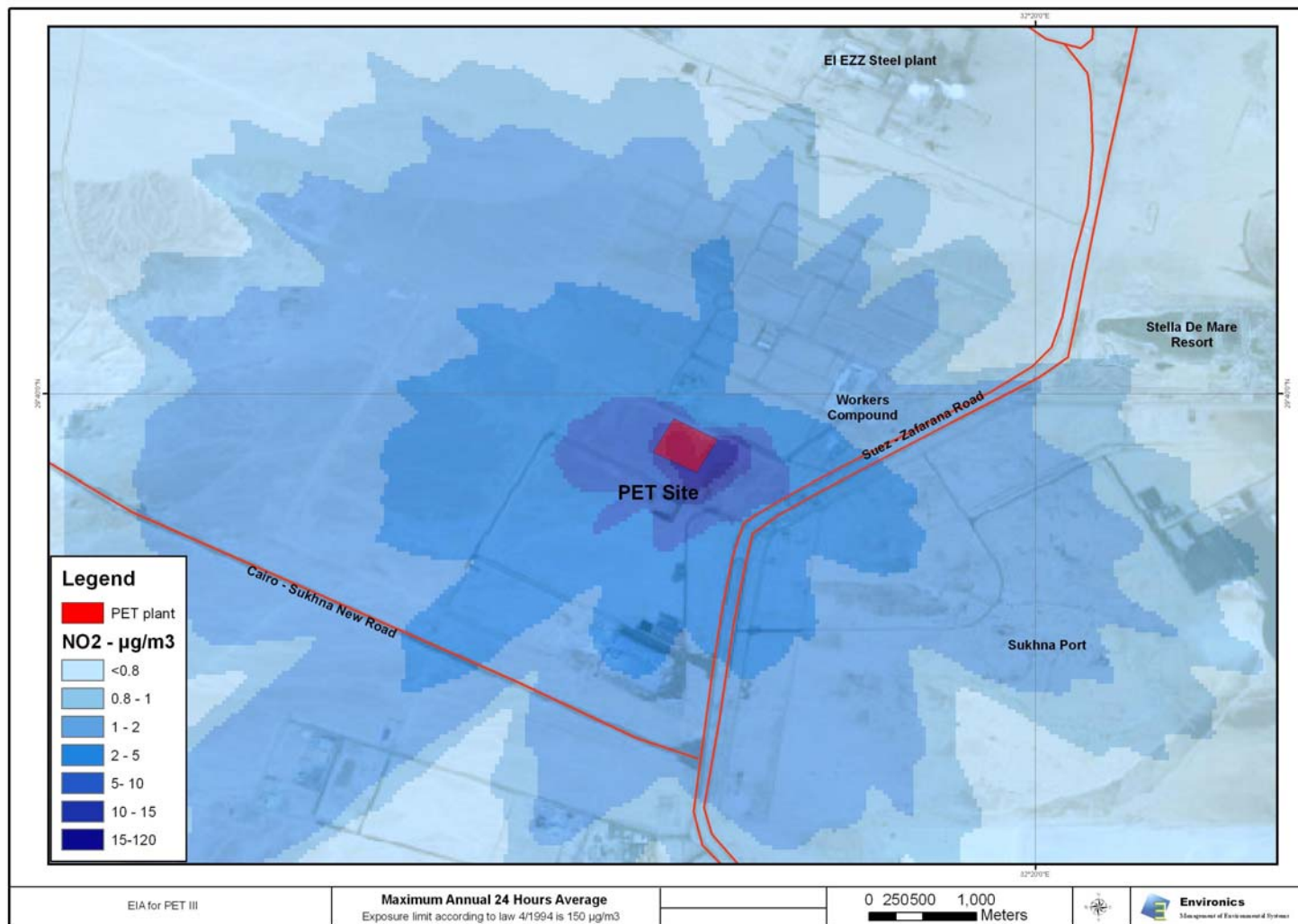


Fig (6.4): Maximum 24 hours average for Nitrogen dioxide NO₂

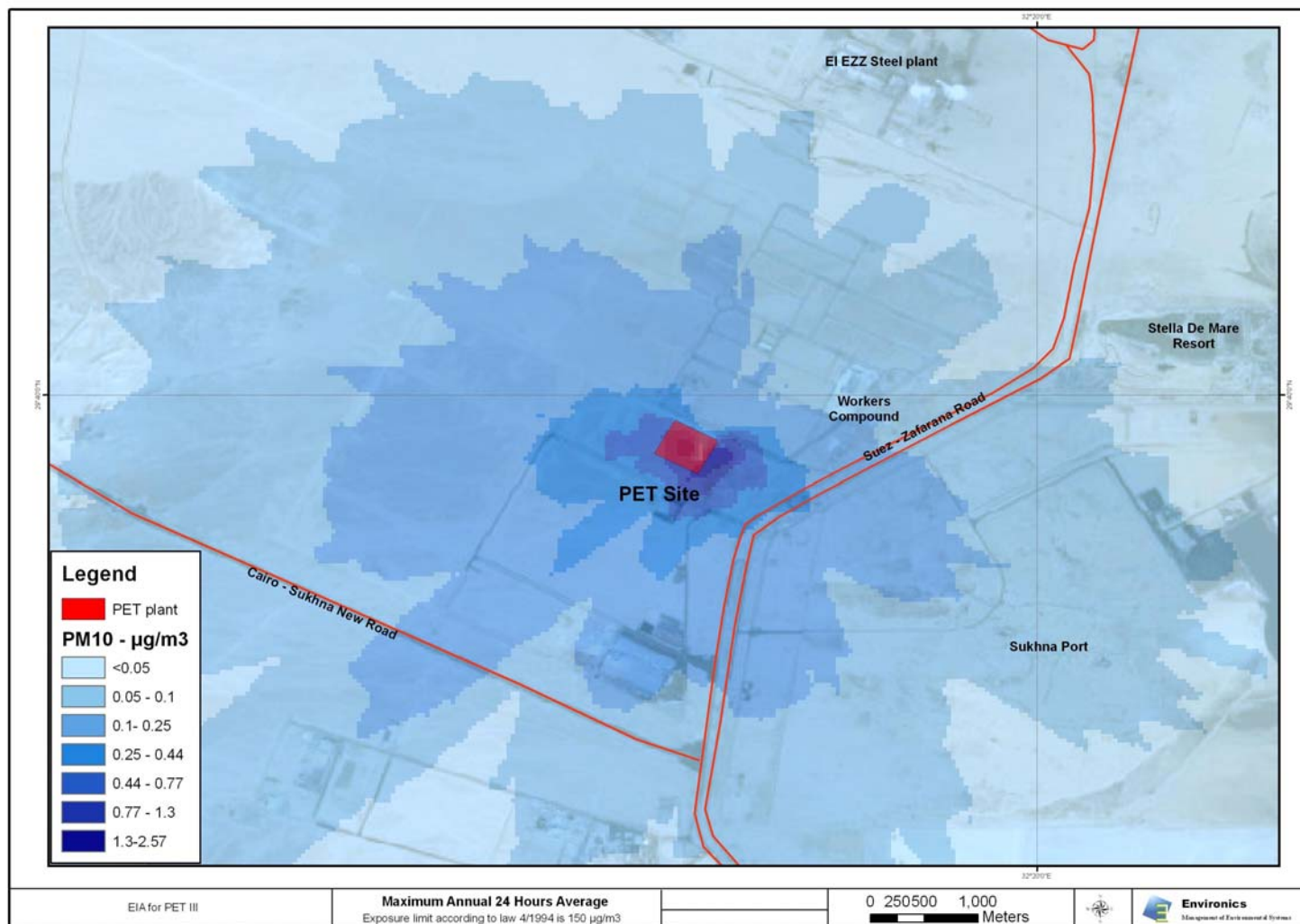


Fig (6.5): Maximum 24 hours average for Particulate Matter (as PM10)

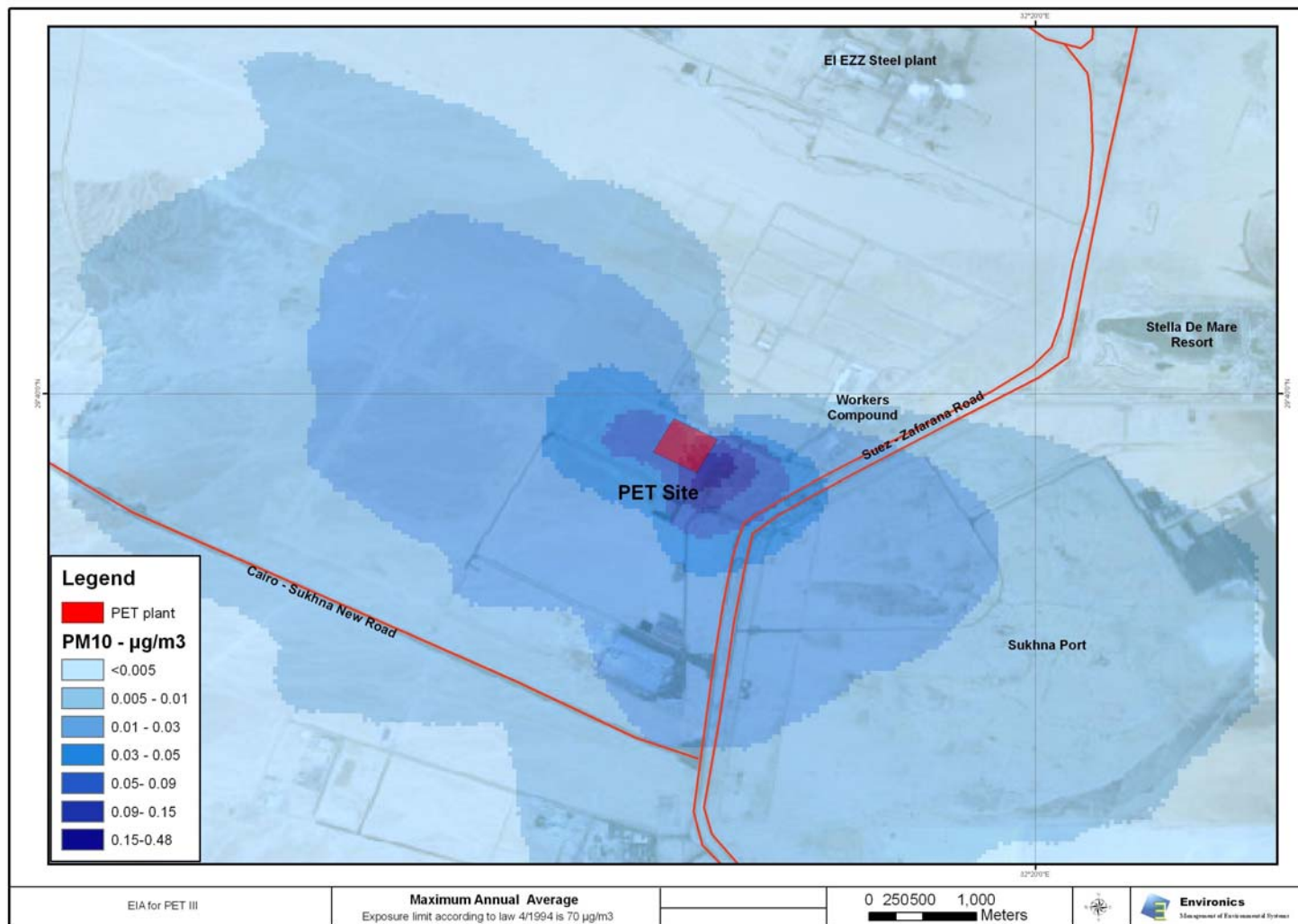


Fig (6.6): Maximum annual average for Particulate Matter (as PM10)

Greenhouse Gas Emissions

The PET manufacturing industry is not considered among the sectors that may have potentially significant emissions of greenhouse gases such as energy, transport, heavy industry (e.g. cement production, iron / steel manufacturing, aluminum smelting, petrochemical industries, petroleum refining, fertilizer manufacturing), agriculture, forestry and waste management. However, the contribution of the facility to greenhouse emissions are presented in this section.

The direct source of carbon dioxide emissions is the combustion of natural gas in the HTM heaters. The facility uses about 6000m³/hr of natural gas. Since the CO₂ emission factor for natural gas is estimated at 2.792 t/kg, the facility consumption of natural gas would contribute to the greenhouse gas emissions with about 273 t/day. Indirect source for CO₂ is the electricity consumption. As mentioned in chapter 3, the facility electricity consumption is 10 MW. Thermal energy generation in Egypt represents about 85% of the electricity generated from all sources (hydro, wind and thermal). According to the National New and Renewable Energy Authority, national average CO₂ emissions from electricity generation is about 0.527 t/Mwhr¹. This is expected to result in indirect CO₂ emissions of about 128t/day.

Energy Efficiency

The energy consumption per ton of product at the PET plant is about 240kWh/t. this is compared with the direct energy consumption of industry benchmark of the EU 1999 of 850 –1500kWh/t (*IFC Environmental, Health and Safety Guidelines for Petroleum – Based Polymer Manufacturing- April 2007*). Thus, the proposed PET project is not considered an intensive energy consuming project.

Residual impacts:

Design-integrated measures reduce the pollutants concentration to the limits stated in Law 4/1994 regarding stack emissions and ensure that no fugitive emissions are generated. Continuous monitoring. and preventive maintenance plans will ensure compliance with legal requirements as well as early detection of violations. Emergency, management and monitoring plans are described in chapter (7).

With the implementation of such plans, residual impacts are negligible

6.3.2 Noise levels

Construction phase

The use of construction equipment may result in localized, short term, increase in noise levels. Table (6.4) shows typical noise levels, in decibels, expected at various distances from construction machinery. It is not expected that noise from the construction activities would pose impacts on the neighboring areas.

¹ Annual National New and Renewable Energy Report , 2005-2006

Table (6.4) Average Noise Levels from Construction Equipment

Equipment Type	Distance from Noise Source (dBA)		
	10m	50m	100m
Crane	72	58	52
Bulldozer	74	60	54
Generator	76	62	56
Backhoe	79	65	59

Mitigation Measures

- When construction equipment are used, such as during site excavation, earth moving, and land grading, workers will wear ear protective equipment to minimize possible impacts from noise.
- Maintain machinery and vehicles in good working conditions to minimize noise generation.

Residual Impacts

Acceptable if mitigation measures are applied

Thus, noise resulting during construction activities is unlikely to have an impact on the general public. However, the impact of construction activities on workplace can be potentially significant. But with implementing the necessary mitigations measures and health and safety procedures, residual impacts are considered negligible.

Operation phase

Noise during operation can result from several sources, including compressors, air blowers and cutters. The average noise emissions from the different sources within the facility ranges between 70-80 dBA. However, this type of industry is not considered a heavy industry that would potentially result in increased noise levels and that the noise levels during operation activities.

Mitigation measures

- Potential noise generating machines and equipment are designed to meet statutory regulations concerning noise and vibrations.
- Acoustic enclosures are installed for casings of all noise generating equipment, wherever possible
- Workers at or near noise generating machinery and equipment will be provided with the necessary personal protective equipment (PPEs).

Residual Impacts

Although the contribution of the facility to the increase in noise level to the surrounding environment is minimal taking into account the design mitigation measures in place and due to the fact that the distance to the nearest sensitive receptor, thus all noise levels produced from the proposed facility would completely vanish by the time they reach the closest sensitive receptors. In addition, the industry is not considered a heavy industry that would potentially result in increased noise levels and that the noise levels during operation will comply with the national and international allowable limits.

Regarding the noise levels within the workplace, implementing the mentioned mitigation measures and implementation of effective occupational health and safety measures including providing the workers with the necessary PPEs and limiting the exposure period, the residual impacts in workplace are considered negligible.

6.3.3 Soil

Construction phase

The activities carried out during construction phase are unlikely to result in soil contamination that will need future decontamination and clean-up activities. Moreover, contracts with different contractors will include requirements for periodic inspection of equipment and machinery which will contribute to minimizing spills and leaks. Wastes generated during construction including municipal and construction waste will be collected by an approved contractor to be disposed of designated in landfill sites.

Mitigation measures

Mitigation measures mainly involve site management procedures and good housekeeping activities. The contractor will implement measures for spill prevention that will contribute to controlling and minimizing any potential impacts.

Residual impacts

With implementation of the mitigation measures, the residual impacts are negligible.

Operation phase

Soil contamination is unlikely to occur during operation since no process activities result in leakages or releases to the soil. In addition, the plant area is paved roads and concrete installations which will prevent any leakage into the soil. Thus, the three risk factors of 'Contaminants', 'Receptors', and 'Exposure Pathways' are not likely to co-exist at the project site. Therefore, soil contamination is not a potential impact.

Mitigation measures

Generally, the facility would be equipped with containment and emergency response procedures and equipment to manage emergencies or accident situations that can result in soil contamination. The facility environmental management plans and practices are described in detail in the next chapter (7).

Residual impacts

With implementation of the mitigation measures, the residual impacts are negligible.

6.3.4 Groundwater

Construction phase

The construction contractors will include requirements for proper operation practices that will prevent groundwater contamination.

Mitigation measures

There is no current massive demand on groundwater resources for drinking or other purposes, where most exiting facilities/communities are connected to the national network or rely on desalination of seawater. The contractor will implement all necessary measures for good housekeeping and spill prevention that will contribute to controlling and preventing any potential impacts inline with the company's HSE Requirements for Contracts.

Residual impacts

None

Therefore, impacts of construction activities on groundwater is negligible

Operation phase

Impact on groundwater might occur from potential leaching from temporary on-site storage of chemicals. However, project site will constitute of paved roads and concrete installations which will prevent any leakage into groundwater. Thus, the three risk factors of 'Contaminants', 'Receptors', and 'Exposure Pathways' are not likely to co-exist at the project site. Therefore, groundwater contamination is not a potential impact.

Mitigation measures

The mitigation measures mainly involve proper chemicals management as well as the spill prevention and preventive maintenance plans. This is to contribute significantly to avoiding groundwater contamination. The facility management procedures and spill prevention measures are described in chapter (7).

Residual impacts

None

Therefore, impact of operation phase on groundwater is negligible.

6.3.5 Public Health***Construction phase***

Impacts on public health are unlikely to occur due to the fact that there is no nearby residential area.

Mitigation measures

The management plans of the company will entail monitoring the construction activities to prevent any potential impacts.

Residual impacts

If proper mitigation measures are applied residual impacts of construction activities on public health are negligible

Operation phase

Impacts on public health from atmospheric emissions are considerably low and will not result in adverse impacts on public health in surrounding areas. This has been proven by the air dispersion of pollutants describes above.

Therefore, impacts of operation activities on public health are considered insignificant.

6.3.6 Workplace Health and Safety

Construction phase

Construction activities may result in safety hazards to construction workers from slips, trips and falls. These impacts are short term in nature, as they disappear after the termination of the construction phase. Stockpiles of construction and other materials such as fuel, oil etc., might also pose health and safety hazards if improperly stored or handled.

Mitigation measures

- Provide personal protective equipment (PPE)
- Properly store materials, and provide necessary measures against leaks and spills.
- Properly label areas of stockpiled material, provide proper access control measures to prevent accidental exposure, and provide personal protective equipment and first-aid kits.
- Store flammable materials in isolated, shaded, well ventilated area.
- Install fire extinguishers in designated places throughout the site.
- Implement all applicable occupational health and safety measures stipulated in the Egyptian labour law 12/2003
- Metal scrap, cut piping scrap, structural steel scrap, packing wood scrap will be sold for recycling
- Waste from temporary construction facilities will be disposed of in an appropriate manner.

The PET facility will ensure that the above-mentioned mitigation measures are addressed by construction contractor. This is in accordance with chapter 2 (construction and work sites) of the ministerial decree 211/2003, implementing Labour law 12/2003.

Residual Impacts

This residual impacts are considered negligible when the proper management procedures are in place.

Operation phase

All national occupational health and safety regulations mentioned in the labour law 12/2003 will be followed as well as the IFC requirements (IFC General EHS Guidelines, 2007- Section 2.0 Occupational Health and Safety) regarding occupational health and safety. Within this framework the facility will implement the following measures:

Emissions in the workplace

The different production processes carried out in the facility take place in an open work environment. However, where confined working areas exist, especially in the area of handling of raw materials and products, dust emissions are potentially generated. For such area proper ventilation will be applied.

Mitigation Measures for workplace emissions:

In this regard, the following measures will be undertaken:

- Preventive maintenance for the different equipment
- Proper handling and storage practices will be developed for the raw materials and products.
- The necessary PPEs will be provided to workers handling such chemicals
- Implement company's HSE plans in compliance with the national laws as well as the IFC General Health and Safety Guidelines
- Utilization of automatic means for handling the raw materials and product packaging

Noise

As previously described in chapter (3), noise during operation potentially results from a number of sources including air compressors, air blowers in the SSP unit and cutters in the CP unit. However, no personnel are continuously working in the production area.

Mitigation measures:

- The use of hearing protection should be enforced actively near noise generating equipment
- Periodic medical hearing checks should be performed on workers potentially exposed to high noise levels.

Occupational Health and Safety

According to the requirements of the ministerial decree 134/2003 of the Ministry of Labour and Manpower implementing law 12/2003, an occupational, environment health and safety committee will be formed comprising of various disciplines of the employees and top management. A Safety committee will also be formed. Besides, the facility will comply with the requirements of the ministerial decree 211/2003 to prevent adverse physical, chemical, biological and mechanical hazards in the workplace. In this context, the facility will develop detailed emergency plans to protect the workers and the facility in emergency situations. The outline of the emergency plan is provided in the following chapter 7. The facility will also abide by the IFC guidelines addressing occupational health and safety issues as per the IFC General Health and Safety Guidelines.

In light of the above it is clear that the impacts during construction activities are localized and short in duration and this have limited significance on the surrounding environment and the work environment. Impacts during operation are mainly affecting the work place environment, whereas off-site impacts are not significant. In this respect, impacts on the work environment are minimized through implementation of effective operation control and health and safety measures.

Residual impacts

The residual impacts are considered minor with the implementation of proper HSE and emergency measures

6.3.7 Risk

The current ESIA study encompasses a quantitative risk assessment to identifying the potential impacts that would result in extreme hazard cases on the surrounding environment. This study attached in Annex (5) of this ESIA presents in detail the results of the individual components of the risk assessment, including the hazard identification, frequency assessment, consequence assessment and risk calculations. These results are compared with the applicable criteria to determine the acceptability of the risk associated with the proposed installation.

The QRA addresses mainly acute, rather than chronic hazard events. This means that emphasis is placed on rare but potentially hazard incidents resulting in fatalities and/or severe injuries, whereas chronic impacts are addressed in detail in the different sections of the ESIA report.

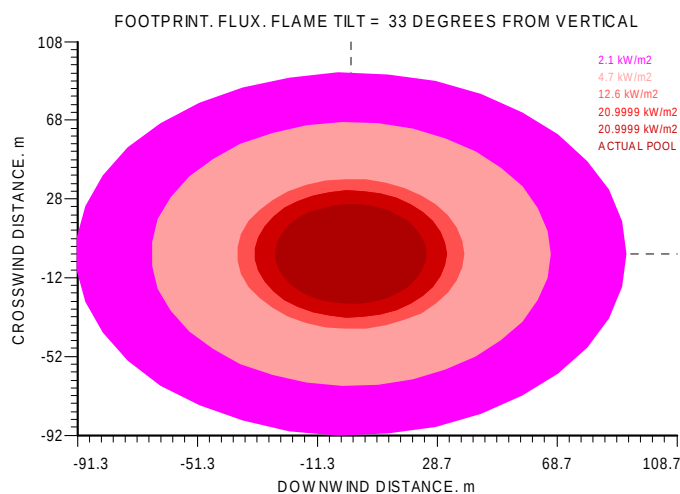
Within this context, the MEG storage tanks and their outlet piping are representative for liquid systems group such that a certain failure within that group could result in similar consequences.

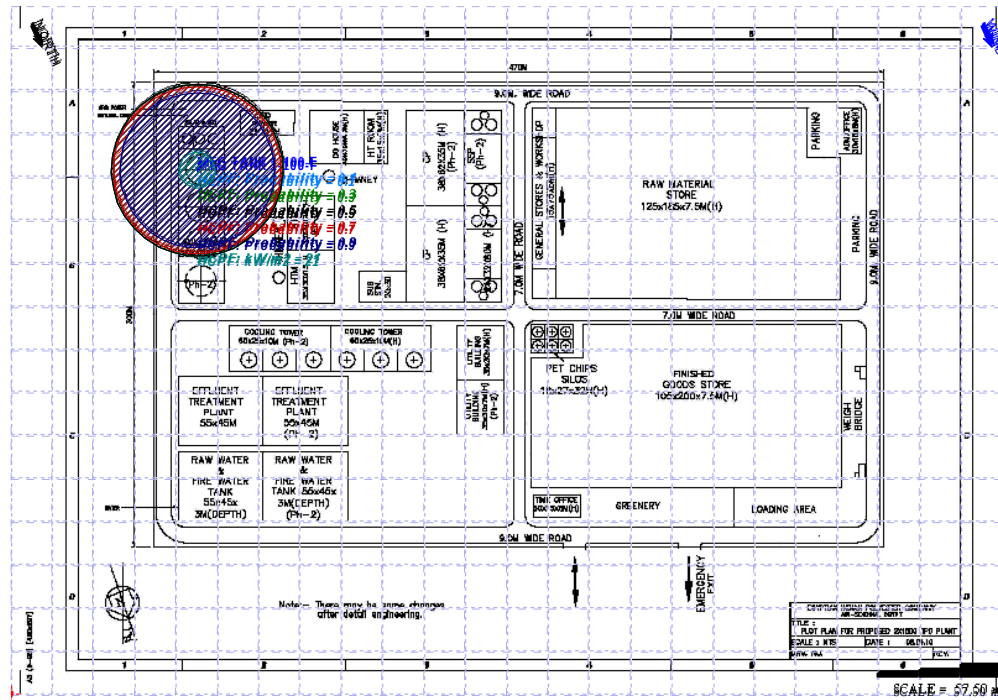
In this context, the hazardous scenarios identified for the tanks are associated with the release of stored MEG from the tanks. The hazard scenarios considered for the QRA are release from MEG tanks resulting in a pool followed by pool fire in presence of fire source..

The results of the QRA software, SUPERCHEMS, indicated that the consequence from the hazard scenarios, namely the heat flux from the pool fire do not extend beyond the tank farm area. Thus the risks at the overall site a minimal and the off-site at the sensitive receptors do not exist.

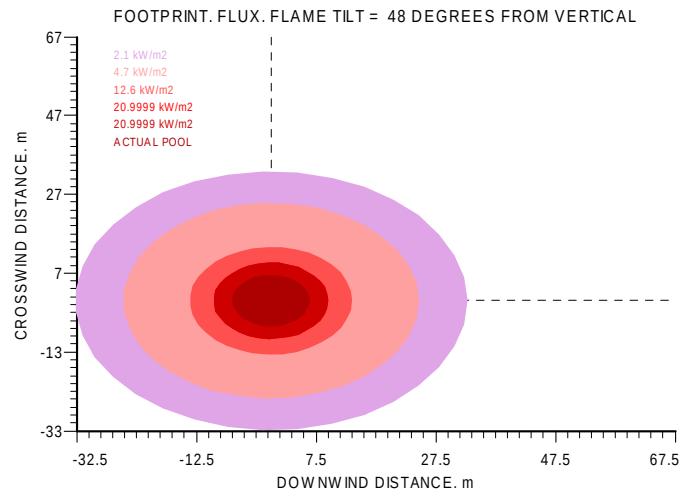
The following figures show that consequence contours for the heat flux resulting from potential pool fire.

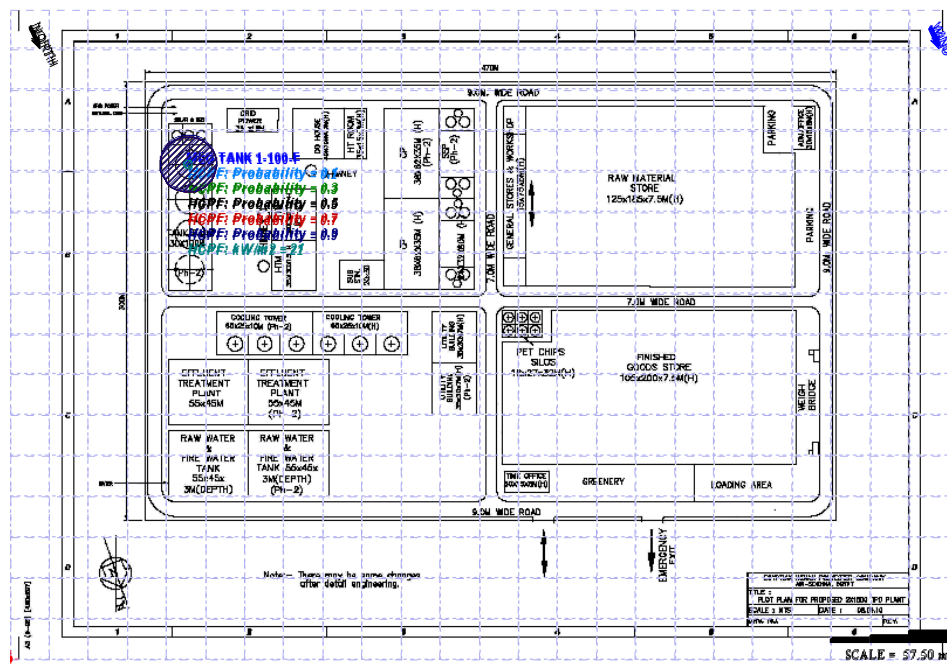
MEG Tanks- 100mm hole size





MEG Tanks – 25mm hole size





6.3.8 Biological Environment

Important species of conservation value do not occur within the project site and its close hinterland as the area has experienced intensive anthropogenic changes due to the establishment of the port and numerous industrial facilities. The most important ecological feature of the Ain Sukhna is its location along a major flyway for Palearctic migrant birds. However, the project site and its vicinity have lost their importance as bird resting stations as result of habitat disturbance from man-made activities.

Construction Phase

Site clearance, leveling and excavation works pose the main source of direct impacts to floral and faunal species as these activities involve physical destruction of habitats. The impact of vegetation clearance and habitat destruction within the site boundaries is irreversible and cannot be mitigated.

However, project sites represent a small portion of the vast coastal desert plain and are not considered as critical habitats. The scattered vegetation cover of the sites is composed of common species which are widespread in the Eastern Desert.

Gaseous emissions, noise and vibrations from construction machinery are short term impacts that can disturb wildlife of the surrounding area and it is known that lights can create disturbance to migrating birds.

Mitigation Measures

- Select construction equipment, especially during site preparation, leveling and clearance activities, that will reflect minimum impact; e.g. the use of hydraulic excavators is preferred over bulldozing for their superior work area control;
- Implement mitigation measures to reduce emissions, noise and vibrations, as detailed in previous sections;
- Take notice of important seasons for bird migration, breeding seasons, etc., in order to reduce impacts on wildlife;
- Avoid working at night and using high energy lights;
- Use, as much as possible, native floral species for landscaping;
- Identify clearing limits preferably using hazard fencing to minimize disturbed area;
- Develop, implement and update a waste management plan to include waste collection, storage, transport and disposal in an environmentally sustainable manner. Pest species such as rodents and insects tend to colonize around wastes.

Residual impacts are minor with proper mitigation and management measures are implemented.

Operation Phase

During operation, the main impacts on wildlife of the area may arise from gaseous emissions, noise and vibrations and artificial lights posing similar impacts of those of the construction phase, but on the long term. On the other

hand, results of air dispersion modeling indicate that the emission concentration for the different parameters in the project vicinity are much below the Egyptian maximum allowable ground level concentrations.

The presence of high stacks might increase the risk of collisions of migrating birds flying at low altitudes. This impact can be hardly mitigated; however surveys of the project site and vicinity have shown a low presence of birds due to the spreading of human and industrial disturbing activities. It is thus possible that migrating birds have modified their migrating route to avoid the industrial area.

Mitigation Measures

- Implement mitigation measures to reduce emissions, noise and vibrations, as detailed in previous sections;
- Take notice of important seasons for bird migration, breeding seasons, etc., in order to reduce impacts on wildlife;
- Night lighting should be managed particularly during the migrating season, unobtrusive lights should be used and angle of light fixtures should be assigned to prevent unnecessary light spread;
- Select and use fertilizers, herbicides and pesticides with caution;
- Develop, implement and update a waste management plan to include waste collection, storage, transport and disposal in an environmentally sustainable manner to avoid spreading of pests.

Residual impacts are minor with proper mitigation and management measures are implemented.

6.4 Social Impacts

The project is located in Eldorado industrial zone in Sokhna area an already industrialized area. Thus, no involuntary resettlement will be required. The existence of the Port and the industries in the area have made people accustomed to the presence of industrial projects and made them familiar with the presence of foreigners.

6.4.1 Employment

Construction phase

The construction phase of the project will provide employment opportunities for an average of 1000 workers. Priority will be given to the community local workforce during labor selection to further enhance positive impact on the local community. It is expected that during the construction phase, foreign workers will be involved in the project.

Mitigation

To mitigate the negative impact that may result from the presence of foreign labor several measures could be taken. The contractor will be instructed to use local labor as much as possible. A well developed Public Consultation and Disclosure Plan which engages all stakeholders in the consultation process will reduce the impact and moderate communication and understanding

between the two groups. It will be clarified that use of foreign labor will be for short period and only during the construction phase.

Operation phase

The project has the potential to decrease unemployment levels in the area by creating employment opportunities in the industrial sector. Furthermore, secretarial and administrative jobs that can be offered by the project has the potential to produce working opportunities for females.

6.4.2 Impact on Cultural Environment

The presence of foreign labor, with a cultural background that is different from that of the locals may cause some cultural tensions. However, the locals are used to the presence of foreigners in the port area. Moreover, it is unlikely that there will be any cultural tensions between foreign workers and the locals, as the foreign workers will be instructed to respect the traditions and the cultural customs of the area.

Mitigation

The foreign workers will be instructed to respect the local prevailing culture.

6.4.3 Infrastructure

Water

Quality of services for provision of potable water is a national problem and not unique to Sokhna area. Even though most houses are connected to water pipelines, as statistics show, some nationwide households do not receive water regularly.

Mitigation

The total water requirements of the facility is about 1700 m³/day, about 1100 m³/day will be supplied by Tap Water Company, the remaining quantity (about 620 m³/day) will be available through extensive recycling of the generated wastewater (water from esterification and the wastewater from the different utilities mainly the blow down of the cooling tower).

Roads

The Port is about 1.5 km away north east of the industrial zone. Transportation of raw materials and products are the main issues of concern when addressing the impact on roads within this ESIA. The quantity of transported raw materials and products from and to the port are estimated to be about 1,161,986 t/year taking into consideration that the product quantity for national consumption is about 20%, which will be transported to the local market through the large road network connecting Sokhna and the other governorates. In this respect, the estimated number of trips transporting the raw materials from the port to the facility is about 5 trucks/hour (assuming average truck capacity 40 tons. This is not expected to have significant impacts on the roads network in the area.

Electricity

The impact on electricity will be insignificant because the amount of electrical energy used is relatively low 10MW.

6.4.4 Community Health

Atmospheric emissions are considerably low as been demonstrated by the mathematical modeling of dispersion of atmospheric pollutants. Therefore, impacts of operation activities on public health are considered not significant

6.4.5 Aesthetic Impact

The presence of an industrial facility will impact the visual aspect of the area. However, the already existing industries have already altered the visual appearance of the area. Thus, the proposed project will not have a significant impact but will contribute to the gradual change of place which the area is experiencing.

Mitigation

In order to manage people's fears and concerns, as they see their environment changing. A well developed Public Consultation and Disclosure plan will mitigate people's fears and reduce the level of impact. In this respect, they will be clarified that positive impacts, namely providing job opportunities and contribution to improving the social status of surrounding communities, will significantly contribute to mitigating the potentially negative aesthetic impacts.

6.4.6 Tourism

The location of the proposed project is far from the tourist area to have a significant impact.

7. Environmental Management Plan

The project's environmental management plan (EMP) consists of a set of mitigation, monitoring and institutional measures to be taken into consideration during the construction and operation phase to ensure the sound environmental performance of the project. The plan also includes the actions needed to be taken to implement these measures.

The project's EMP consists of the following:

- **Summary of the impacts**
- **Mitigation measures** to identify feasible and cost effective measures that will reduce potentially significant adverse environmental impacts to acceptable levels as discussed in Chapter (6).
- **Monitoring Plan** during project implementation to provide information about key environmental aspects of the project, particularly to monitor environmental impacts of the project and the effectiveness of mitigation measures.

7.1 Summary of Impacts

As discussed in chapter 6, impacts were categorized into the following.

Table (7.1) Impacts Categories

Potentially Significant impacts	Insignificant impacts	Irrelevant impacts
Operation phase - Air emissions in workplace - Air emissions impacts on surrounding environment - Noise levels in workplace	Construction phase - Air quality - Soil quality - Noise level - Groundwater - Public health - Workplace health and safety Operation phase - Noise impact on surrounding environment - Impact on soil - Impact on groundwater	Impact on marine water quality and aquatic life

It should be mentioned that for the project in hand, many proactive preventive measures were taken into consideration during an early stage of the design phase. Moreover, all residual impacts are mitigated/addressed through an integrated management plan as will be described in section (7.2) below.

7.2 Mitigation Measures

The mitigation measures for this particular project include measures integrated in the project design as well as management and monitoring plans and procedures as discussed previously in chapter 6 above. Following is a brief summary of the mitigation measures for the construction and operation phases previously discussed in chapter (6). The mitigation measures either address the environmental aspect (for example contributes to preventing/ avoiding/ minimizing the occurrence of the aspect) or address the potential exposure to the impact. The facility EMP plan will be developed in accordance with the relevant national regulatory requirements as well as the IFC EHS guidelines.

7.2.1 Construction Phase

Contractors commissioned for the construction will be required to undertake the necessary measures to protect the environment and the workers. PET facility will ensure that contractors will carry out necessary measures to minimize impacts. This is to be included in the contractor's scope of work (contract). This is in accordance with chapter 2 (construction and work sites) of the Ministerial Decree 211/2003, implementing Labour law 12/2003 as well as the IFC EHS guidelines.

Table (7.2) presents a summary of impacts during construction, the possible mitigation measures and the elements addressed.

Table (7.2) Summary of Impacts of the Construction Phase and Related Mitigation Measures

Parameter	Measures	Elements addressed
Air quality	- Dust suppression - Maintaining machinery and equipment - Frequent inspection of all construction equipment	Aspect
Noise level	- Using PPE - Machinery maintenance - Restrict noise generating activities to morning hours	Exposure/ Aspect
Soil and groundwater	- Implement measures for site management, good housekeeping and spill prevention	Aspect
Workplace Health and Safety	- Provision of PPE to workers - Adopting spill prevention plans - Proper material storage, labeling and handling - Installing fire detection and fighting system - Proper waste management	Exposure/ Aspect

7.2.2 Operation Phase

Table (7.3) Summary of Impacts of the Operation Phase and Related Mitigation Measures

Parameter	Measures	Elements addressed
Air quality	- Use of NG fuel in HTM heaters - Burn off-gases from stripper with NG - Control fuel/air ratio to reduce CO formation	Aspect
Noise levels	- Machinery and equipment designed according to standard specifications - Acoustic enclosures are installed for casings of all noise generating equipment - Provide workers with PPEs	Exposure/Aspect
Soil and groundwater	- Adopt spill prevention plans - Provision of containment and emergency response procedures and equipment	Exposure/Aspect
Workplace Health and Safety	- Utilize automatic means for handling chemicals and products. - Abide by all national occupational health and safety regulations as well as IFC EHS guidelines - Planning for preventive maintenance programs - Provision of suitable PPE	Exposure/Aspect

7.3 Institutional Arrangements

Stemming from its concern for ensuring high standard of environmental performance, the facility is committed to meet the stipulations of national environmental and labour laws, no 4/1994 and 12/2003 respectively as well as the IFC HSE guidelines. Furthermore, the facility will have an HSE policy, which presents part of its contract with ECHEM, which it is corresponding to the Requirements for Sharing Agreements. The outline of the HSE policy requirements for EHCHEM and PET facility is summarized as follows:

- Carry out Environmental Impact Assessment
- HAZARD studies with complete risk assessment.
- HSE training for all staff in safety and emergency plans and procedures,
- Emergency Plans to be updated and integrated with Egypt's National Emergency Plan and other national plans for protecting the environment and public health and safety.
- Audits HSE Requirements for Contracts

7.3.1 Human Resources Policy

The National Labour law 12/2003 addresses the employment relationships including the individual working contracts, the wages, the workers responsibilities as well as the organization of the work including the working hours, the overtime and the vacations. Within this framework, the facility will

develop its human resources policy in light of the national labour law as well as in light of the International Finance Corporation's Guidance Notes: Performance Standards on Social & Environmental Sustainability, July 31, 2007. Following is an outline of EIPET Human Resources Policy:

- Entitlement to and payment of wages; permissible wage deductions;
- Overtime payments; hours of work and any legal maximums;
- Entitlement to leave for holidays, vacation, illness, injury, and maternity and other reasons;
- Entitlement to benefits;
- The employees' right to form and join workers' organizations of their choosing without any interference or employment consequences and to bargain collectively with the employer;
- Disciplinary and termination procedures and rights;
- Conditions of work;
- Vocational training opportunities

7.3.2 Health and Safety Policy

According to the requirements of the ministerial decree 134/2003 of the Ministry of Labour and Manpower implementing law 12/2003, an occupational, environment health and safety committee will be formed comprising of various disciplines of the employees and top management. A Safety committee will also be formed as well as an environment department. Within this framework, following are the key responsibilities for the different departments:

Responsibilities of the Safety Department

Fire department comprises dedicated firemen who will maintain the fire truck, fire hydrant system, fire alarm system and fire extinguishers in the plant. Safety officer will also be in-charge of fire department.

Responsibilities of the HSE Department

These include, but not limited to the following:

- Maintain and update the environmental register and HW register of the company
- Develop and review of company HSE policies and maintain periodic communication meetings.
- Monitor the different pollutants in the workplace and identify measures for pollution minimization and control
- Determine in cooperation with different departments, occupational, health, safety and environmental criteria and identify the necessary personal protective equipment.
- Contribute in organizing awareness and training programmes and workshops for all employees in cooperation with the different concerned bodies and institutions.
- Carry out daily inspections to ensure compliance of workers HSE requirements. Safety audit and environmental audit will be conducted by internal and external audit agencies.
- Maintain register for occupational health and safety management procedures.

- The head of the HSE department will be also the focal point for the environmental and socioeconomic issue in cooperation with the external communities

First aid clinic will be also established inside the facility with visiting doctor. The company will establish contacts and understanding with the nearby hospital to treat the injured personnel. Mutual aid system will also be discussed with the neighboring industries to have enough medical facilities in the vicinity for the workforce.

7.4 Management Plans

Within its commitment to ensure environmental protection and maintain efficient environmental performance, the facility will develop various environmental management plans addressing the different environmental aspects. The different environmental dimensions will be incorporated throughout the operation of the plant. In this regard the environmental plans to be developed will address:

- Hazardous and solid waste management
- Chemicals management
- Preventative maintenance
- Spill Prevention Plans
- Housekeeping
- Fire Fighting and emergency response
- Training and awareness

The following sections provide details of the different environmental management plans.

7.4.1 Hazardous Waste (HW) Management

HW Identification

The identification is carried out according to the HW list issued by the Ministry of Industry in 2002. Accordingly, HW generated from the different processes include:

- used oils,
- filters used in the catalyst filtration section and
- spent catalyst containing platinum used in SSP reactors.

The hazardous waste management guidelines¹ issued by EEAA provide best practice information regarding proper identification of HW and the compatibility requirements that should be taken into considerations during storage and handling of the different hazardous wastes.

Hazardous Waste Segregation

HW will be separated from other types of non-hazardous waste. Proper identification of hazardous waste forms a basis for waste segregation. It is therefore essential that all personnel are familiar with waste identification.

¹ EEAA has issued guidelines for HW classification, on-site storage and off-site transportation.

On-site HW Storage

HW will be temporarily stored on-site in specifically designated area according to the stipulations of law 4/1994 and its executive regulations.

HW Disposal

- Used oils will be collected and temporarily stored till transfer off site. According to the national used oil management system, used oils are collected by Petrotrade oil contractor that is authorized by EGPC for collection and recycling of used oils.
- The catalyst used at EIPET contains precious metal that is platinum, which will be returned to the supplier for metal recovery.
- Regarding the PP filters and the sludge generated from filter cleaning, these are stored temporarily on site till final disposal in the Hazardous Waste Management Centre in Nasreya - Alexandria

HW Register

A HW register will be maintained including information about the type and quantity of the generated waste and methods of its disposal.

7.4.2 Solid Waste Management

The generated solid waste will be safely managed during all phases, including generation, handling, storage and final disposal. Minimization of solid wastes at sources will be adopted. This includes the following:

- Reducing the generation of off-spec product by optimizing the operation control
- Minimizing the losses at the final product bagging, by continuously inspecting the bags quality and minimize manual interference.
- Collection and disposal of solid waste will be in areas designated by Suez governorate.

Solid wastes management will be carried out in accordance to the requirements of Laws 4/1994 for the Environment and 37/1967 for General Cleanliness.

7.4.3 Chemicals Management

Operation chemicals are received in solid form and stored in silos. The used chemicals are not classified as hazardous substances according to the Ministry of Industry list, issued by the ministerial decrees 7/1999 and 851/2006, for hazardous substances that should only be handled with a permit from the industry development authority. Water treatment chemicals will be directly unloaded into storage tanks near the DM plant. Proper handling procedures for such chemicals will be developed in accordance with the instruction of their Material safety Data Sheets (MSDS). Records will be maintained for the types and amounts of the different chemicals including their MSDS in accordance to article 211 of the Labour Law 12/2003 and the decree of the Minister of Labour and Manpower no. 211/2003 regarding requirements to prevent adverse physical, chemical, biological and mechanical hazards in the workplace. Article 34 of decree 211/2003, stipulates that companies should prepare, records/ reports/register for chemical safety including the following information:

- Types and quantities of chemicals and their physical and chemical characteristics
- Potential hazards on human health and the environment if not properly handled
- The emergency response, fire fighting and first aid measures
- Proper storage and transportation procedures
- Proper disposal for chemical waste
- Date of preparation of the document

7.4.4 Preventive Maintenance

Various types of planned activities (preventive, predictive) are undertaken with the basic objective of avoiding the need for emergency (breakdown) maintenance and the corresponding loss of plant profitability. Preventive and predictive maintenance procedures will be used to maintain the compressors, pumps, pipes and fittings. Specific inspection programs are carried out periodically to maintain the machines online. All the static equipment and piping will undergo Non Destructive Examination (NDE) methods and will be operated with scheduled preventive and predictive maintenance as per the schedule. The facility's preventive maintenance program will include the following basic elements:

- Inventory of equipment with detailed design and operating parameters.
The operating parameters are monitored and are indicators for predictive maintenance.
- A record of failure rate and causes
- Evaluation of condition of equipment using the following criteria:
 - Maintenance cost per unit of product
 - Downtime due to maintenance
 - Percent of planned maintenance hours as compared with emergency maintenance
 - Determination of corrective action

Record keeping of equipment checks, repairs, cleaning and equipment failure indicate will be carried out. Maintenance measures include inter alia:

- Maintaining equipment history cards at equipment locations.
- Maintaining a master preventive maintenance (PM) schedule.
- Keeping vendor maintenance manuals handy
- Maintaining a manual or computerized repair history file.

Maintenance schedule will be prepared for mechanical work as well as periodic replacement of parts before breakdown occurs. Equipment to be checked includes but not limited to:

- Fire detectors
- Filters
- Temperature controllers
- Protective equipment
- Developing leak detection and repair programs (LDR).
- Calibration of all instruments related to alarming and inspection to safeguard process interlocks and machinery protections will be carried out periodically by master instruments

7.4.5 Spill Prevention Plan and Storage Precautions

Spill and leaks prevention are critical to pollution prevention. The necessary procedures will be in place for safe handling of chemicals that could cause spillages/leaks particularly MEG and DEG. Normally spills are minimized/prevented through the implementation of a good chemicals management system as well as the adoption of preventive maintenance programs. On the other hand, in the accidental event of any spill, appropriate provision is made for handling such spills.

Spill response plans

The facility will develop a spill response plan and procedures to ensure effective and prompt actions in case of emergency spills. The complexity and detail of the plan will, depend upon the physical characteristics and volume of materials being handled, their potential toxicity, and the potential for releases to the environment. The outline of the spill response plan includes the following measures:

- Review of Material Safety Data Sheets (MSDSs) or other references for recommended spill cleanup methods and materials, and the need for personal protective equipment (e.g., respirator, gloves, protective clothing, etc.)
- Acquire sufficient quantities and types of appropriate spill control materials to contain any spills that can be reasonably anticipated.
- Names and telephone numbers of individuals to be contacted in the event of a spill.
- Evacuation plans for the room or building, as appropriate.
- Instructions for containing the spilled material, including potential releases to the environment (e.g., protect floor drains).
- Inventory of spill control materials and personal protective equipment.
- Develop decontamination procedures of the area following the cleanup.
- Discuss the spill response plans with all employees in the area and who are expected to respond outside their work area to assist with spill cleanup.

7.4.6 Housekeeping

Regarding housekeeping of the plant, a safety committee will periodically inspect the plant to ensure proper housekeeping. Good housekeeping practices will be followed such as:

- Optimizing the use of water for cleaning purposes.
- Performing adequate noise and heat stress protection measures in the related places within the facility.
- Minimizing the spills during handling, transport of raw materials and product.
- Minimizing the product losses

7.4.7 Fire Fighting Plan

All plant buildings and areas will be provided with extinguishers (water, powder, CO₂ ...etc) that are suitable for the type of fire. In case of fire, the initial response will be to sound the alarm and evacuate the area according to a well designed evacuation plan. A fire fighting plan will be developed in a later

stage prior to the project operation and is to be approved by the Civil Defense Authority. The company should consider the level of local fire fighting capacity and whether equipment is available for use at the facility in the event of a major emergency or natural disaster.

7.4.8 Emergency Preparedness and Response Plans

PET plant will have a written Emergency Response Plan, to respond to and mitigate any accidental release to minimize the impact on employees, community, and environment according to the national laws and the IFC HSE guidelines. Employees will be trained on the implementation of the plan and on response activities that could be required in the event of an emergency.

The company is committed to the following:

- A knowledgeable, highly trained, and motivated employee group
- Improvements that enhance safety and accident prevention where appropriate
- A superior safety and accident record
- Preparation and training for emergency response and mitigation

In addition, the written emergency plan will be prepared to address the following phases:

- Preparedness, includes the activities which government, organizations and individuals are communicated for rescuing and minimize damage.
- Response, includes the actions necessary to minimize loss of life and property damage and provide emergency assistance.
- Recovery, includes short and long terms activities which restore the process operation and help return the facility and surroundings to normal state.
- Mitigation, includes the activities which eliminates or reduce the probability of disaster.

The following section outlines the facility's emergency plans:

Chemical Specific Prevention Program

The company will have written policies and procedures addressing all aspects of Process Safety Management. The Prevention Program will contain elements and policies which are briefly outlined below.

- *Employee Participation* - Employees will be involved in all aspects of the program and will be provided any information developed in the program.
- *Process Safety Information* - All necessary process information and records will be maintained including information on the hazards of the chemicals, process technology with safe operating procedures, and equipment records and design requirements
- *Process Hazard Analysis* - Process hazard analysis and review will be conducted by employee teams to identify and correct any perceived hazards.

- *Operating Training* - All operators will be initially trained on the process and its operating procedures and will receive refresher training.
- *Contractors* - Contractor selection will include review of safety performance and programs. Contractors will be oriented to known hazards in the company, the emergency plan, and are required to adhere to company safe work practice procedures
- *Mechanical Integrity* - Procedures for inspection and testing and correction of equipment deficiencies will be prepared.
- *Compliance Audit* - Compliance with the program will be audited periodically to verify compliance with these procedures. Findings, if any, of the audit will be documented and any deficiencies will be corrected and documented.

Emergency Response Plan

An emergency occurring at any plant or installation may cause injuries or loss of life or damage to property or disruption inside as well as outside the premises. The emergency could be a result of abnormal functioning within the facility or caused by third parties or by natural factors. If the emergency becomes uncontrollable and leads to damage to life and property in the industry and its neighborhood, it may be defined as off-site emergency. An emergency, which can be controlled with the available resources and does not spread outside the plant boundary, is termed as on-site emergency.

Objectives of on-site emergency plan

1. Controlling the emergency
2. Saving human lives
3. Minimizing damage to property and environment
4. Restoring normalcy

The on-site Emergency Plan is prepared to tackle emergencies effectively so as to avoid an off site emergency.

- Alarms, pre-alarms, fail safe shut down procedures, and uninterrupted power supply are built in during the design stages. All critical operations are connected to captive power generation plant
- A hydrant system will be established. Smoke detectors and fire alarm points are to be provided wherever required at a number of places in the plant area. Automatic fire detection and extinguishing system will be provided if required.
- The company will interact with the various local agencies in its emergency planning such as local fire departments; law enforcement agencies (such as the police) and hospitals.

Preliminary Hazard Analysis and Mitigation

Classification of emergencies based on release of toxic/flammable gases or spill of flammable/toxic liquid into atmosphere are mentioned below:

- (1) **Class ‘A’ : Level I Emergency**
Minor leaks/spill arising out of gland/flange leaks or leaks/spills from drums/carboys or breakage of bottles containing hazardous chemicals etc. - serious injuries requiring medical attention.
- (2) **Class ‘B’ : Level II Emergency – On Site Emergency**
Major leaks/ spills of toxic/ flammable liquids/ gases from process/storage resulting in atmospheric/ground pollution
- (3) **Class ‘C’ : Level III Emergency – Off Site Emergency**
Release of large quantity of MEG, caused by catastrophic failure of storage tanks or vessels.

The spills/release under Class ‘A’ are the most commonly encountered type and are easily handled by the operating personnel by taking necessary actions with the available resources in the section.

Accidental occurrences involving spills under Class ‘B’ will require initiating the steps for on-site emergency procedures of the plant and are unlikely to spread beyond the plant boundary.

Situation, which can be truly described as off-site emergency can occur only out of spills, mentioned under Class ‘C’. The help from external agencies like district crisis group is required for off site emergencies. However, as described in section 6.3.7 of this ESIA report, and in the QRA study prepared for the facility and presented in Annex (3), indicate evident that there is virtually no off-site risk to the surrounding population. The risk to the onsite population is extremely low and can be further mitigated with the implementation of proper mitigation measures and provision of proper PPEs for personnel handling the emergency cases.

7.4.9 Training and Awareness

In order to ensure the competence of the project personnel in undertaking the environmental management procedures and plans, training will be conducted for the personnel according to the particular responsibility.

Training programmes will involve training staff on safe handling of equipment, chemicals, and wastes and on the use of equipment. They will be informed of any potentially harmful health effects of the hazardous chemicals they may handle. Moreover, they will be trained on proper operation of equipment and chemical handling and spill cleanup. They will also be trained on the use of fire hose reels and fire extinguishers.

- Emergency personnel will perform drill rescue techniques periodically. Safety, emergency response and first aid training will be provided at induction upon recruitment.
- The environmental department will attend the courses so that the concerned personnel are aware of latest developments in the field and new laws and regulations
- All employees will be trained on HSE related activities and there will be refresher programs periodically to keep them updated. The policies

and procedures of HSE activities will be displayed at various places in the factory.

Employees will receive training on implementing the emergency response plan in general and in the competencies relative to their required roles in the plan. Periodically the plan will be practiced in a tabletop classroom type setting and also tested in mock emergencies.

- External agencies will also be hired for training over and above internal training. This includes safety classes, fire drills, first aid training etc
- Safety posters will be displayed in around the plan. The entire factory premises will be declared as non-smoking area.

7.4.10 Facility Decommissioning Plans

Decommissioning follows the decision to close an industrial facility. Decommissioning is defined as the close down of operations, the removal of process equipment, buildings and structures and carryout site cleanup and remediation if required. The level of cleanup is site-specific and generally dependent on proposed future land use. The expected lifetime of the project is 25 years that will be renewable as long as the proper predictive maintenance measures are taken and all the necessary revamps and upgrades are done. Following are the main issues addressed by the facility's decommissioning plan:

- Development of the decommissioning plan according in light of the national and international requirements.
- Removal procedures for all above ground and below ground structures
- Removal, treatment and disposal or secure isolation and/or treatment of contaminated materials

7.5 Monitoring Plan

The monitoring plan is an essential element for the environmental management scheme of the project. It provides information for periodic review and adjustment of the environmental management plan as necessary ensuring that environmental protection is achieved through early detection of negative environmental impacts.

Monitoring programs is designed for the different parameters. The monitoring results will be fed into the decision making process as a trigger for the implementation of corrective actions, in order to maintain compliance with environmental laws and regulations, ensure environmental protection and workplace safety, as well as ensure appropriate operation of the mitigation measures and management plans.

It is important to note here that environmental monitoring is a dynamic process. Generally, a first round of monitoring is carried out based on the potential pollution parameters which are included in the monitoring plan. The results of this round and the deviation from the permissible limits of applicable laws are considered the base for the consequent monitoring rounds.

In other words, the first monitoring round draws the critical points, as well as identifies the measurements of the following plans. It is worth mentioning, that in the first phase of operation (project trial operation), monitoring includes more parameters than those monitored during normal operation. Therefore, the periodic monitoring plan will exclude those parameters which are temporarily released and only relevant to trial phase.

According to law 4/1994, establishments should maintain an environmental register to track all the environmental aspects of their activities. The environmental register will contain all self-monitoring results as well as the following:

- List of raw materials and chemicals
- List of products
- List of hazardous materials and wastes
- Wastewater analysis results
- Air emissions measurement results
- Workplace noise and heat stress measurement results
- Solid waste description (quality and quantity)

Furthermore, a register for Hazardous Wastes will be prepared according to the requirements of Law 4/1994. This register will include description for hazardous wastes sources, types, quantities/ amounts, handling and their disposal off-site as well as the relevant documentation.

7.5.1 Monitoring Point Source Air Emissions

During Construction

Workplace air monitoring will be performed quarterly at the same locations of the baseline study. Emissions are generated from exhaust from construction equipment and motor vehicles and particulates during site works. Monitoring results will be compared with the allowable limits of Law 4/1994 for the exhaust generated from motor vehicles provided in Chapter (2) of this study.

The following parameters shall be measured:.

- Carbon monoxide, CO
- Sulfur dioxide, SO₂
- Nitrogen oxides, NO_x
- PM₁₀

During Operation

The point source air emissions from the HTM stack will be monitored annually for the NO₂ and CO. The monitoring results will be compared with the permissible limits, which are stated in Annex (6) of the Modified ERs of Law 4/1994 (Chapter 2). It is worth mentioning that the stack will be provided with a monitoring port for insertion of monitoring equipment probes.

7.5.2 Workplace Monitoring

Workplace Noise

During Construction

During construction, the facility will ensure that the noise level from all operating equipments would not exceed the allowable limit set by Law 4/1994 for 8 hours duration shift (90 dB). In case the noise levels exceeded this

limit, the exposure periods will be carried out according to those indicated in Annex (7) of Law 4/1994. Moreover, ear plugs will be provided for the workers at the locations generating increased noise levels. Noise level measurement will be carried out biannually.

During Operation

Sources of noise inside the plant include compressors, blowers and cutters. The measured noise levels will be compared to the levels set in Annex (7) of Law 4/1994. In case the noise exceeded the maximum limit of 90 dB, exposure periods will be proceeded as stipulated in Law 4/1994. Table (7.4) shows the noise monitoring locations and frequencies. Regular checks will be carried out quarterly for areas of direct exposure to equipment. Moreover, ear plugs will be provided for the workers at the given locations.

Table (7.4) Noise Monitoring Locations and Frequencies

Monitoring Location	Frequency
Blowers	Quarterly
Cutters	Quarterly
Compressors	Biannually

Heat Stress

During Construction

Heat stress is negligible during the construction phase.

During Operation

During the operation phase, heat stress will be monitored biannually at the HTM heaters and the polycondensation SSP reactors. Measurements will be compared to heat stress limits, provided in Annex (9) of the ERs of Law 4/1994. However, there is no permanent workforce in these areas.

Work Place Emissions

Monitoring the emissions inside workplace will be performed according to the plan shown in Table (7.5). Measurement results will be compared to the limits given in Annex (8) of Law 4/1994.

Table (7.5) Air Pollution Monitoring in Work Place

Location	Proposed Parameters	Frequency
Catalyst preparation unit	PM ₁₀	Biannually
PET packaging	PM ₁₀	Biannually
PTA/PIA charging system	PM ₁₀	Annually

7.5.3 Solid and Hazardous Wastes

Non-hazardous solid wastes will be recorded in the Environmental register of the plant. On the other hand according to Law 4/1994, a register will be prepared for hazardous wastes. Information of the HW register should include

types and quantities of hazardous wastes, storage means and details of transportation and disposal.

7.5.4 Wastewater

As previously described in Chapter (3) of this report, the effluent from the ETP and the non-contaminated water will be directed to a further stage of treatment at the MBR unit. The treated water will be reused as makeup water for the cooling tower. The backwash from the MBR unit will be used for landscaping within the industrial zone. A grab sample, from the MBR effluent, will be analyzed periodically as shown in Table (7.6). The results of all monitoring analysis will be included in the Environmental Register of the facility.

Table (7.6) Wastewater Monitoring

Parameters	Monitoring Method	Frequency
ETP Effluent		
Temperature	Measured at site	Quarterly
pH	Measured at site	
COD	Grab sampling	
BOD	Grab sampling	
Blow down		
TDS	Grab sampling	Biannually
pH	Measured at site	
Temperature	Measured at site	

7.5.5 Performance Monitoring

Process control is considered one of the basic components in any industry and specifically in Petrochemical Industry. It ensures efficient operation and minimizes potential up-sets. Process control at the proposed project is based on a Distributed Control System (DCS), in which the control elements are not centralized but they are rather distributed throughout the process streams. DCS system depends on automatic and computerized monitoring that avoids human interference. This system ensures accurate and continuous inspection and control.

7.5.6 Inspection and Auditing

In addition to the periodic monitoring detailed in the above sections, self-auditing and periodical inspection is necessary for ensuring maximum safety and environmental protection. The following activities will be carried out in relevance to inspection and auditing:

Emergency and Fire Fighting Plans

The HSE unit within the facility will periodically train the workers and employees on emergency situations and events. This will be carried out practically and theoretically. This training will be implemented in coordination with the Civil Defense Authority. Training will include first aid, fire fighting, electrical isolations and mitigation practices

HSE Inspection

Ensure that workers adhere to the requirements on environmental management and safety as well as the proper usage of protective equipment.

Inspection of Emergency Equipment

The following will be periodically inspected:

- Emergency equipment and the alarm system as well as the fire and smoke detection systems all over the plant to ensure their effectiveness.
- Protective equipment to investigate their effectiveness

7.5.7 Approximate Monitoring Costs

The PET facility will hire an independent consultant for carrying out the monitoring activities. The following table (7.7) provides approximate monitoring costs for guidance purposes only. The costs only cover analysis and field measurements. However, they do not include specific sample collection costs.

Table (7.7) Approximate costs for Environmental Monitoring
(to be updated upon actual laboratory offers and to add level of effort for sample collection)

Parameter	Description	Approximate annual cost (L.E)
Construction Phase		
Noise level	Measurement at four locations twice a year	800
Air quality (SO ₂ , NO ₂ , CO, PM ₁₀)	Measurement at 2 locations 4 times per year	7000
Operation phase		
Noise level and PM ₁₀	Measurement at 5 locations 4 times per year	2000
Stack Emissions (SO ₂ , NO ₂ , SO ₂)	Measurements of stack emissions once per year	900
Effluent water from ETP and blow down (COD, BOD, TDS, pH)	Analysis for duplicate samples (quarterly for ETP effluent and biannually for blow down)	4000

8. Public Consultation

As part of the comprehensive ESIA, a process of public consultation was carried out for identification of environmental concerns of different stakeholders regarding the proposed project. Accordingly, extensive individual scoping meetings were conducted with key stakeholders in Suez Governorate. Following the individual meetings a disclosure meeting was organized to present the ESIA and its results to the public. The consultation process encompasses the following phases:

- Public consultation for developing the ESIA
 - Stakeholder identification
 - Initial stakeholder meetings and scoping before and during ESIA development
- Ongoing consultation during project development and operation

Decree 11/2005 issued by Minister of Suez Governorate establishes a higher environmental committee in Suez Governorate and Decree 233/2005, identifies the members of the committee. As per decree 233/2005, the committee is composed of 33 main members, and is headed by the Suez Governor. A main objective of the committee is the preliminary environmental assessment of any proposed project within the governorate, prior to presenting it to the public.

8.1 Initial scoping meetings

Preliminary scoping meetings were conducted with a number of stakeholders in Suez governorate and Sokhna. The scoping meetings took place on Monday 19/4/2010 in Suez governorate and Sokhna Industrial area. The discussion issues are presented below. The entities interviewed encompassed:

Suez RBO - EEAA

Dr. Laila El-Kholy	Head of the Suez Regional Branch Office - EEAA
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Suez Popular Council

Representatives from the popular council

Neighboring Activities

Eng. Mohamed Fathy	Head of Engineering Department – Egyptian Chinese Company.
Eng. Ezzat Essawy	General Factories Manager - Cleopatra Group
Mr.Mohammed Gamil	Executive Housekeeping of El Wadi Resort

The meetings were carried out individually with the different interviewees. At the beginning of each meeting, a brief description about the purpose of the meeting and its objectives as an integral part of the EIA process was provided followed by brief description of project, its phases and production processes. Discussions were then conducted to address potential environmental impacts, concerns and requirements that the project needs to take into account at the different stages of execution.

The discussion issues are presented below. Annex (6) of the ESIA presents the details of the individual meetings.

- Project and company description
- Project relocation
- Wastewater management
- Employment
- Air emissions and emission loads
- Water Sources
- Waste management
- Health and safety
- Community services and community contribution

8.2 Conclusion of the Scoping meetings

All interviewees expressed their support to the different types of industrial development in Egypt provided that such development projects do not have adverse impacts on the public health or the environment and that they contribute to the improvement of social and economic status of the surrounding communities

8.3 Meeting with the Higher Environmental Committee of Suez Governorate

8.3.1 Meeting preparation

The Suez Governorate was responsible for inviting the relevant public and concerned entities representatives to the meeting. Annex (7) includes the list of attendees of the meeting.

Background document about the project has been prepared before the meeting as well as a presentation including its production activities, inputs and outputs and the findings of the environmental and social impact assessment was prepared and sent to the Governorate prior to the meeting to be reviewed and commented on.

8.3.2 The Disclosure meeting

The meeting was headed by Suez Governor. In addition to EIPET representatives, members of ECHEM also attended the meeting as well as Prof. Magdi Ghanem – Head of Institute for Environmental Consultation – Suez Canal University – Ismailia Branch, who was involved in reviewing the ESIA before submission to EEAA. EIPET presentation was conducted by Eng. Yasser Sherif, General manager of Environics. The presentation included the following :

- Description of EIPET company, its field of activities, its products and the project partners
- Selection of Sokhna area as third project alternative
- Raw materials and products
- Results of the Air Dispersion Modeling
- Quantitative Risk Assessment

8.3.3 Discussions and Feedback

After the presentation, a discussion session took place which was moderated by Suez governor.

It was emphasized by the attendees that the system adopted by the Suez Governor for managing the public disclosure is efficient, as it eliminates intense discussions not based on scientific basis. It has also been mentioned that the involvement of Suez Canal University, as a highly recognized institution in the governorate would give credibility to the study results.

The topics raised by the attendees during discussions included the following:

- **Project Location**

Regarding Sokhna area as third location selected for establishing the PET project, Suez governor has explained that most investors targeting the European markets, would be generally reluctant to establish their project in Sokhna area mainly because of the high fees to be paid for crossing Suez Canal. He advised that an initiative is currently being studied to return Suez Canal crossing fees to the investors. This would encourage various investors to establish their projects in the area.

- **Employment**

All attendees stressed on the importance of providing employment opportunities to Suez communities particularly for youth and new graduates. The governor commented that this issue should be considered in all projects in the governorate. The Governor advised that plans are underway for establishment of a new faculty for Petroleum Engineering under supervision of the Minister of Petroleum, and that the department for Petrochemical studies would be beneficial in providing the market with qualified graduates in this field. Moreover, the governor mentioned that a technology training complex has been established that includes technical training for workers and is expected to start its programmes in 2010. Suez governor invited the EIPET Company to contribute in developing the training programmes and syllabus. EIPET is pleased to extend help to the Department of Petrochemical Studies by means of qualitative contribution in developing the training programmes and syllabus. EIPET Management contemplates to provide a pragmatic approach on various programmes with balanced fusion between theoretical and practical knowledge. Apart from its participation in developing internationally recognized technical syllabus, EIPET also proposes to depute its technical experts to impart training on operational and industrial application of theoretical knowledge.

- **Social Responsibility**

Suez governor emphasized on the importance of effective contribution of the different industries the community development projects. The company expressed its commitment to implementation of community development project in coordination with Suez governorate and in light of the governorate development plans. The EIPET Management recognises the importance of the community development projects and reiterate its commitment to join any plan that would have the approval of Suez Governorate. The community development projects may include ;

1. Health care check-ups in nearby villages.
2. Imparting knowledge on environmental awareness.
3. Educational programmes.
4. Woman empowerment.

- ***Impact on traffic***

The potential impacts on the road traffic as result of material and product transportation was raised. It was clarified that the ESIA has investigated the potential impact on traffic and it was indicated that the number of vehicles required for transport of raw materials and product from and to Sokhna port which is about 1.5 km eastern the site is 5 trucks per hour. the estimated number of trips transporting the raw materials from the port to the facility is about 5 trucks/hour (assuming average truck capacity 40 tons. This is not expected to have significant impacts on the roads network in the area. Mr. Mahmoud Shawky, head of industrial projects at the EIA department – EEAA mentioned that returning the Suez Canal crossing fees to the investors would significantly contribute to elevate the burden on the road networks.

- ***Process water and Wastewater***

The issue of source of process water and disposal of industrial wastewater was raised. The governor advised the required water quantities will be secured and that in the near future no water problem will be envisaged this is because Suez governorate is intending to establish a central sea water desalination plant to meet the requirements of the industrial facilities in Suez and Sokhna area. Regarding the treatment and disposal of the industrial wastewater, EIPET indicated that the industrial and domestic wastewater is treated in an on-site treatment plant with the purpose of minimizing the fresh water consumption. The treated wastewater will be reused as make-up for the cooling tower. The reject of the treatment plant will be used for irrigation within the industrial zone. In this respect, the governor indicated that studies are being discussed with the cabinet of Ministers and the Ministry of Investment regarding plans for construction of a central wastewater treatment plant to serve the different industrial zones, this is expected to contribute significantly in proper management of the industrial wastewaters in the area.

- ***Availability of utilities***

Attendees stressed on the importance of ensuring the availability the natural gas and electricity requirements for the project in order to avoid the utilization of gasoil as an alternative fuel, which is being imported from abroad. It was clarified that the different agreements and contracts regarding the natural gas and electricity requirements are currently being finalized with the concerned authorities, and that utilization of gasoil will be limited only in cases of the unlikely situations of natural gas shortage.

- ***Impact on groundwater***

Regarding the inquiry regarding the potential impacts of the project on groundwater, it was clarified that the PET project does include activities involving disposal into groundwater wells. Besides, the facility will take

all necessary management measure to prevent any leakage to soil or groundwater during construction and operation as indicated in the ESIA.

- ***Socioeconomic impacts***

Inquiries regarding the number of foreign labour and their impact on the socioeconomic environment. The governor indicated that the national laws set limits for the permitted percentage for utilizing foreign labour and that it should not exceed 10%. EIPET indicated that the majority of labour will be mainly from the area and all around Egypt and that foreign labour will be only used for specific areas of specializations in the PET manufacturing technology that might not be available nationally.

- ***IFC requirements***

Mr. Mahmoud Shawky of EEAA raised the issue of importance of meeting the IFC requirements in the ESIA in order to be eligible to utilize the IFC funding. It was clarified that the ESIA addressed all IFC requirements and that the draft ESIA has been already reviewed by the IFC.

- ***Cumulative pollution study***

Suez governor advised that the PET project should coordinate with Suez Canal University to carry out a cumulative pollution dispersion study. It was clarified that the PET project has investigated the impacts of its minor emissions on the neighbouring receptors and it was indicated that the impacts are minimal. However, the governor advised that the study to be carried out by Suez Canal University would take into considerations the emissions of all industries in the area to establish a regional pollution load map. He also emphasised that the additionally required cumulative study will not present a constraint regarding the project approval by the governorate higher environmental committee.

8.3.4 Conclusion

All participants expressed their support to this type of industrial development in Egypt and Suez governorate in particular provided that such development projects do not have adverse impacts on the public health or the environment and that they contribute to the improvement of social and economic status of the surrounding communities. After voting, the governor announced the approval of the higher environmental committee on the PET project in Sokhna area.

8.4 Public Consultation Meetings during the Project Lifetime

A schedule of stakeholder meetings will be developed based on a variety of objectives, such as:

- Providing information to stakeholders on project development
- Obtaining public feedback
- Coordinating community development objectives.

This will be carried out through an integrated consultation plan including:

- Activities of the public consultation system
- Issues raised by the community and need discussions with different stakeholders.

8.5 Grievance System

An effective grievance mechanism will be functioning throughout the project lifetime and available to affected communities at no cost and without retribution. The grievance system will allow direct communication between the community and PET facility management at any time, independently of the meeting schedules. This will likely involve a combination of avenues, such as telephone, mail, emails, oral communication through meetings, etc.

Grievance related to any aspect of a project will be resolved through consultations conducted in a transparent manner with the ultimate goal of reaching consensus.

A computerized data-base will be established to record all grievances/complaints and the completion date that the complaint was closed/corrected. This will include the suggested actions, date to be completed by, date it actually was completed by and the effectiveness of the response. Once the data base is established, staff will be trained and will be required to use the data-base. A grievance log (table 8.3) will include a documentation of grievance and documentation of the results of consultation to the project-affected communities, and either demonstrating how the comments and recommendations made by the project-affected communities have been accommodated; or providing a rationale why these comments and recommendations have not been accommodated. As much as possible, the meetings will strive for a win-win situation through facilitation and discussion between the facility personnel and affected groups. The project will publicize the grievance system and how it works among project affected people. The response time between activating the procedures and reaching a resolution should be as short as possible.

Table (8.1): Complaint Log

Name	Contact details	Date Complaint Received	Nature of Complaint	Recorded by	Description of Complaint	Actions Proposed	Response Date	Responsible Person	Date of close up

8.6 Reporting

All public communications and meetings will be recorded and documented. The reporting will account for:

- Description of stakeholders representatives involved
- Formal grievance and its outcomes
- Summary of meetings with stakeholders (Location and dates of meetings and discussions and the outcomes)
- Community liaison activities carried out by the project
- Performance against set targets

8.7 Community Development

Community service is a key component for the ESIA. It is understandable that community needs could not all be addressed by one investor/project but should be addressed through collaborative efforts of the different investors. The facility would coordinate with the governorate of Suez to identify the potential areas for their contribution in the governorates development plans and define specific areas for contribution, the resources required and the role and responsibilities of the different parties involved. Preliminary areas for community development would include:

- Training
- Health services
- Infrastructure
- Educational programmes

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Annex 1
MSDS



MCC PTA India Corp Private Limited

Regd. Off.: 22, Camac Street, Block-C, 4th Floor, Kolkata-700016, India; Tel: 91(33)2283
6300/01/02/03/04, Fax: 91(33)2280 8470

MATERIAL SAFETY DATA SHEET

DATE PREPARED : 5.Aug,1998

PRODUCT NAME : Purified Terephthalic Acid

COMPANY IDENTIFICATION :

SUPPLIER Name : MCC PTA India Corp Private Limited

Address: 22, Camac Street, 4th Floor, Block - C, Kolkata - 700016

Telephone: +91-33-22175500 Facsimili : +91-33-22175968/4467

MANUFACTURER

Name: MCC PTA India Corporation Private Limited

Address: Vill. & P.O. Bhuniaraichak, Via Sutahata (Haldia), Purba Midanapore
West Bengal, Pin - 721635, India

Telephone: +91-3224-272001 Facsimili: +91-3224-272017

Substance/mixture : substance

Chemical name Terephthalic acid (1,4-benzenedicarboxylic acid)

Ingredients and composition: 100%

Chemical formula: $\text{HOOC}-(\text{C}_6\text{H}_4)-\text{COOH}$

Cas registry number : 100-21-0

Einecs registry number : 202-830-0

Un class : not listed

CLASS NAME OF HAZARDOUS CHEMICALS FOR MSDS IN INDIA : Not applicable
PHYSICAL AND CHEMICAL HAZARDS : Under dust-air mixture, static electricity
may cause an explosion.

EYE CONTACT :

Wash eyes immediately with fresh running water for at least 15 minutes until
no
evidence of chemical remains. If abnormality remains in the eyes, have a
medical
examination and a treatment by a physician.

SKIN CONTACT :

Remove all contaminated clothing and shoes from the affected areas
immediately.
Wash TPA off the skin with soap and a large amounts of water. If
redness, itching
or burning sensation develops, have a medical examination and a treatment
by a
physici

an.

INHALATI

ON :

Remove from exposure area to fresh air immediately. Keep person at rest.

When
inhaling voluminously, have a medical examination and a treatment by a
physician
immediately

y. INGESTION

:

Give person a fresh water or a salt water and try to let person vomit.

When
swallowing a large amount, immediately have a medical examination and
a
treatment by a physician.



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Fax: 91(33)2280 8470

METHOD OF EXTINCTION :

Extinguish the fire with water or dry chemical powder with keeping up wind. Wear suitable respiratory equipment avoid breathing hazardous vapor. For larger fires, use water spray or foam.

EXTINGUISHING MEDIA :

Water spray, dry chemical powder or foam.

Do not let person enter the leaking place. Shut off all sources of ignition in dangerous area. Always wear suitable protective equipment. Sweep up and place in suitable containers without raising dust. Do not flush spilled TPA into sewers or river.

HANDLING :

- * Wear suitable protective equipment to prevent inhalation of TPA or contact with TPA to eyes or skin.
- * Do not raise the dust from spilled TPA.
- * When raising the dust, provide local exhaust ventilation system.
- * Keep away from the source of ignition.
- * Keep O₂ content at 12% or below at places where high powder content exists in gas phase (e.g. in silo, pneumatic conveyer). Introduce N₂ gas if needed.
- * Prevent build-up of electrostatic charge (e.g. by grounding)
- * Provide a shower and eye wash fountain within the work area for emergency use.

STORAGE :

- * Keep away from sunlight and store in a cool, dry and dark place without source of ignition.
- * When storing in flexible container, fix the bags to prevent from turning over.
- * Avoid contact with strong oxidizers.

OCCUPATIONAL EXPOSURE LIMIT

ACGIH TWA : 10 mg/m³ (2000ed.)

ENGINEERING MEASURES

Use exhaust ventilation to keep airborne concentration below exposure limit.

PERSONAL PROTECTIVE EQUIPMENT

Respiratory protection ; Filter respirator

Eye protection ; Safety goggles

Hand protection ; Gloves (made from butyl rubber)



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APPEARLANCE : White Powder

MELTING POINT: >300 °C (sublimate)

DENSITY: 1.51

SOLUBILITY: insoluble in WATER,ETHER and ACETONE. Soluble in Pyridine,DMF and Alkalies.

METHANOL: 16.9g/100cm³ (at 20DC)

FLASH POINT: 300 °C(above)

AUTOIGNITION TEMPERATURE : 680 °C (as dust cloud)

Under dusty conditions,static electricity may cause an explosion.

LOWER EXPLOSION LIMIT : 50g/m³(air)

MINIMUM IGNITION ENERGY : 20mJ

BURNING CALORIE : 19.51KJ/g

FLAMMABILITY : Yes

STABILITY and REACTIVITY : Stable under normal conditions.

MATERIALS TO AVOID : Strong oxidizer and alkaline materials.

HAZARDOUS DECOMPOSITION PRODUCTS(except burning) : None known.

IRRITANT PROPERTIES : Eyes Rabbit 500mg/24H mild

ALLERGENIC AND SENSITIZING EFFECTS : No 2

ACUTE TOXICITY:ORAL LD₅₀(RAT) 18800mg/kg

2)ORAL LD₀ (RAT) 6400mg/kg above

SUB-ACUTE TOXICITY : Groups of Wistar Rats were maintained on a diet containing TPA(first week:5%, afterwards:3%) for a period of 13 weeks. Urinary calculus was generated for 61% of male and 16% of female.

Pathological changes were observed only at kidney and urinary bladder, tumorous changes were not observed.

3)CARCINOGENIC EFFECTS : Not available.

MUTAGENIC EFFECTS : Negative in AMES TEST (TA98,TA100,TA1535,TA1537,S9)

4) BIODEGRADABILITY : Biodegradable.

5)OTHER INFORMATION ON ECOTOXICITY : OCTANOL/WATER
partition coefficient : 0.4

6)Disposal should be done under conditions, which meet all regulations relating to waste in country.

FURTHER INFORMATION

After examining the toxicity of TPA,treat TPA with an activated sludge.

Follow all regulations in your country.

FURTHER INFORMATION :

* When using a flexible container,check the stitch of lifting rope or belts,and handle the flexible container with all lifting belts.

* In handling a load,do not go under a flexible container, without the table for safety.

* When transporting flexible container or paper bag,prevent the load from falling down with tying rope.



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- * When using containerjorry or tank train,prevent build-up of electrostatic charges, (e.g.by grounding).
- Keep away from sunlight and rainwater and avoid contact with strong oxidizers.

Follow all regulations in your country.

- 1)NIOSH,"Registry of Toxic Effects of Chemical Substances",U.S.DHHS,1993. 1 Update
- 2)"Kankyo Kagaku Busshitsu Youran",MARUZEN,(Japan), 1988
- 3)E.E.Vogin,Subacute Feeding Studies(13-Week)in Rats with DMT,IA and TA, Food and Drugs Reseach Laboratories,Maspeth,N.Y(1972)
- 4)E.Zeigler et ahPhthalate Ester Testing in the National Toxicology Program's Environmental Mutagenesis Test Development Program,Environm Health Perspectives 45 99-101(1982)
- 5)"MITI(Ministry of International Trade and Industry) Communique of Japan",Aug.27.1975
- 6)IPCS,"International Chemical Safety Cards(ICSC)",1992

1 Identification of the substance/preparation and of the company/undertaking

- **Product name:** Purified Isophthalic Acid
- **Application of the substance / the preparation** Intermediate
- **Manufacturer/Supplier:**
Perstorp Singapore Pte Ltd
12, Sakra Road
Jurong Island
Singapore 627892

Perstorp Specialty Chemicals AB
SE-284 80 Perstorp, Sweden
Tel. +46 435 38000
Fax +46 435 37067

polyolinfo@perstorp.com
www.perstorp.com
- **Further information obtainable from:** EHS-department Perstorp Specialty Chemicals AB
- **Information in case of emergency:** (Int.) +46 8 337043 (Emergency Response Center, Sweden)

2 Hazards identification

- **Hazard description:** Not classified.
- **Classification system:**
The classification is according to the latest editions of the EU-lists, and extended by company and literature data.
- **Additional information:**
Slightly irritating to eyes
May cause mild skin irritation
Dust can form an explosive mixture with air

3 Composition/information on ingredients

- **Chemical characterization**

- **Chemical components:**

CAS: 121-91-5	isophthalic acid	≥ 99.85%
EINECS: 204-506-4		

4 First-aid measures

- **General information:** Remove any clothing soiled by the product.
- **After inhalation:** Supply fresh air; consult doctor in case of complaints.
- **After skin contact:** Wash with water and soap and rinse thoroughly.
- **After eye contact:**
Rinse opened eye for several minutes under running water, immediately consult a doctor.
- **After swallowing:**
Rinse out mouth and then drink plenty of water or milk.
If you feel unwell consult doctor.

5 Fire-fighting measures

- **Suitable extinguishing agents:**
CO₂, powder or water spray. Fight larger fires with water spray or alcohol resistant foam.
- **For safety reasons unsuitable extinguishing agents:** Water with full jet
- **Special hazards caused by the substance, its products of combustion or resulting gases:**
Can form explosive gas-air mixtures.

(Contd. on page 2)

Safety Data Sheet

according to 1907/2006/EC, Article 31

09.11.2007

Revision: 09.11.2007

Product name: Purified Isophthalic Acid

(Contd. of page 1)

- Formation of toxic gases is possible during heating or in case of fire.
- **Protective equipment:**
Wear self-contained respiratory protective device.
Wear fully protective suit.
- **Additional information** Cool endangered receptacles with water spray.

6 Accidental release measures

- **Person-related safety precautions:**
Wear protective equipment. Keep unprotected persons away.
Avoid formation of dust.
- **Measures for environmental protection:**
Do not allow to enter sewers/ surface or ground water.
Inform respective authorities in case of seepage into water course or sewage system.
- **Measures for cleaning/collecting:** Pick up mechanically.

7 Handling and storage

- **Information for safe handling:**
Ensure good ventilation/exhaustion at the workplace.
Prevent formation of dust.
- **Information about fire - and explosion protection:**
Dust can form an explosive mixture with air.
Keep ignition sources away - Do not smoke.
Protect against electrostatic charges.
- **Storage:**
- **Further information about storage conditions:**
Keep container tightly sealed.
Store receptacle in a well ventilated area.
Store in dry conditions.
Keep away from any source of ignition

8 Exposure controls/personal protection

- **Ingredients with limit values that require monitoring at the workplace:** Not required.
- **Additional information:**
Ensure that eyewash stations and safety showers are proximal to the work-station location.
- **Personal protective equipment:**
- **General protective and hygienic measures:** Wash hands before breaks and at the end of work.
- **Respiratory protection:**
Use suitable respiratory protective device in case of insufficient ventilation.
Dustfilter
Filter P2
- **Protection of hands:**



Protective gloves

PVC gloves
Plastic gloves

- **Material of gloves**

The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer.

(Contd. on page 3)

Safety Data Sheet

according to 1907/2006/EC, Article 31

09.11.2007

Revision: 09.11.2007

Product name: Purified Isophthalic Acid

(Contd. of page 2)

· Eye protection:


Safety glasses

9 Physical and chemical properties

· General Information

Form:	Crystalline powder
Colour:	White
Odour:	Odourless

· Change in condition

Melting point/Melting range:	347 °C
Boiling point/Boiling range:	Sublimes

· Flash point:	Not applicable.
-----------------------	-----------------

· Ignition temperature:	>650 °C
--------------------------------	---------

· Danger of explosion:	The product is not explosive. However, formation of explosive air-vapour/dust mixtures are possible.
-------------------------------	--

· Density at 20 °C:	1.54 g/cm ³
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· Solubility in / Miscibility with water at 20 °C:	0.10 g/l
---	----------

· Partition coefficient (n-octanol/water):	-2.34 log POW (at pH 7)
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10 Stability and reactivity

- **Thermal decomposition / conditions to be avoided:** Stable at environment temperature.
- **Materials to be avoided:** Keep away from oxidizing agents
- **Dangerous reactions** Risk of dust explosion.

11 Toxicological information

· Acute toxicity:
· LD/LC50 values relevant for classification:
121-91-5 isophthalic acid

Oral	LD50	>5000 mg/kg (rat)
Dermal	LD50	>2000 mg/kg (rabbit)

· Primary irritant effect:

- **on the skin:** May cause skin irritation.
- **on the eye:** Slightly irritating.

· Subacute to chronic toxicity:
121-91-5 isophthalic acid

AMES test	negative OECD 471 (salmonella typhimurium)
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· Additional toxicological information:

The substance is not subject to classification according to the latest version of the EU lists.

GB

(Contd. on page 4)

Safety Data Sheet

according to 1907/2006/EC, Article 31

09.11.2007

Revision: 09.11.2007

Product name: Purified Isophthalic Acid

(Contd. of page 3)

12 Ecological information

- **Information about elimination (persistence and degradability):**
- **Other information:**
The product is readily biodegradable.
85 % after 16 days, aerobic (OECD 301 B)
- **Behaviour in environmental systems:**
- **Mobility and bioaccumulation potential:**
Due to the distribution coefficient n-octanol/water an accumulation in organisms is not expected.
- **Ecotoxicological effects:**

- **Aquatic toxicity:**

121-91-5 isophthalic acid

EC50	617 mg/l (bacteria)
NOEC	>1000 mg/l (alga)
	>1000 mg/l (daphnia)
	>1000 mg/l (fish)

- **Remark:**
Low toxicity to aquatic organisms.
The product is not classified as dangerous to the environment.

13 Disposal considerations

- **Recommendation:** Disposal must be made according to official regulations.

14 Transport information

- **Land transport ADR/RID (cross-border)**
- **ADR/RID class:** -
- **Transport/Additional information:** Not dangerous goods according to the above specifications.

15 Regulatory information

- **Labelling according to EU guidelines:**
The product is not subject to identification regulations under EU Directives and the Ordinance on Hazardous Materials.
- **Safety phrases:**
24/25 Avoid contact with skin and eyes.

16 Other information

This Safety Data Sheet is not a Product Specification. It is based on our present knowledge and experience and it is intended to serve as a guide for safe handling of the product regarding to health and environmental aspects.

- **Department issuing SDS:** EHSQ-department, Perstorp Specialty Chemicals AB.

—GB—



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Therminol VP-3 | Therminol LT | Therminol D-12 | Therminol VLT | Therminol XP | Therminol FF

Therminol 66 Heat Transfer Fluid

[View MSDS](#)[Product Bulletin](#)

Product Description

Therminol 66 is the world's most popular high temperature, liquid phase heat transfer fluid. Suitable for operation up to 650°F (345°C), Therminol 66 is pumpable to 27°F (-3°C) and delivers exceptional performance. Consider the following:

30 °F to
650 °F



- **Experience** - Therminol 66 is the most popular high temperature liquid phase heat transfer fluid in the world. No heat transfer fluid material in the world has a higher degree of customer satisfaction than Therminol 66.
- **Proven Fluid** - In a wide variety of applications and thousands of systems around the world, Therminol 66 delivers superior performance. When your heat transfer fluid system is not operating, then your process is not operating either. Do not settle for second best. In critical applications, Therminol 66 is the only choice.
- **True 650°F (345°C) Performance** - Therminol 66 sets the performance standard for high temperature liquid phase fluids. Users can expect many years of reliable, trouble-free operation, even when operating continuously at the recommended maximum temperature of 650°F.
- **Fouling Resistant** - Therminol 66 is specifically engineered to resist solids formation and system fouling. Your system will operate more reliably and you will save money.

Applications

Therminol 66 is used in a wide variety of industries, such as:

- Chemicals
- Plastics
- Biodiesel

For more information on Therminol 66 systems and applications [e-mail](#) us or contact the Therminol Technical Service Hotline at **1-800-433-6997**.

Detailed Properties

[Click here to download the product bulletin](#) containing detailed physical and transport properties for Therminol 66.

Typical Properties

Therminol® 66
Heat Transfer Fluid

Operating Range 0 °C to 345 °C (30 °F to 650 °F)

Appearance	Clear, pale yellow liquid
Composition	Modified terphenyl
Moisture Content, Maximum	150 ppm
Flash Point (ASTM D-92)	184 °C (363 °F)
Fire Point (ASTM D-92)	212 °C (414 °F)
Autoignition Temperature (ASTM E-659)	374 °C (705 °F)
Kinematic Viscosity, at 40 °C	29.6 cSt
Kinematic Viscosity, at 100 °C	3.8 cSt
Density at 25 °C	1005 kg/m ³ (8.39 lb/gal)
Specific Gravity (60 °F/60 °F)	1.012
Coefficient of Thermal Expansion at 200 °C	0.000819/ °C (0.000455/°F)
Average Molecular Weight	252
Pour Point	-32 °C (-25 °F)
Pumpability, at 2000 mm ² /s (cSt)	-3 °C (27 °F)
Pumpability, at 300 mm ² /s (cSt)	11 °C (52 °F)
Minimum Temperatures for	
Fully Developed Turbulent Flow (Re = 10000)	
10 ft/sec, 1-in tube	72 °C (162 °F)
20 ft/sec, 1-in tube	53 °C (128 °F)
Transition Region Flow (Re = 2000)	
10 ft/sec, 1-in tube	35 °C (96 °F)
20 ft/sec, 1-in tube	26 °C (78 °F)
Boiling Range, 10%	348 °C (658 °F)
Boiling Range, 90%	392 °C (738 °F)
Normal Boiling Point	359 °C (678 °F)
Heat of Vaporization at Maximum Use Temp 345°C	272 k J/kg (117 Btu/lb)
Optimum Use Range	0-345 °C (30-650 °F)
Maximum Film Temperature	375 °C (705 °F)
Pseudocritical Temperature	569 °C (1056 °F)
Pseudocritical Pressure	24.3 bar (353 psia)
Pseudocritical Density	317 kg/m ³ (19.8 lb/ft ³)

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 SOUTH ASIAN PETROCHEM LTD.			MATERIAL SAFETY DATA SHEET		
			POLY ETHYLENE TEREPHTHALET (PET)		
			For :All grades including ASPET 16C, 18C, 19C, 20C, 21C, 21CF, 22CF, 22CJ, 16WOI		
USE					
Textile fibres (POY, FDY), industrial plastics, bottles (with food grade approval), foils, films, etc.					
Chemical and Physical data :					
Formula :	(C ₁₀ H ₈ O ₄) _n				
Molecular Weight	-	g/mol	Rel. vapour density (Air=1)	Solid Material	
Melting Point	235-265	°C	Value of evapn.	-	
Boiling Point (1013 mbar)	-	°C	(Ether = 1)		
			Ignition Temp.	-	°C
Other Sources	-	°C	Other Sources	-	°C
Density			Temperature Class	-	
at 22°C	1.332- 1380	Kg/m ³			
at 80°C	-	Kg/m ³	Flashpoint	-	°C
at	-	Kg/m ³			
Vapour Pressure			Explosion limits (In Air)	dust explosion hazard	
at 20°C	Solid material	mbar	LEL (at °C)		Vol.-%
			UEL (at °C)	>50 mg/m ³	Vol.-%
Other Sources		mbar			
			Other Sources	grain size fraction	
at 30°C	-	mbar	LEL (at °C)	7-60 um	Vol.-%
at 50°C	-	mbar	UEL (at °C)		Vol.-%
at 60°C	-	mbar			
at 105°C	-	mbar	Solubility (Water)		
at 120°C	-	mbar	at 20°C	Non soluble	g/l
			at 25°C	-	g/l
Saturation Conc'n			Other sources		g/l
at 20°C	-	g/m ³			
			Solubility (general)	-	-
Other Sources		g/m ³			
			Odour level	odourless	ppm
at 30°C	-	g/m ³			
at 50°C	-	g/m ³			
at 120°C	-	g/m ³			
Conv'n. Factors					
1mg/m ³	-	ml/m ³			
1ml/m ³	-	mg/m ³			
Health effects on the workplace					
Limit in Air :	- ml/m3 (ppm)		Skin resorption	-	
(acc. TRGS 900)			Sensibility	-	
dust (cumulative)	20 mg/m ³		BAT	-	
	(waste air)		Parameter	-	
			Exam. Material	-	

 SOUTH ASIAN PETROCHEM LTD.		MATERIAL SAFETY DATA SHEET	
		POLY ETHYLENE TEREPHTHALET (PET)	
		For :All grades including ASPET 16C, 18C, 19C, 20C, 21C, 21CF, 22CF, 22CJ, 16WOI	
Kind of value :	MAK (DFG)	Examination time	-
Peak limit., cat.	-	Pre-examination :	-
Carcinogene acc. DFG		1. Examination	-
Section III	-	2. Examination	-
Carcinogene acc. EG		Further examination	-
Category	-	Basics of Professional Association	
Gene mutation effects acc. DFG		Occupational disease	-
Group	-		
Gene mutation effects acc. EG			(also not listed in the American Standards)
Category	-		
Pregnancy acc. DFG			
Group	-		
Effects of reproduction acc. EG			
Category	- (also not listed in the American Standards)		
Hazardous Chemical Reactions : Stability : Stable Incompatibility : Material can react with strong oxidizing agents, Hazardous polymerization will not occur hazardous decomposition products. At processing temperature, some degree of thermal degradation will occur. Although highly dependent on temperature and environmental conditions. Decomposition products are : simple hydrocarbons (methane, propane), carbon monoxide, carbon dioxide, aldehydes and other organic vapours - secondary conflagration gases.			
TC _{L0} (inhal, human)	-	LC ₅₀ (inhal., mouse)	- mg/m ³
(shortness of breath)	- ppm	LD ₅₀ (ip., mouse)	- mg/kg
		LD ₅₀ (iv., mouse)	- mg/kg
LD ₅₀ (oral, rat, fem)	-	LD ₅₀ (sc., mouse)	- mg/kg
LD ₅₀ (dermal, guin-pig)	>1000 mg/kg	LD ₅₀ (oral, rabbit)	- mg/kg
skin sensitization ("-")	none	LD _{L0} (iv., rabbit)	- mg/kg
LD ₅₀ (ip., rat)	- mg/kg	LD _{L0} (derm, rabbit)	- mg/kg
LD ₅₀ (oral, rat)	>3200 mg/kg	LD _{L0} (sc., frog)	- mg/kg
LD ₅₀ (inhal, rat)	- mg/m ³	eye irritation (rabbit)	slight
LD ₅₀ (oral, mouse)	>3200 mg/kg		
Environmental Effects : Environmental index of toxicity for mammals fishes bacteria - - -			
Waste Classification : Polyethylene terephthalate is not classified as hazardous waste and unless prohibited by state of local laws can be disposed of in a municipal landfill or incinerated.			

 SOUTH ASIAN PETROCHEM LTD.	MATERIAL SAFETY DATA SHEET POLY ETHYLENE TEREPHTHALET (PET) For :All grades including ASPET 16C, 18C, 19C, 20C, 21C, 21CF, 22CF, 22CJ, 16WOI
Labels for transport and handling This product is not classified by the Department of Transportation as a hazardous material.	
R - Codes No R - Codes Eye Protection : It is a good industrial hygiene practice to minimize eye contact Skin Protection : It is a good industrial hygiene practice to minimize skin contact material is heated, wear gloves to protect against thermal burns. S - Codes No S - Codes	
Technical Measures Safety instructions for cases of fire - block the area in the direction of wind - information of neighborhood - development of CO, CO₂, H₂, O₂ by fire is possible (see hazardous chemical reactions) - safeguard the sewage system against extinguishing water Safety instructions for environmental accident Air : Use spray water against vapors of decomposition products (see hazardous chemical reactions) Powdered Material form dust-air mixtures; Avoid accumulation and dispersion of dust to reduce explosion hazardous.	
Water : Information of the use of drinking - , cooling - , and industrial water keep back extinguishing water; PET in water is not toxic. Ground : Sweep and scoope up and remove. Avoid generating dust clouds. Safety instructions for fire fighting - fire fighting by extinguishers Class A or Class B - fire fighting by blazes with water spray / fog or foam - fire fighting of small fires with hand-fire-extinguishers (powder, foam, CO₂, water) - protect the fire fighting squads with protective clothing and respiratory equipment which is independently of ambient air - use it also during the decontamination works	
Medical Measures Skin contact : If burned by contact with molten material, cool as quickly as possible and do not peel material from skin. EXAMINATION OF SPECIALIST IS DEMANDED ! Ingestion : PET is not expected to be absorbed from the gastrointestinal tract. Induction of vomiting should not ordinarily required. Inhalation : Not ordinarily required. Move to fresh air if symptomatic.	

MATERIAL SAFETY DATA SHEET

1. Product and Company Identification

Trade name: Cobalt Acetate

Chemical name: Cobalt Acetate Tetra-hydrate

Chemical formula: $\text{Co}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 4\text{H}_2\text{O}$

Molecular weight: 249.08

Manufacturer: Coremax Taiwan Corporation

Emergency call: + 886 3 5983101

Address: 11 Wen Hwa Road Hsinchu Industrial Park Hsinchu Hsien Taiwan ROC

2. Composition/Information on Ingredients

CAS No.	Component	%
6147-53-1	Cobalt acetate tetra-hydrate	100

3. Hazards Identification

Hazard Symbols



Xn: Harmful

Emergency Overview

WARNING! HARMFUL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. MAY CAUSE ALLERGIC SKIN OR RESPIRATORY REACTION. CHRONIC EXPOSURE MAY AFFECT THYROID, LUNGS, HEART, AND KIDNEYS.

Potential health effects

Inhalation:

Cause delayed lung injury. Cause respiratory tract irritation. May cause asthmatic attacks due to allergic sensitization of the respiratory tract. May cause asthma and shortness of breath.

Ingestion:

Harmful if swallowed. May cause gastrointestinal irritation with nausea, vomiting and diarrhea. May cause allergic reaction. May cause flushing of the face and ears, mild hypotension, ringing in the ears, and nerve deafness. Ingestion of beer with cobalt additives may cause heart disorders.

Eyes:

Causes irritation.

Skin:

Prolonged and/or repeated contact may cause irritation and/or dermatitis. May cause skin sensitization, an allergic reaction, which becomes evident upon re-exposure to this material.

Chronic:

May cause cancer according to animal studies.

4. First Aid Measures

Eye contact:

Holding the eyelids apart, flush eyes promptly with copious flowing water for at least 20 minutes and seek medical advice immediately.

Skin contact:

Wash skin thoroughly with mild soap and plenty of water for at least 15 minutes. Treat contaminated clothing with 10% sodium bicarbonate and wash them before re-use. Seek medical advice, if necessary.

Inhalation:

Remove from exposure to fresh air. Apply artificial respiration if necessary and seek medical advice.

Ingestion:

If swallowed, wash mouth thoroughly with plenty of water and give water or milk to drink. Seek medical advice immediately.

5. Fire Fighting Measures

Flash point: Not available

Extinguishing media:

Material is not combustible. Use extinguishing media appropriate to surrounding fire conditions.

Fire fighting procedure:

Cool containers with water spray. In closed stores, provide fire fighters with self-contained breathing apparatus in positive pressure mode.

Unusual fire and explosion hazard:

Air oxidation catalyst - Avoid contact with oil based products. When heated to decomposition, may release poisonous and corrosive fumes of acetic acid.

6. Accidental Release Measures

Vacuum or sweep up material and place into a suitable disposal container. Ventilate area and wash spill site after material pickup is complete. Avoid generating dusty conditions.

7. Handling and Storage

Handling:

Keep containers tightly closed and protected from physical damage. Use with adequate ventilation. Minimize dust generation and accumulation. Avoid contact with skin and eyes. Avoid ingestion and inhalation.

Storage:

Store in a dry, cool, well-ventilated area away from incompatible materials.

8. Exposure Controls/Personal Protection

Engineering controls:

Use adequate general or local exhaust ventilation to keep airborne concentration below the permissible exposure limits.

Exposure limits:

AGGIH: None listed

NIOSH: as Co: 0.05 mg/m³ TWA

OSHA-Final PEL: as Co: 0.1mg/m³ TWA

Personal protective equipment:

Respiratory protection: Approved respirator

Gloves: Rubber gloves

Eye protection: Chemical safety goggles

Clothing: Wear suitable protective clothing to prevent skin exposure.

Industrial hygiene:

Safety shower and eye bath should be provided. Do not eat, drink or smoke until after-work showering and changing clothes.

9. Physical and Chemical Properties

Appearance: Red crystal with a slight acetic acid odor.

Boiling point: Not available.

Relative vapor density: Not applicable.

Vapor pressure: Not applicable

Specific gravity: 1.7 (H₂O=1)

Solubility: Soluble in water, pH : 6 in water.

No erode.

10. Stability and Reactivity

Stability: Stable under normal conditions.

Materials to avoid:

Strong oxidants (ex. HNO₃), perchloric acid, amine, alkali, most of metals

Hazardous decomposition:

Toxic fumes and metal oxides may be present during decomposition.

Hazardous polymerization: Will not occur.

11. Toxicological Information

Toxicity data (oral, rat): LD50 = 708 mg/kg for Co

12. Ecological Information

No information found.

13. Disposal Considerations

Waste disposal:

Dispose in accordance with Local laws. Add slowly to a large amount of soda ash and slaked lime solution while stirring and cooling. Remove to approved incinerator or landfill.

Disposal of packaging:

Dispose in accordance with Local laws.

14. Transport Information

IMO-IMDG code:

Proper shipping name: Chemicals, N.O.S. (Non-Regulated)

US DOT:

Proper shipping name: Chemicals, N.O.S. (Non-Regulated)

IATA: Not restricted.

15. Regulatory Information

Not available

16. Other Information

Disclaimer:

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall Coremax Taiwan Corporation be liable for any claims, loses, or damages of any third party or for lost profits, damages, arising, even if Coremax Taiwan Corporation has been advised of the possibility of such damages.

Effective Date: December 22, 2008**Designation:** Wesley Ho



Material Safety Data Sheet

MEGlobal International FZE

Product Name: ETHYLENE GLYCOL POLYESTER GRADE

Issue Date: 2007/12/03

Print Date: 20 Feb 2009

MEGlobal International FZE encourages and expects you to read and understand the entire (M)SDS, as there is important information throughout the document. We expect you to follow the precautions identified in this document unless your use conditions would necessitate other appropriate methods or actions.

1. Identification of the substance/preparation and of the company/undertaking

Product Name

ETHYLENE GLYCOL POLYESTER GRADE

Use of the substance/preparation

Chemical intermediate, e.g. for manufacture of polyester resins. De-icing fluid. Heat transfer fluid. It is recommended that you use this product in a manner consistent with the recommended use. If your intended use is not consistent with the recommended use, please contact our Customer Information Group (telephone number in Section 1 of this document).

COMPANY IDENTIFICATION

MEGlobal International FZE
PO Box 293615
Building 5W-B-Wing, 6th Floor
Dubai Airport Free Zone Authority
Dubai
UAE

Customer Information Number:

888-610-9048
<http://www.meglobal.biz/>

EMERGENCY TELEPHONE NUMBER

24-Hour Emergency Contact:

989-636-4400

Local Emergency Contact:

91 22 67978600

2. Composition/information on ingredients

Component	Amount	Classification:	CAS #	EC #
Ethanediol; ethylene glycol	> 99.0 %	Xn: R22	107-21-1	203-473-3

See Section 16 for full text of R-phrases.

3. Hazards Identification

Harmful if swallowed.

4. First-aid measures

Eye Contact: Flush eyes thoroughly with water for several minutes. Remove contact lenses after the initial 1-2 minutes and continue flushing for several additional minutes. If effects occur, consult a physician, preferably an ophthalmologist.

Skin Contact: Wash skin with plenty of water.

Inhalation: Move person to fresh air. If not breathing, give artificial respiration; if by mouth to mouth use rescuer protection (pocket mask, etc). If breathing is difficult, oxygen should be administered by qualified personnel. Call a physician or transport to a medical facility.

Ingestion: Do not induce vomiting. Seek medical attention immediately. If person is fully conscious give 1 cup or 8 ounces (240 ml) of water. If medical advice is delayed and if an adult has swallowed several ounces of chemical, then give 3-4 ounces (1/3-1/2 Cup) (90-120 ml) of hard liquor such as 80 proof whiskey. For children, give proportionally less liquor at a dose of 0.3 ounce (1 1/2 tsp.) (8 ml) liquor for each 10 pounds of body weight, or 2 ml per kg body weight [e.g., 1.2 ounce (2 1/3 tbsp.) for a 40 pound child or 36 ml for an 18 kg child].

Notes to Physician: If several ounces (60 - 100 ml) of ethylene glycol have been ingested, early administration of ethanol may counter the toxic effects (metabolic acidosis, renal damage). Consider hemodialysis or peritoneal dialysis & thiamine 100 mg plus pyridoxine 50 mg intravenously every 6 hours. If ethanol is used, a therapeutically effective blood concentration in the range of 100 - 150 mg/dl may be achieved by a rapid loading dose followed by a continuous intravenous infusion. Consult standard literature for details of treatment. 4-Methyl pyrazole (Antizol®) is an effective blocker of alcohol dehydrogenase and should be used in the treatment of ethylene glycol (EG), di- or triethylene glycol (DEG, TEG), ethylene glycol butyl ether (EGBE), or methanol intoxication if available. Fomepizole protocol (Brent, J. et al., New England Journal of Medicine, Feb. 8, 2001, 344:6, p. 424-9): loading dose 15 mg/kg intravenously, follow by bolus dose of 10 mg/kg every 12 hours; after 48 hours, increase bolus dose to 15 mg/kg every 12 hours. Continue fomepizole until serum methanol, EG, DEG, TEG or EGBE are undetectable. The signs and symptoms of poisoning include anion gap metabolic acidosis, CNS depression, renal tubular injury, and possible late stage cranial nerve involvement. Respiratory symptoms, including pulmonary edema, may be delayed. Persons receiving significant exposure should be observed 24-48 hours for signs of respiratory distress. Maintain adequate ventilation and oxygenation of the patient. In severe poisoning, respiratory support with mechanical ventilation and positive end expiratory pressure may be required. If lavage is performed, suggest endotracheal and/or esophageal control. Danger from lung aspiration must be weighed against toxicity when considering emptying the stomach. If burn is present, treat as any thermal burn, after decontamination. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient.

5. Fire Fighting Measures

Extinguishing Media: Water fog or fine spray. Dry chemical fire extinguishers. Carbon dioxide fire extinguishers. Foam. Do not use direct water stream. May spread fire. Alcohol resistant foams (ATC type) are preferred. General purpose synthetic foams (including AFFF) or protein foams may function, but will be less effective.

Fire Fighting Procedures: Keep people away. Isolate fire and deny unnecessary entry. Use water spray to cool fire exposed containers and fire affected zone until fire is out and danger of reignition has passed. Fight fire from protected location or safe distance. Consider the use of unmanned hose holders or monitor nozzles. Immediately withdraw all personnel from the area in case of rising sound from venting safety device or discoloration of the container. Burning liquids may be extinguished by dilution with water. Do not use direct water stream. May spread fire. Move container from fire area if this is possible without hazard. Burning liquids may be moved by flushing with water to protect personnel and minimize property damage.

Special Protective Equipment for Firefighters: Wear positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, trousers,

boots, and gloves). If protective equipment is not available or not used, fight fire from a protected location or safe distance.

Unusual Fire and Explosion Hazards: Container may rupture from gas generation in a fire situation. Violent steam generation or eruption may occur upon application of direct water stream to hot liquids.

Hazardous Combustion Products: During a fire, smoke may contain the original material in addition to combustion products of varying composition which may be toxic and/or irritating. Combustion products may include and are not limited to: Carbon monoxide. Carbon dioxide. Nitrogen oxides.

6. Accidental Release Measures

Steps to be Taken if Material is Released or Spilled: Contain spilled material if possible. Collect in suitable and properly labeled containers. Small spills: Absorb with materials such as: Cat litter. Sand. Sawdust. Zorb-all®. Hazorb®. Large spills: Dike area to contain spill. Pump into suitable and properly labeled containers. See Section 13, Disposal Considerations, for additional information.

Personal Precautions: Isolate area. Keep unnecessary and unprotected personnel from entering the area. Refer to Section 7, Handling, for additional precautionary measures. Use appropriate safety equipment. For additional information, refer to Section 8, Exposure Controls and Personal Protection.

Environmental Precautions: Prevent from entering into soil, ditches, sewers, waterways and/or groundwater. See Section 12, Ecological Information.

7. Handling and Storage

Handling

General Handling: Do not swallow. Avoid contact with eyes. Wash thoroughly after handling. Spills of these organic materials on hot fibrous insulations may lead to lowering of the autoignition temperatures possibly resulting in spontaneous combustion. See Section 8, EXPOSURE CONTROLS AND PERSONAL PROTECTION.

Storage

Do not store near food, foodstuffs, drugs or potable water supplies. Additional storage and handling information on this product may be obtained by calling your sales or customer service contact. Ask for a product brochure.

8. Exposure Controls / Personal Protection

Exposure Limits

Component	List	Type	Value
Ethanediol; ethylene glycol	ACGIH	Ceiling	100 mg/m3
	EU IOELV	Aerosol. TWA	52 mg/m3 20 ppm SKIN
	EU IOELV	STEL	104 mg/m3 40 ppm SKIN

Personal Protection

Eye/Face Protection: Use safety glasses. Safety glasses should be consistent with EN 166 or equivalent. If exposure causes eye discomfort, use a full-face respirator. Chemical goggles should be consistent with EN 166 or equivalent.

Skin Protection: Use protective clothing chemically resistant to this material. Selection of specific items such as face shield, boots, apron, or full body suit will depend on the task. Remove contaminated clothing immediately, wash skin area with soap and water, and launder clothing before reuse or dispose of properly. When handling hot material, protect skin from thermal burns as well as from skin absorption.

Hand protection: Use chemical resistant gloves classified under Standard EN374: Protective gloves against chemicals and micro-organisms. If hands are cut or scratched, use gloves

chemically resistant to this material even for brief exposures. Use gloves with insulation for thermal protection (EN 407), when needed. Examples of preferred glove barrier materials include: Butyl rubber. Natural rubber ("latex"). Neoprene. Nitrile/butadiene rubber ("nitrile" or "NBR"). Polyethylene. Ethyl vinyl alcohol laminate ("EVAL"). Polyvinyl alcohol ("PVA"). Polyvinyl chloride ("PVC" or "vinyl"). When prolonged or frequently repeated contact may occur, a glove with a protection class of 2 or higher (breakthrough time greater than 30 minutes according to EN 374) is recommended. NOTICE: The selection of a specific glove for a particular application and duration of use in a workplace should also take into account all relevant workplace factors such as, but not limited to: Other chemicals which may be handled, physical requirements (cut/puncture protection, dexterity, thermal protection), potential body reactions to glove materials, as well as the instructions/specifications provided by the glove supplier.

Respiratory Protection: Atmospheric levels should be maintained below the exposure guideline.

When respiratory protection is required for certain operations, use an approved air-purifying respirator. Use the following CE approved air-purifying respirator: Organic vapor cartridge with a particulate pre-filter, type AP2.

Ingestion: Use good personal hygiene. Do not consume or store food in the work area. Wash hands before smoking or eating.

Engineering Controls

Ventilation: Provide general and/or local exhaust ventilation to control airborne levels below the exposure guidelines.

9. Physical and Chemical Properties

Physical State	Liquid
Color	Colorless
Odor	Sweet
Flash Point - Closed Cup	116 °C ASTM D56
Flammable Limits In Air	Lower: 3.2 %(V) <i>Literature</i> Upper: 15.3 %(V) <i>Literature</i>
Autoignition Temperature	427 °C <i>Literature</i>
Vapor Pressure	0.06 mmHg @ 20 °C <i>Literature</i>
Boiling Point (760 mmHg)	> 197 °C <i>Literature</i>
Vapor Density (air = 1)	2.1 <i>Literature</i>
Specific Gravity (H2O = 1)	1.115 20 °C/20 °C <i>Literature</i>
Freezing Point	-13 °C <i>Literature</i>
Melting Point	Not applicable to liquids
Solubility in Water (by weight)	100 % <i>Literature</i>
pH	9 ASTM E70
Molecular Weight	62 g/mol <i>Literature</i>
Octanol/Water Partition Coefficient	-1.36 <i>Measured</i>
Evaporation Rate (Butyl Acetate = 1)	0.01 <i>Literature</i>
Kinematic Viscosity	18.7 cSt <i>Literature</i>

10. Stability and Reactivity

Stability/Instability

Thermally stable at recommended temperatures and pressures.

Conditions to Avoid: Exposure to elevated temperatures can cause product to decompose. Generation of gas during decomposition can cause pressure in closed systems.

Incompatible Materials: Avoid contact with: Strong acids. Strong bases. Strong oxidizers.

Hazardous Polymerization

Will not occur.

Thermal Decomposition

Decomposition products depend upon temperature, air supply and the presence of other materials. Decomposition products can include and are not limited to: Aldehydes. Alcohols. Ethers.

11. Toxicological Information**Acute Toxicity****Ingestion**

Oral toxicity is expected to be moderate in humans due to ethylene glycol even though tests with animals show a lower degree of toxicity. Small amounts swallowed incidentally as a result of normal handling operations are not likely to cause injury; however, swallowing larger amounts may cause serious injury, even death. May cause nausea and vomiting. May cause abdominal discomfort or diarrhea. Excessive exposure may cause central nervous system effects, cardiopulmonary effects (metabolic acidosis), and kidney failure.

For ethylene glycol: Lethal Dose, Human, adult 100 ml

LD50, Rat 6,000 - 13,000 mg/kg

Eye Contact

May cause slight eye irritation. Corneal injury is unlikely. Vapor or mist may cause eye irritation.

Skin Contact

Brief contact is essentially nonirritating to skin. Prolonged contact may cause slight skin irritation with local redness. Repeated contact may cause skin irritation with local redness.

Skin Absorption

Prolonged skin contact is unlikely to result in absorption of harmful amounts. Repeated skin exposure to large quantities may result in absorption of harmful amounts. Massive contact with damaged skin or of material sufficiently hot to burn skin may result in absorption of potentially lethal amounts.

LD50, Rabbit > 22,270 mg/kg

Inhalation

At room temperature, exposure to vapor is minimal due to low volatility. With good ventilation, single exposure is not expected to cause adverse effects. If material is heated or areas are poorly ventilated, vapor/mist may accumulate and cause respiratory irritation and symptoms such as headache and nausea.

LC50, 7 h, Aerosol, Rat > 3.95 mg/l

Repeated Dose Toxicity

Repeated excessive exposure may cause irritation of the upper respiratory tract. In humans, effects have been reported on the following organs: Central nervous system. Observations in humans include: Nystagmus (involuntary eye movement). In animals, effects have been reported on the following organs: Kidney. Liver.

Chronic Toxicity and Carcinogenicity

Ethylene glycol did not cause cancer in long-term animal studies.

Developmental Toxicity

Based on animal studies, ingestion of very large amounts of ethylene glycol appears to be the major and possibly only route of exposure to produce birth defects. Exposures by inhalation or skin contact, the primary routes of occupational exposure, had minimal effect on the fetus, in animal studies.

Reproductive Toxicity

Ingestion of large amounts of ethylene glycol has been shown to interfere with reproduction in animals.

Genetic Toxicology

In vitro genetic toxicity studies were negative. Animal genetic toxicity studies were negative.

12. Ecological Information

CHEMICAL FATE

Movement & Partitioning

Bioconcentration potential is low ($BCF < 100$ or $\log Pow < 3$). Potential for mobility in soil is very high (Koc between 0 and 50). Given its very low Henry's constant, volatilization from natural bodies of water or moist soil is not expected to be an important fate process.

Henry's Law Constant (H): $8.05E-09 \text{ atm}\cdot\text{m}^3/\text{mole}$; 25 °C Estimated

Partition coefficient, n-octanol/water ($\log Pow$): -1.36 Measured

Partition coefficient, soil organic carbon/water (Koc): 1 Estimated

Persistence and Degradability

Material is readily biodegradable. Passes OECD test(s) for ready biodegradability. Material is ultimately biodegradable (reaches > 70% mineralization in OECD test(s) for inherent biodegradability).

OECD Biodegradation Tests:

Biodegradation	Exposure Time	Method
> 94 %	28 d	OECD 301F Test

ECOTOXICITY

Material is not classified as dangerous to aquatic organisms ($LC_{50}/EC_{50}/IC_{50}$ greater than 100 mg/L in most sensitive species).

Fish Acute & Prolonged Toxicity

LC_{50} , rainbow trout (*Oncorhynchus mykiss*), static, 96 h: 18,000 - 46,000 mg/l

Aquatic Invertebrate Acute Toxicity

LC_{50} , water flea *Daphnia magna*, static, 48 h: 46,300 - 51,100 mg/l

Aquatic Plant Toxicity

EC_{50} , green alga *Selenastrum capricornutum*, biomass growth inhibition, 96 h: 9,500 - 13,000 mg/l

Toxicity to Micro-organisms

EC_{50} , OECD 209 Test; activated sludge, respiration inhibition, 30 min: 225 mg/l

13. Disposal Considerations

This product, when being disposed of in its unused and uncontaminated state should be treated as a hazardous waste according to EC Directive 91/689/EEC. Any disposal practices must be in compliance with all national and provincial laws and any municipal or local by-laws governing hazardous waste. For used, contaminated and residual materials additional evaluations may be required. Do not dump into any sewers, on the ground, or into any body of water.

14. Transport Information

ROAD & RAIL

NOT REGULATED

OCEAN

NOT REGULATED

AIR

NOT REGULATED

INLAND WATERWAYS

NOT REGULATED

This information is not intended to convey all specific regulatory or operational requirements/information relating to this product. Additional transportation system information can be obtained through an authorized sales or customer service representative. It is the responsibility of the transporting organization to follow all applicable laws, regulations and rules relating to the transportation of the material.

15. Regulatory Information

Toxic Substances Control Act (TSCA)

All components of this product are on the TSCA Inventory or are exempt from TSCA Inventory requirements under 40 CFR 720.30

European Inventory of Existing Commercial Chemical Substances (EINECS)

This product is on the EINECS inventory.

Classification and User Label Information

Hazard Symbol :

Xn - Harmful.

Risk Phrases :

R22 - Harmful if swallowed.

Safety Phrases :None Required

Chemical Ethanediol; ethylene glycol

Name (EC Label) (EC # 203-473-3)

16. Other Information

Risk-phrases in the Composition section

R22 Harmful if swallowed.

Revision

Identification Number: 23826 / 3946 / Issue Date 2007/12/03 / Version: 1.0

Most recent revision(s) are noted by the bold, double bars in left-hand margin throughout this document.

Legend

N/A	Not available
W/W	Weight/Weight
OEL	Occupational Exposure Limit
STEL	Short Term Exposure Limit
TWA	Time Weighted Average
ACGIH	American Conference of Governmental Industrial Hygienists, Inc.
DOW IHG	Dow Industrial Hygiene Guideline
WEEL	Workplace Environmental Exposure Level
HAZ_DES	Hazard Designation

MEGlobal International FZE urges each customer or recipient of this (M)SDS to study it carefully and consult appropriate expertise, as necessary or appropriate, to become aware of and understand the data contained in this (M)SDS and any hazards associated with the product. The information herein is provided in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ between various locations. It is the buyer's/user's responsibility to ensure that his activities comply with all federal, state, provincial or local laws. The information presented here pertains only to the product as shipped. Since conditions for use of the product are not under the control of the manufacturer, it is the buyer's/user's duty to determine the conditions necessary for the safe use of this product. Due to

the proliferation of sources for information such as manufacturer-specific (M)SDSs, we are not and cannot be responsible for (M)SDSs obtained from any source other than ourselves. If you have obtained an (M)SDS from another source or if you are not sure that the (M)SDS you have is current, please contact us for the most current version.

MSDS Number: **P3973** * * * * * Effective Date: **11/21/08** * * * * * Supercedes: **01/03/06**

MSDS	Material Safety Data Sheet	24 Hour Emergency Telephone: 908-859-2151 CHEMTREC: 1-800-424-9300
		National Response in Canada CANUTEC: 613-996-6666
From: Mallinckrodt Baker, Inc. 222 Red School Lane Phillipsburg, NJ 08865		Outside U.S. and Canada Chemtrec: 703-527-3887
Mallinckrodt CHEMICALS		J.T. Baker
NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.		
All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.		

PHOSPHORIC ACID

1. Product Identification

Synonyms: Ortho-phosphoric acid; white phosphoric acid

CAS No.: 7664-38-2

Molecular Weight: 98.00

Chemical Formula: H₃PO₄ in H₂O

Product Codes:

J.T. Baker: 0238, 0248, 0259, 0260, 0262, 0263, 0264, 0265, 0268, 0269, 0273, 0274, 5372, 5682, 5686, 5804, 5841, 5854, 6908

Mallinckrodt: 2779, 2788, 2796, 2797, 3563, H106, XM-223

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Phosphoric Acid	7664-38-2	55 - 95%	Yes
Water	7732-18-5	5 - 45%	No

3. Hazards Identification

Emergency Overview

DANGER! CORROSIVE. CAUSES SEVERE IRRITATION AND BURNS TO EVERY AREA OF CONTACT. HARMFUL IF SWALLOWED OR INHALED.

SAF-T-DATA^(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe

Flammability Rating: 0 - None

Reactivity Rating: 2 - Moderate

Contact Rating: 4 - Extreme (Corrosive)

Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES

Storage Color Code: White (Corrosive)

Potential Health Effects

Inhalation:

Inhalation is not an expected hazard unless misted or heated to high temperatures. Mist or vapor inhalation can cause irritation to the nose, throat, and upper respiratory tract. Severe exposures can lead to a chemical pneumonitis.

Ingestion:

Corrosive. May cause sore throat, abdominal pain, nausea, and severe burns of the mouth, throat, and stomach. Severe exposures can lead to shock, circulatory collapse, and death.

Skin Contact:

Corrosive. May cause redness, pain, and severe skin burns.

Eye Contact:

Corrosive. May cause redness, pain, blurred vision, eye burns, and permanent eye damage.

Chronic Exposure:

No information found.

Aggravation of Pre-existing Conditions:

Persons with pre-existing skin disorders or eye problems, or impaired respiratory function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician immediately.

Ingestion:

If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical

attention immediately.

Skin Contact:

Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician, immediately. Wash clothing before reuse.

Eye Contact:

Immediately flush eyes with gentle but large stream of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Call a physician immediately.

5. Fire Fighting Measures

Fire:

Not considered to be a fire hazard. Contact with most metals causes formation of flammable and explosive hydrogen gas.

Explosion:

Not considered to be an explosion hazard.

Fire Extinguishing Media:

Use any means suitable for extinguishing surrounding fire. Water spray may be used to keep fire exposed containers cool. If water is used, use in abundance to control heat and acid build-up.

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRASORB® acid neutralizers are recommended for spills of this product.

7. Handling and Storage

Keep in a tightly closed container. Protect from physical damage. Store in a cool, dry, ventilated area away from sources of heat, moisture, incompatibilities, and direct sunlight. Corrosive to mild steel. Store in rubber lined or 316 stainless steel designed for phosphoric acid. Do not wash out container and use it for other purposes. When diluting, the acid should always be added slowly to water and in small amounts. Never use hot water and never add water to the acid. Water added to acid can cause uncontrolled boiling and splashing. Protect from freezing. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

-OSHA Permissible Exposure Limit (PEL):
1 mg/m3 (TWA)

-ACGIH Threshold Limit Value (TLV):
1 mg/m3 (TWA), 3 mg/m3 (STEL)

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):

If the exposure limit is exceeded, a full facepiece respirator with high efficiency dust/mist filter may be worn up to 50 times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:

Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Physical data below refers to concentrated phosphoric acid.

Appearance:

Clear, colorless syrupy liquid.

Odor:

Odorless.

Solubility:

Miscible in all proportions in water.

Specific Gravity:

1.69 @ 25C

pH:

1.5 (0.1 N aqueous solution)

% Volatiles by volume @ 21C (70F):

100

Boiling Point:

158C (316F)

Melting Point:
21C (70F)
Vapor Density (Air=1):
3.4
Vapor Pressure (mm Hg):
0.03 @ 20C (68F)
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Substance can supercool without crystallizing.
Hazardous Decomposition Products:
Phosphorus oxides may form when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Liberates explosive hydrogen gas when reacting with chlorides and stainless steel. Can react violently with sodium tetrahydroborate. Exothermic reactions with aldehydes, amines, amides, alcohols and glycols, azo-compounds, carbamates, esters, caustics, phenols and cresols, ketones, organophosphates, epoxides, explosives, combustible materials, unsaturated halides, and organic peroxides. phosphoric acid forms flammable gases with sulfides, mercaptans, cyanides and aldehydes. It also forms toxic fumes with cyanides, sulfide, fluorides, organic peroxides, and halogenated organics. Mixtures with nitromethane are explosive.
Conditions to Avoid:
Incompatibles.

11. Toxicological Information

Oral rat LD50: 1530 mg/kg; investigated as a mutagen.

-----\Cancer Lists\-----			
Ingredient	---NTP Carcinogen---		IARC Category
	Known	Anticipated	
Phosphoric Acid (7664-38-2)	No	No	None
Water (7732-18-5)	No	No	None

12. Ecological Information

Environmental Fate:
When released into the soil, this material may leach into groundwater. When released to water, acidity may be readily reduced by natural water hardness minerals. The phosphate, however, may persist indefinitely.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved incinerator or disposed in a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: PHOSPHORIC ACID SOLUTION
Hazard Class: 8
UN/NA: UN1805
Packing Group: III
Information reported for product/size: 350LB

International (Water, I.M.O.)

Proper Shipping Name: PHOSPHORIC ACID SOLUTION
Hazard Class: 8
UN/NA: UN1805
Packing Group: III
Information reported for product/size: 350LB

15. Regulatory Information

-----\Chemical Inventory Status - Part 1\-----				
Ingredient	TSCA	EC	Japan	Australia
Phosphoric Acid (7664-38-2)	Yes	Yes	Yes	Yes
Water (7732-18-5)	Yes	Yes	Yes	Yes

-----\Chemical Inventory Status - Part 2\-----

Ingredient	--Canada--			
	Korea	DSL	NDSL	Phil.
Phosphoric Acid (7664-38-2)	Yes	Yes	No	Yes
Water (7732-18-5)	Yes	Yes	No	Yes

-----\Federal, State & International Regulations - Part 1\-----

Ingredient	-SARA 302-		-SARA 313-	
	RQ	TPQ	List	Chemical Catg.
Phosphoric Acid (7664-38-2)	No	No	No	No
Water (7732-18-5)	No	No	No	No

-----\Federal, State & International Regulations - Part 2\-----

Ingredient	CERCLA	-RCRA-		-TSCA-
		261.33	8(d)	
Phosphoric Acid (7664-38-2)	5000	No	No	No
Water (7732-18-5)	No	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: No Fire: No Pressure: No
Reactivity: No (Pure / Liquid)

Australian Hazchem Code: 2R

Poison Schedule: S5

WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: 3 Flammability: 0 Reactivity: 0

Label Hazard Warning:

DANGER! CORROSIVE. CAUSES SEVERE IRRITATION AND BURNS TO EVERY AREA OF CONTACT. HARMFUL IF SWALLOWED OR INHALED.

Label Precautions:

Do not get in eyes, on skin, or on clothing.

Keep container closed.

Use only with adequate ventilation.

Do not breathe vapor or mist.

Wash thoroughly after handling.

Label First Aid:

In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In all cases call a physician immediately.

Product Use:

Laboratory Reagent.

Revision Information:

No Changes.

Disclaimer:

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Prepared by: Environmental Health & Safety

Phone Number: (314) 654-1600 (U.S.A.)



THERMINOL
Heat Transfer Fluids by Ischludde

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North America

Therminol 55 | Therminol 59 | Therminol 62 | Therminol 66 | Therminol 72 | Therminol 75 | Therminol VP-1 |
Therminol VP-3 | Therminol LT | Therminol D-12 | Therminol VLT | Therminol XP | Therminol FF

Therminol VP-1 Vapor Phase/Liquid Phase Heat Transfer Fluid

[View MSDS](#)

[Product Bulletin](#)



Product Description

Therminol VP-1 heat transfer fluid is a synthetic heat transfer fluid designed to meet the demanding requirements of vapor phase systems from 495°F to 750°F (257°C - 400°C) or liquid phase systems from 54°F to 750°F (12°C - 400°C). Performance features of Therminol VP-1 include:

54 °F to

750 °F

Liquid Use Range

- **Superb Heat Transfer Properties** -

Therminol VP-1 is a synthetic heat transfer fluid which combines exceptional thermal stability and low viscosity for efficient, dependable, uniform performance in a wide optimum use range of 54°F to 750°F (12°C - 400°C). Therminol VP-1 has the highest thermal stability of all organic heat transfer fluids.

495 °F to

750 °F

Vapor Use Range

- **Vapor Phase Heat Transfer Fluid** - Therminol VP-1 is a eutectic mixture of 73.5% diphenyl oxide (DPO) and 26.5% biphenyl. It can be used as a liquid heat transfer fluid or as a boiling-condensing heat transfer medium up to its maximum use temperature. It is miscible and interchangeable (for top-up or design purposes) with other similarly constituted diphenyl-oxide (DPO)/biphenyl fluids.
- **Low Viscosity** - Therminol VP-1 has a low viscosity to 54°F (12°C). Because of its crystallization point of 54°F (12°C), this fluid may require tracing in colder climates to avoid operational problems.
- **Temperature Control** - Due to its ability to operate as a vapor phase heat transfer fluid, Therminol VP-1 is superb for use in heat transfer fluid systems requiring very precise temperature control.

Applications

Therminol VP-1 is used in a wide variety of industries, such as:

- Fibers/Nylon Manufacture
- Chemicals

For more information on Therminol VP-1 systems and applications [e-mail](#) us or contact the Therminol Technical Service Hotline at **1-800-433-6997**.

Detailed Properties

[Click here to download the product bulletin](#) containing detailed physical and transport properties for Therminol VP-1.



Typical Properties

Therminol® VP-1 Vapor Phase/Liquid Phase Heat Transfer Fluid

Liquid Use Range 12 °C to 400 °C (54 °F to 750 °F)

Vapor Use Range 260 °C to 400 °C (495 °F to 750 °F)

Appearance	Clear, water white liquid
Composition	Biphenyl/diphenyl oxide (DPO) eutectic mixture
Crystallizing Point	12 °C (54 °F)
Moisture Content	300 ppm
Flash Point (ASTM D-92)	124 °C (255 °F)
Fire Point (ASTM D-92)	127 °C (260 °F)
Autoignition Temperature (ASTM D-2155)	621 °C (1150 °F)
Kinematic Viscosity, at 40 °C	2.48 cSt
Kinematic Viscosity, at 100 °C	0.99 cSt
Density at 25 °C	1060 kg/m ³ (8.85 lb/gal)
Specific Gravity (60 °F/60 °F)	1.069
Coefficient of Thermal Expansion at 200 °C	0.000979/ °C (0.000544/°F)
Volume Contraction Upon Freezing	6.27%
Volume Expansion Upon Melting	6.69%
Surface Tension in Air at 25 °C	36.6 dyn/cm
Specific Resistivity at 20 °C	6.4 x 10 ¹¹ ohm-cm
Average Molecular Weight	166
Heat of Fusion	97.3 kJ/kg (41.8 Btu/lb)
Minimum Vapor Temperatures for	
Fully Developed Turbulent Flow (Re = 10000)	
10 ft/sec, 1-in tube	208 °C (406 °F)
20 ft/sec, 1-in tube	181 °C (358 °F)
Transition Region Flow (Re=2000)	
10 ft/sec, 1-in tube	151 °C (304 °F)
20 ft/sec, 1-in tube	131 °C (268 °F)
Normal Boiling Point	257 °C (495 °F)
Heat of Vaporization at Max. Use Temp 400°C	206 kJ/k g (88.7 Btu/lb)
Optimum Use Range, Liquid Vapor	12-400 °C (54-750 °F) 260-400 °C (495-750 °F)
Maximum Film Temperature	425 °C (800 °F)
Pseudocritical Temperature	499 °C (930 °F)
Pseudocritical Pressure	33.1 bar (480 psia)

MSDS Number: **08764** * * * * * Effective Date: **12/26/08** * * * * * Supersedes: **07/09/08**

MSDS	Material Safety Data Sheet	24 Hour Emergency Telephone: 908-859-2151 CHEMTREC: 1-800-424-9300
		National Response in Canada CANUTEC: 613-996-6666
From: Mallinckrodt Baker, Inc. 222 Red School Lane Phillipsburg, NJ 08865		Outside U.S. and Canada Chemtrec: 703-527-3887
Mallinckrodt CHEMICALS		J.T. Baker
NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.		
All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.		

DIETHYLENE GLYCOL

1. Product Identification

Synonyms: 2,2'-Oxydiethanol; 2,2'-Oxybisethanol; 2,2' Dihydroxydiethyl ether; CELLOSOLVE®
CAS No.: 111-46-6
Molecular Weight: 106.14
Chemical Formula: C₄H₁₀O₃
Product Codes:
J.T. Baker: S856
Mallinckrodt: 11413

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Diethylene Glycol	111-46-6	99 - 100%	Yes

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL IF SWALLOWED. MAY CAUSE IRRITATION TO SKIN AND EYES.

SAF-T-DATA^(tm) Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate (Life)
Flammability Rating: 1 - Slight
Reactivity Rating: 1 - Slight
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES
Storage Color Code: Green (General Storage)

Potential Health Effects

Inhalation:

Low inhalation hazard unless heated because of low vapor pressure.

Ingestion:

Low acute toxicity. Probable lethal dose to humans is 0.5-5 g/kg. Causes nerve depression, liver and kidney lesions and anuria (urination retardation). Causes irritation to the gastrointestinal tract. Symptoms may include nausea, vomiting and diarrhea.

Skin Contact:

May be an irritant to skin on prolonged exposure.

Eye Contact:

May be an irritant to eyes and surrounding tissue.

Chronic Exposure:

Liver and kidney lesions and damage.

Aggravation of Pre-existing Conditions:

Persons with pre-existing skin disorders or eye problems or impaired liver or kidney function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:

Remove to fresh air. Not expected to require first aid measures.

Ingestion:

Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Call a physician.

Skin Contact:

Remove any contaminated clothing. Wash skin with soap and water for at least 15 minutes. Get medical attention if irritation develops or persists.

Eye Contact:

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes, lifting upper and lower eyelids occasionally. Call a physician if irritation persists.

5. Fire Fighting Measures

Fire:

Flash point: 124C (255F) CC

Autoignition temperature: 229C (444F)

Flammable limits in air % by volume:

lcl: 1.6; ucl: 10.8

Fire is possible at elevated temperatures or by contact with an ignition source.

Explosion:

Above flash point, vapor-air mixtures are explosive within flammable limits noted above.

Fire Extinguishing Media:

Powder, alcohol foam, water spray or carbon dioxide.

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Collect liquid in an appropriate container or absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer!

7. Handling and Storage

Keep in a tightly closed container. Protect from physical damage. Store in a cool, dry, ventilated area away from sources of heat, moisture and incompatibilities. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

AIHA Workplace Environmental Exposure Level (WEEL): TWA = 10mg/m3.

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):

If the exposure limit is exceeded, a half-face respirator with an organic vapor cartridge and particulate filter (NIOSH type P95 or R95 filter) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece respirator with an organic vapor cartridge and particulate filter (NIOSH P100 or R100 filter) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. Please note that N series filters are not recommended for this material. For emergencies or instances where the exposure levels are not known, use a full-face piece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Wear protective gloves and clean body-covering clothing.

Eye Protection:

Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:

Clear, colorless liquid.

Odor:

Odorless.

Solubility:

Infinitely soluble.

Specific Gravity:

1.118 @ 20C/20C

pH:

No information found.

% Volatiles by volume @ 21C (70F):

100

Boiling Point:

244 - 245C (471 - 473F)

Melting Point:

-6.5C (21F)

Vapor Density (Air=1):

3.66

Vapor Pressure (mm Hg):

1 @ 91.8C (198F)

Evaporation Rate (BuAc=1):

No information found.

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:

Toxic gases and vapors may be released if involved in a fire. Carbon dioxide and carbon monoxide may form when heated to decomposition.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

Strong oxidizers, strong acids and strong bases.

Conditions to Avoid:

Incompatibles.

11. Toxicological Information

Oral rat LD50: 12565 mg/kg. Skin rabbit LD50: 11.89 g/kg Irritation: eye rabbit, standard Draize: 50 mg mild. Investigated as a tumorigen and reproductive effector.

-----\Cancer Lists\-----			
Ingredient	---NTP Carcinogen---		IARC Category
	Known	Anticipated	
Diethylene Glycol (111-46-6)	No	No	None

12. Ecological Information

Environmental Fate:

No information found.

Environmental Toxicity:

No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

-----\Chemical Inventory Status - Part 1\-----				
Ingredient	TSCA	EC	Japan	Australia
Diethylene Glycol (111-46-6)	Yes	Yes	Yes	Yes

-----\Chemical Inventory Status - Part 2\-----				
Ingredient	--Canada--			
	Korea	DSL	NDSL	Phil.
Diethylene Glycol (111-46-6)	Yes	Yes	No	Yes

-----\Federal, State & International Regulations - Part 1\-----				
Ingredient	-SARA 302-		-----SARA 313-----	
	RQ	TPQ	List	Chemical Catg.
Diethylene Glycol (111-46-6)	No	No	No	No

-----\Federal, State & International Regulations - Part 2\-----			
Ingredient	CERCLA	-RCRA-	-TSCA-
		261.33	8(d)
Diethylene Glycol (111-46-6)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No
Reactivity: No (Pure / Liquid)

Australian Hazchem Code: None allocated.

Poison Schedule: None allocated.

WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **1** Flammability: **1** Reactivity: **0**

Label Hazard Warning:

WARNING! HARMFUL IF SWALLOWED. MAY CAUSE IRRITATION TO SKIN AND EYES.

Label Precautions:

Wash thoroughly after handling.

Avoid contact with eyes, skin and clothing.

Label First Aid:

If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Call a physician. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes. Call a physician if irritation develops or persists.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 1, 2, 15.

Disclaimer:

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Prepared by: Environmental Health & Safety

Phone Number: (314) 654-1600 (U.S.A.)

Pseudocritical Density	327 kg/m3 (20.4 lb/ft3)
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search by North America

Application

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Annex (2)
Building and Stack Height prior approval

بسم الله الرحمن الرحيم

وزارة الدفاع

هيئة عمليات القوات المسلحة

القيد : د ١٤٢١ / ١١ / ١٠

التاريخ : ١٩٩٩ / ١٠ / ١٠

موافقة رقم (٩٩ / ١٩ ٥٦)

إلى السيد اللواء أ ح / ممدوح الزهيري - محافظ السويس

العنوان / ديوان عام محافظة السويس

تحية طيبة ... وبعد ،

إيماءا إلى قرار مجلس الوزراء بجلسته المنعقدة في ٩٩/٤/٢١ والمتضمن العمل على متابعة تنفيذ القطاع الخاص لمشروعاته بكل من المنطقة الاقتصادية شمال غرب خليج السويس والمنطقة الاقتصادية شرق تفرعة بورسعيد ،
نفيدكم بالموافقة على استغلال الأرض بالمنطقة الاقتصادية شمال غرب خليج السويس من وجهة النظر العسكرية وبالشروط الآتية :-
١- الالتزام بالموقع والمساحة المحددة باللون الأسود على الكروكي المعتمد المرفق بمقياس

رسم : ١ : ١٠٠٠٠٠٠

٢- الالتزام بالقرار الوزاري رقم ٣٦٧ لسنة ١٩٨٦ وملحقاته .

٣- الالتزام بتنفيذ تعليمات قوات حرس الحدود لتأمين حدود وسواحل الدولة .

٤- البعد عن طبان الطرق طبقا لقوانين الطرق .

٥- سداد مبلغ وقدره (١٦٥ و ١٦٠) مليون جنيه (فقط ستة عشر مليون ومائتان وخمسون ألف جنيهها) نظير الانشاءات البديلة والتنسيق مع قيادة قوات الدفاع الجوي قبل اثناء تنفيذ المنشآت بشأن مطالب تواجد عناصر الدفاع الجوي اعلى هذه المنشآت .

٦- عدم إقامة مباني او منشآت بارتفاعات تزيد عن ما هو موضح بعد من سطح البحر :-

أ- (١٠٠) م (مائة متر) للمنطقة الملونة باللون الاخضر والمنطقة الملونة باللون البرتقالي .

ب- (١٢٠) م (مائة وعشرون متر) للمنطقة الملونة باللون الاحمر .

ج- (٢٠٠) م (مائتان متر) للمنطقة الملونة باللون الاصفر .

٧- لامانع من دراسة زيادة الارتفاعات التي تطلب مستقبلا في حينه لكل مشروع على حده .

٨- لا قيود على ارتفاعات الابراج والمداخن مع قيام الجهات المستفيدة بتوقيع محضر تنسيق مع قيادة القوات الجوية لتحديد ضوابط وشروط هذه الارتفاعات طبقا لموقع كل مشروع .

٩ - موافقة هيئة عمليات القوات المسلحة بالمشروعات الجديدة لوضع الضوابط والشروط لها بما لا يتعارض مع اوضاع ونشاط القوات المسلحة .

١٠- التنسيق مع قيادة القوات الجوية بشأن :-

أ- تحديد المساحات على الطبيعة طبقا لقيود الارتفاعات بالبند رقم (٦) .

ب- إقامة منشآت حول المهابط لتحديد قيود الارتفاع لها .

- ١١- عدم التعارض مع الأراضي التي تخص القوات المسلحة سواء كانت مشغولة او غير مشغولة بـوحدات عسكرية وكذا اراضي الانشطة المختلفة للقوات المسلحة .
- ١٢- السماح بالعمل بالمشروع لمدة ٢٤ ساعة يوميا على أن يضاء موقع العمل اعتبارا من آخر ضوء حتى اول ضوء من اليوم التالي .
- ١٣- التنسيق مع قيادة الجيش الثالث الميداني قبل وأثناء العمل لتحديد حدود المساحة الموافقة على استغلالها على الطبيعة ولتأمين الكوابل وخطوط المياه والمنشآت العسكرية بالمنطقة .
- ١٤- التنسيق مع رئاسة مكاتب المخابرات وامن حرس الحدود والمخابرات الحربية بالسويس قبل بدء العمل لاستخراج تصاريح العمل اللازمة .
- ١٥- لا نضمن خلو المنطقة من مخلفات الحروب السابقة ويلزم التنسيق مع جهاز مشروعات الخدمة الوطنية بهذا الشأن مع عدم مسئولية القوات المسلحة عن حدوث أى أخطار نتيجة حدوث انفجارات .
- ١٦- حق القوات المسلحة فى إيقاف العمل وإلغاء الموافقة فى حالة المخالفة لأحد شروط الموافقة .
- ١٧- عدم مسئولية القوات المسلحة عن بحث موقف التخصيصات الصادرة من أجهزة الدولة وتعديلاتها حيث تعبر الموافقة عن وجهة نظر القوات المسلحة فقط وتقع مسئولية إجراءات التخصيص أو إلغاؤه أو تعديله على أجهزة الدولة المختصة بذلك .
- ١٨- لا تعتبر هذه الموافقة تصريحاً بالاستغلال ولكنها وجهة نظر القوات المسلحة فقط ويلزم الحصول على موافقة الوزارات والهيئات المعنية قبل التنفيذ .
- مع وافر التحية ،،،

١٩٩٩
التوقيع /
لواء أ.ح / على ماهر حجاب
رئيس هيئة عمليات القوات المسلحة

الموافقة رقم (موافقة ٩٩/١٩٥٦) تاريخ ٩٩/١٠/١٠

جبل الزيت

المنطقة الاقتصادية "أ"

المنطقة الاقتصادية "ب"

السويس

العين السخنة

٤٩٠٠ (٩) + ٤٩٠٠ (٥) = ٩٨٠٠
١٠/١/١٠

Annex (3)
EEAA Site Approval

قطاع الإدارة البيئية
الإدارة المركزية لتقييم التأثير البيئي
لقيد / ٧ / ٤٠١٠ /
التاريخ: ٢٠١٠/٦/٦

السيد المهندس / هانى سليمان

رئيس الشركة المصرية القابضة للبتروكيماويات

تحية طيبة وبعد ،،

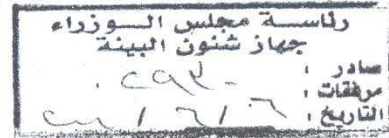
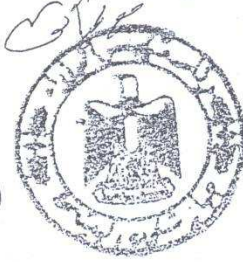
بالإشارة إلى التعاون المثمر بين جهاز شئون البيئة وشركتكم الموقرة وإلى اللجنة المشتركة المشكلة لمعاينة المواقع المقترحة للمشروعات المستقبلية للبتروكيماويات وبالإشارة إلى المعاينة التى تمت بتاريخ ٢٠١٠/٥/١٧ للموقع المقترح لإقامة مشروع الشركة المصرية الهندية لإنتاج البولى إستر بالعين السخنة فإننا نحيط سيادتكم علماً بأنه لا يوجد إعتراض من حيث المبدأ على إقامة المشروع بالموقع المقترح داخل نطاق منطقة الدورادو بالقطعة الثانية فى المنطقة الجنوبية الصناعية والتى تقع شمال غرب خليج السويس بالعين السخنة على أن يتم تقديم دراسة تقييم تأثير بيئى كاملة متضمنة دراسة أحمال التلوث البيئى بالمنطقة وذلك لمراجعتها وإيداء الرأى البيئى قبل البدء فى إقامة المشروع مع عقد جلسة التشاور المطلوبة لعرض المشروع على ممثلى المجتمع المدنى وجامعة السويس .

شاكرين صادق تعاونكم معنا،،

وتفضلوا بقبول فائق الاحترام

الرئيس التنفيذى

(د.مواهب أبو العزم)



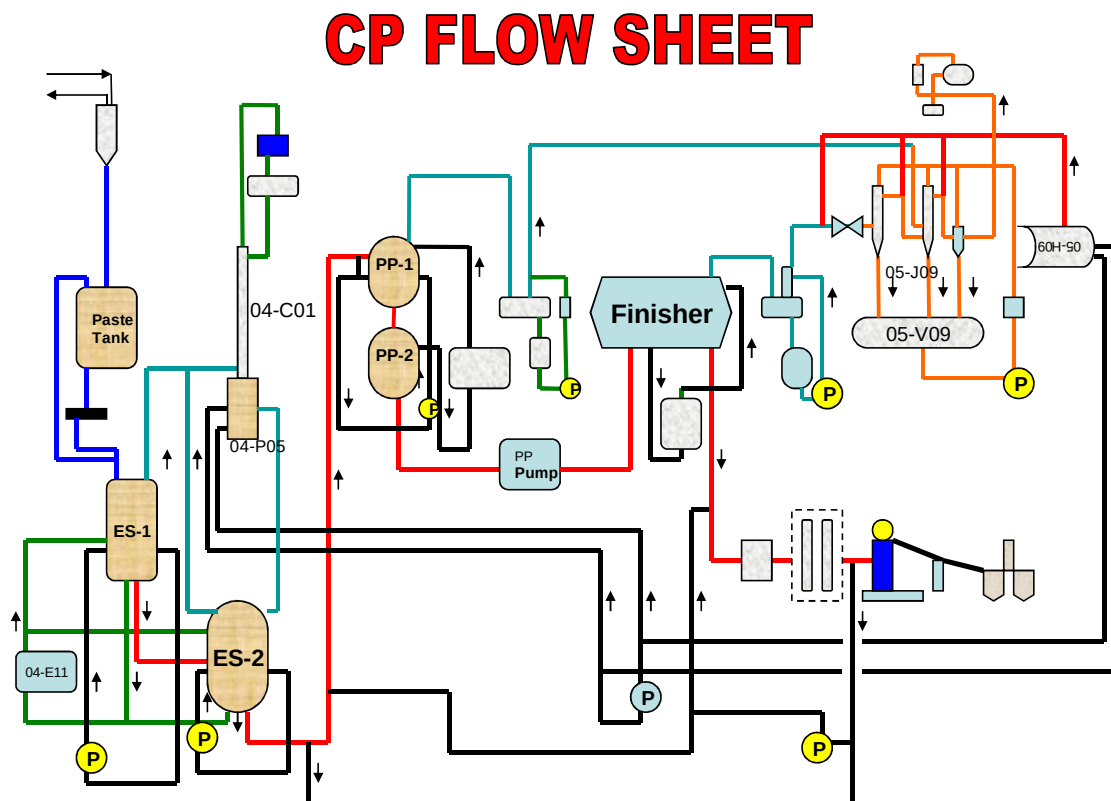
Annex (4)

Details of Technology Alternatives

NOTE ON PROCESS AND TECHNOLOGY EVALUATION (1500 TPD)

MANUFACTURING PROCESS

Polyethylene Terephthalate (PET) is a polyester polymer. PET is produced by the polymerization of **Pureterephthalic acid [PTA]** and **Monoethylene glycol [MEG or EG]** to produce polyester chips. The chips undergo a solid-state polymerization process (SSP), where IV (Intrinsic Viscosity) is increased to form the resin. The manufacturing process involves following stages:



Source: Management

Stage 1: Esterification

The raw materials PTA and MEG are metered, quantified and mixed in a particular mole ratio in a ***paste preparation vessel*** to form a thick paste.

The paste from the paste preparation vessel is metered and then fed into ***Esterification Reactor-I. [EST-I]***. Here the product temperatures are maintained around 260 - 270°C.

The liquid Heat Transfer Medium [HTM] flowing through the internal coils and jackets of the reactors, increase the temperature of the reactants to the required level.

The product from the Esterification Reactor-I is then fed into **Esterification Reactor-II [EST-II]** by a pump/gravity, where the conversion is further increased. By-product i.e., the water vapors from both EST-I & EST-II go into a **distillation column** where the water is separated and taken out as the byproduct.

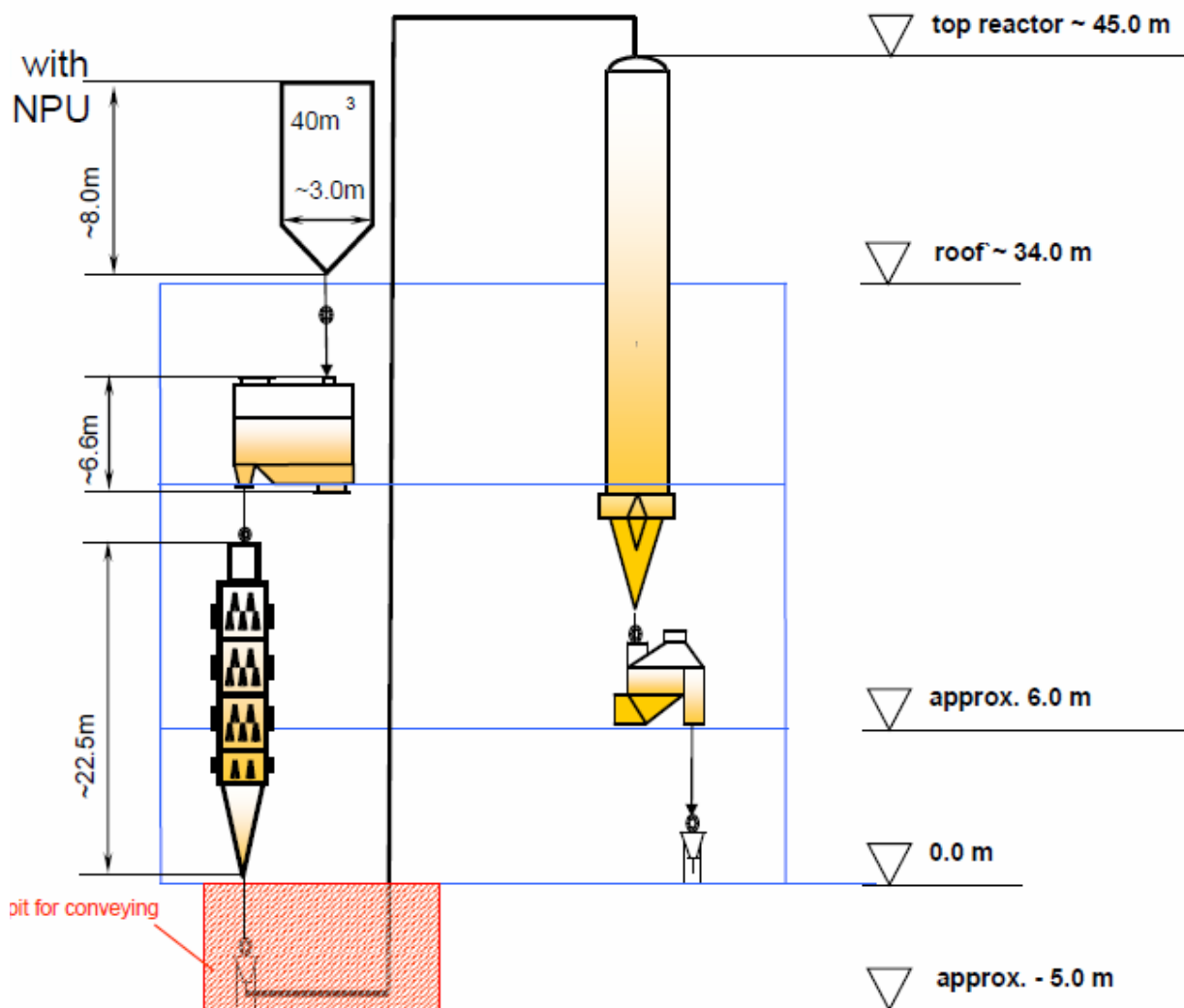
Stage 2: Poly Condensation

The product from the EST-II is now transferred to **Pre-poly-condensation reactors (PP)**. Under catalytic action, pre-poly condensation reaction starts here at higher product temperatures and under vacuum.

The product of PP is transferred to the **Final Reactor (Finisher)** aided by **pre-polymer transfer pumps**. The vacuum levels in final reactor are very fine. For PP-II and final reactor the vacuum is achieved with **EG vapor jet ejectors** and **vacuum pumps**. During the process of poly-condensation the excess EG keeps getting liberated which in turn keeps increasing the viscosity of the polymer.

A **gear pump** then transfers the product of final reactor through **product filter** to **chip cutters** (Under water Strand Granulator) where the polymer strands are quenched with **demineralised water** and granulated into chips. These chips are then conveyed into an **intermediate silo i.e. Amorphous chips silos** for storage and further processing.

Stage 3: Solid State Polymerization



Source: Management

The amorphous PET with **Intrinsic Viscosity [IV]** of 0.62 dl/gm is processed in **Solid State Polymerization [SSP]** plant to get an IV lift up to 0.90 dl/gm. The SSP Plant has 2 Nos. SSP lines each of 660 TPD capacity. The amorphous PET chips are initially conveyed into a **dosing vessel**. The chips flow by gravity via a **rotary lock feeder** into the **Crystallizer**. Here the chips are fluidized by hot **Nitrogen Gas [N₂]** increasing the chips temperature to 180°C. Owing to high turbulence of chips in the **fluidized bed** and due to the residence time (≈ 15 min) the chips get crystallized to a crystallinity level of 40-42%.

The **crystallization process** is highly exothermic and may result in the sticking of chips in the **crystallizer inlet**. Hence care needs to be taken in the operation of the crystallizer, i.e. in optimizing the N₂ gas temperature and flow. The circulating N₂ gas is heated up in a **Heat Exchanger (HE)** with liquid **HTM** flowing through the tubes.

The crystallized product (chips) then flows into the **Pre-heater** by gravity.

The chips are raised to higher temperatures in the Pre-heater and the chips are then conveyed hot with hot N₂ into the SSP reactor. The IV of the chips is increased here in the SSP reactor, to the required level of 0.90 dl/gm.

The IV rise in the SSP reactor is influenced by

- Initial IV of the base chips,
- Catalyst concentration,
- Carboxylic end groups,
- Chips size,
- Residence time,
- Nitrogen Gas flow to the reactor,
- Dew point of circulating N₂ gas.

The chips that enter the SSP reactor are to have a residence time of $\approx$ 12 -13 hrs. Hot, purified N₂ gas enters above the bottom cone of the reactor and is circulated through a chips bed of $\approx$ 130-135 MT. The gas flow of N₂ is fed at a ratio of 60% to the flow of chips. Thus owing to a residence time and flow of hot N₂ gas the IV of the chips is lifted up to 0.90 dl/gm. In the process of IV lift the circulating N₂ gas becomes impure by carrying the hydrocarbons viz. Monoethylene Glycols [MEG], acetaldehydes.

This impure N₂ is initially purified in the **Nitrogen Purifier Unit [NPU]**. This is an **Oxidation Reactor [OR]** having a Platinum catalyst. Before the N₂ enters the OR a small stream of compressed air is injected into the line. In the process all hydrocarbons in the impure N₂ are burnt in the presence of O₂ and Platinum catalyst in the OR at a temperature of 380°C. The excess O₂ content at the exit of the OR is monitored. The N₂ that is purified of all the hydrocarbons is later passed through the NPU driers for moisture removal. The driers have **molecular sieve beds** upon which the N₂ is dried. The purified and dried N₂ is later circulated into the SSP reactor.

The chips from the SSP reactor with the increased IV are fed into the **Cooler-Deduster [CD]** by gravity through **rotary lock feeders**. Here the chips are cooled and dedusted with air as the medium. The chips are then conveyed to the final **chips silos** for storage.

Thus the final chips have the following quality parameters:

IV	: up to 0.90 dl/gm
COOH groups	: 20 meq/kg KOH
IPA	: up to 2.0% by weight of PET
DEG	: 1.5% by weight of PET
AA	: $\leq$ 1.0 ppm
Dust content	: < 100 ppm.

Source: Management

The final SSP chips upon meeting the quality specifications are packed into **Jumbo bags/ Bulk Lined Containers/25 kg bags** for dispatch.

TECHNOLOGY EVALUATION

PET Process Technologies

The PET manufacturing process involves an integration of continuous poly-condensation (CP) and solid state polymerization (SSP) processes.

The following five technologies/technology suppliers have been considered for CP process:

1. Aquafil Engineering GmbH, Germany.
2. Chemtex Inc, Italy.
3. CTIEI, China.
4. Lurgi Zimmer, Germany.
5. Oerlikon Barmag, Germany.

CP Technology Details in Brief:

1. Auafil Engineering:

The raw materials - PTA/IPA, MEG/DEG as well as additives must be dosed with high accuracy, at the chosen molecular ratio, into the esterification reactor to form a uniform monomer, DGT (Diglycolterephthalate), and uniform polymer respectively.

In the esterification, the reaction takes place for the formation of monomer. As result of the under stoichiometric feed of glycol, a monomer is produced which consists of monomer, low molecular weight polymer and not reacted acid.

The esterification reaction is achieved in two-steps, sections, in the UPR®-REACTOR. The first section of the reactor has an integrated heat exchanger and is equipped with an agitator for better mixing and heat transfer. By pressure difference the product is flowing from the first section to the second section. In the second section of the reactor the final rate of reaction, required for the polycondensation, is achieved. This section is not agitated. It has integrated heating coils and special product passes. The esterification takes place at raised temperature, approximately 265 °C, and raised pressure, approx. 0,5 – 2,0 bar gauge pressure.

The heating of section 1 and 2 of the UPR®-REACTOR is done by liquid high temperature heating oil, HTM oil.

From the second ester section the monomer is flowing by pressure difference to the third section of the UPR®-REACTOR, the pre-poly section. During polycondensation, the excess MEG is evaporated to allow chain formation of the polymer. The pre-polycondensation takes place at raised temperature and vacuum.

The pre-poly section has a vertical heat exchanger and a special horizontal disc ring agitator. The vacuum, required for the pre-poly section is generated by the vacuum group of the finisher. The polymer transfer between pre-poly section of the UPR®-REACTOR and finisher is made by a polymer gear pump. A viscometer is installed in the polymer line to indicate and control the pre-polymer viscosity.

The final polycondensation is carried out in a shaft-less horizontal DISC-RING-CAGE reactor, the finisher. In that reactor thin films and strings are formed mechanically by the discs, which are presenting a large product/evaporation surface to the vacuum.

The finisher is of special design with heating jacket and drive gearbox. The vacuum sealing is of simple and reliable design. The motor speed can be adjusted according to the required viscosity and throughput.

The polymer enters the reactor on one side and is flowing through the reactor, forced by the incoming product and by the DISC-RING-CAGE agitator. On the opposite side of the product inlet, the product outlet and the vacuum connection nozzle are provided. In- and outlet product levels are measured by radiometric level sensors.

To achieve the desired viscosity the finisher operates at product temperature of about 280 °C and at vacuum between 0,6 and 2 mbar.

At the outlet of the finisher a diverter valve is installed to split the polymer flow into two feeding lines. In each feeding line a discharge gear pump is feeding the polymer through a no-stop polymer filter to a common diverter valve (21 K04).

An inline viscometer is installed behind the polymer filter, measuring the viscosity of the polymer. The signal of agitator torque and other criteria are used for vacuum (viscosity) control of the finisher. From the common polymer diverter valve (21 K04) the polymer is fed to the die heads of the three cutting units.

Polymer lines, valves, pumps and filter are jacketed and heated by a separate liquid HTM secondary heating system.

Three original Reiter strand cutter type M USG 900H and one common spare cutting head are foreseen.

In the spinneret of the die head, strands of 2 to 3 mm diameters are formed. The strands are solidified and cooled by water and led to the cutting equipment. From the cutter the chips are conveyed by the cooling water to a chips-water separator. From there, the chips are falling through a screen into a chips collecting tank and conveyed pneumatically to amorphous storage silos. The water, used for this process, is filtered, cooled and fed back to the cutting system.

Observation:

1. Even though they claim the processing with only two reactors, there is no plant in operation with capacity above 150 MTD.
2. Raw material consumption figures are on the higher side.
3. Utilities and Power consumption are higher than their competitors.

Conclusion:

So this technology is not considered for the proposed project.

2. Chemtex Inc, Italy:

Only three reactors are for the CP process (Esterifier, UFPP and Finisher) and can supply a single line of 1500 TPD.

TPA, IPA and EG are mixed in a slurry mix tank on a continuous basis, and the slurry is fed to the esterifier heat exchanger. EG from CP recycle tank, along with hot EG from esterifier EG tank, and TPA from TPA storage bin are used to prepare slurry.

The reaction of the TPA, IPA and EG mixture is accomplished in the esterifier, which is a combination of an external heat exchanger and a vapor separator. The heat exchanger works by natural circulation due to the hydrostatic pressure imbalance between the inlet liquid and the two-phase mixture in the heat exchanger tubes. HTF vapor is supplied to the shell side of the heat exchanger and the vapor separator jacket. The slurry is injected below the heat exchanger through 1 of 2 injection nozzles located in the interconnecting pipe between the bottom of the vapor separator and the heat exchanger. Water formed in the reaction, along with excess EG is taken off the top of the vapor separator into a water separation column mounted on the top of vapor separator.

The oligomer formed in the esterification reactor is fed to the continuous polymerization (CP) reaction vessels using gear pumps.

The continuous polymerization (CP) line consists of two polymerization vessels in which the oligomer further reacts to form polyester polymer of the desired viscosity and color.

The first vessel is UFPP, which consists of a shell-and-tube heat exchanger called a preheater, attached to the bottom of a tray column. Column is provided with 16 bubble cap trays and a dome at the top. The shell side of the preheater, UFPP column and piping jackets are heated with HTF vapor. Oligomer enters at the bottom of the preheater.

The heat, reduced pressure, surface area generation and action of catalyst remove most of the excess EG. On reaching the top of the UFPP, the pre-polymer and EG vapor are separated. Prepolymer flows to the finisher from the UFPP. The line between the UFPP and the finisher called as "loop seal" is designed to provide a liquid seal between the two vessels. Prepolymer flows by pressure difference between UFPP and the finisher and the hydraulic gradient between the two vessels.

To effect polycondensation, removal of excess EG from the melt is required. To promote mass transfer, the UFPP is operated under vacuum. EG vapors are condensed in spray condenser (UFPP).

The second vessel (finisher) is a specially designed horizontal, cylindrical vessel with a full-length agitator, which generates high surface area in the polymer. The jacket is heated with HTF vapor.

A proprietary agitator design is used to promote mass transfer by generating a large polymer surface area for evolution of EG. The agitator is composed of numerous screens perpendicular to the vessel axis with peripheral longitudinal wiper bars running along the length of the vessel to form a cage. Clearance between the wiper bars and the inside wall of the finisher is minimal to prevent polymer buildup. A mechanical seal is provided at each stub shaft.

Molten polymer from finisher with the required IV is transferred to chip making units using two polymer gear pumps through continuous polymer filter. Chips from the cutter outlet are transferred to amorphous chip storage silos.

Observations:

1. Chemtex is taken over by M&G, Italy who is a PET Resin producer.
2. Chemtex has quoted for a 1500 TPD plant.
3. Only one plant which can produce 1500 TPD (nameplate 1200 TPD) is in operation.
4. Utilities and Power consumption figures are lower.

Conclusion:

- a. Conflict of interest as it has both producer and technology supplier status. Hence, not considered.
- b. No proven track record of 1500 TPD Plant.

3. CTIEI, China:**Paste Preparation**

The paste with constant mole ratio prepared continuously by adding PTA, IPA and MEG to paste preparation tank is fed directly to the esterification reactor. The prepared catalyst and additives solution are also added to the paste preparation tank.

Esterification Reaction

The esterification reaction stage comprises two reactors. The esterification rate in the first reactor can reach 91% and the temperature is 260~265°C. The esterification continues in the second reactor where the esterification rate is controlled at about 96.5% and the reaction temperature is about 265~270°C. One process column is used for vapor phase separation and is shared by the two esterification reactors. The separated heavy component EG flows back to the two reactors. After condensation of light component on the head, part will be reflux to the tower, the remaining will be sent as production sewage to the waste water steam stripper system.

Pre-Polycondensation Reaction

The esterification product leaving the esterification stage is fed into the pre-polycondensation reactor which is equipped with an agitator. The polycondensation process initiated in the esterification is further continued in the pre-polycondensation reactor and a low molecular PET is obtained. The pre-polycondensation reactor has two rooms where the reaction temperature is about 272°C and the operation pressure is about 38-53 mmHg abs. in the first room and the reaction temperature is about 277°C and the operation pressure is about 8~15 mmHg abs. in the second room. The degree of polycondensation is set by maintaining the pressure, temperature and residence time at an appropriate level.

The MEG split off during pre-polycondensation is withdrawn in the form of vapor, condensed in the oligomer collector MEG cycle and fed back into the process column. The required vacuum is generated by a central vapor MEG vacuum ejector, serving the pre- and final-polycondensation reactors, i.e. both pre-polycondensation reactor and final polycondensation reactor share one set of MEG vacuum ejector only. The accumulating load

is passed back into the process. Pre-polymer is transferred into the final polycondensation reactor via pre-polymer gear pumps.

Final Polycondensation Reaction

The reaction temperature is about 280~285°C and the operation pressure is controlled at about 0.75 mmHg absolute in the final polycondensation reactor. By controlling vacuum degree of the system, the polymerization degree of the melt will meet requirement.

Polymer melt is transferred by the gear pumps and filtrated by the polymer filter(s) and sent to the chips production units. The polyester strands emerging from the extrusion head are cooled down by means of a loop of demineralised water. After cooling, the strands are cut into chip of uniform size.

The chips leaving the chip cutter together with the demineralised water are transferred to a water separator and a pre-dryer where most of the water is removed. Then the chips are screened off the over-sizes & fines and on-spec chips are collected in the intermediate silos.

Total four and six reactors are used for 600 and 1200 TPD production respectively.

Observations:

1. CTIEI is able to supply process technology, engineering design and complete equipments for CP and executed more than 15 projects for Bottle & Film grade Chips.
2. Raw material consumption figures lower than competitors.
3. Utility and Power consumption are comparable with other technologies.
4. Supplied CP plant of capacity up to 1200 TPD.
5. Project execution time is less than competitors.
6. CTIEI had tie-up with SSP technology suppliers and can implement total project on turnkey basis. CTIEI is taking single point responsibility in integrating CP & SSP process and offering all guarantees till the end product.

Conclusion:

CTIEI has been short listed for commercial negotiation.

4. Lurgi Zimmer, Germany: DHI PROCESS i.e. No SSP Plant:

The paste is made by mixing the continuous streams, i.e. the PTA powder and the EG are filled into the PTA preparation tank while stirring. The PTA paste is pumped by the paste pump(s) into the esterification stage continuously

In the esterification section (Vertical Compact Cascade Reactor), PTA and EG react to form diglycol terephthalate (DGT) and oligomers while water is split off.

The vapors discharged from the esterification stage are fed into the process column for rectification. Part of this vapor is used in an EG Jet to generate vacuum for the prepolycondensation and for the final esterification section.

The internal heat exchanger coil of the upper esterification section is directly heated by primary HTM while the rest of the stage is heated by dowtherm vapor.

The polycondensation process initiated in the esterification is further continued in the prepolycondensation top section of the 'Vertical Compact Cascade Reactor'. Here a low molecular PET is obtained. The degree of polycondensation is set by adjusting the pressure, temperature and residence time at an appropriate level. The EG split off during prepolycondensation is withdrawn in the form of vapor and is condensed. The accumulated glycol load is passed back into the process directly.

The prepolycondensation section of the 'Vertical Compact Cascade Reactor' is heated by dowtherm vapor system.

The product leaving the prepolycondensation section of the 'Vertical Compact Cascade Reactor' is continuously fed into the final polycondensation reactor, where under agitation and high vacuum the final product qualities are achieved.

The final polycondensation (disc ring) reactor is a horizontal multistage reactor with rotating discs to generate a large polymer surface, which supports the evaporation of EG at the possible lowest PET melt temperature. The degree of polycondensation measured as intrinsic viscosity (continuous measurement and controlled by an online viscometer at the outlet of this reactor) is set to the desired final value by maintaining the pressure, temperature and residence time at an appropriate level.

The polymer melt is pumped by the polymer discharge pump through the polymer filter to the chip production where the molten high viscosity polymer is converted into spherical chips. A booster pump is used to maintain constant melt pressure at the die face which ensures consistent chips size and shape.

The water circulation system is operated at a temperature just below the boiling point of water in order to minimize heat losses from the chips, thereby ensuring optimum latent heat crystallization in the next process step. To minimize water vapor plumes and the related water losses to the atmosphere, condensers (using cooling tower water as the cooling source) are provided at the outlet of each centrifugal dryer. Condensed water is collected in the water circulation system reservoir.

Dealdehydization Process

The chips fall from the outlet of the centrifugal dryer into a small vertical tube crystallizer, where the latent heat of the pellets initiates their crystallization.

A pneumatic conveying system with heated air moves the product to the top of the dealdehydization tower where the dealdehydization process takes place. During the process, hot air is blown counter-current through the chips to remove the formed and evaporated acetaldehyde.

During the dealdehydization process the acetaldehyde level in the chips is reduced by diffusion of acetaldehyde from the chips to a hot air stream passing through the chips. As a part of the continuous polycondensation plant, the dealdehydization section is also designed for uninterrupted operation.

The process requires only ambient air. It is filtered and drawn through a conditioning unit where its dew point is adjusted to the target level. The conditioned air stream is then blown through an economizer and heater before it enters the dealdehydization tower.

Acetaldehyde diffuses from the chips to the hot air stream as it passes through the chips mass. The air stream exits the tower at the top and passes through a fines filter. After filtration, the air stream is passing through the economizer where the thermal energy is transferred to the incoming conditioned air stream. From the economizer the air stream is vented to the organic stripping column where a portion of this stream is used as stripping gas.

The chip level of the dealdehydization tower is measured over the entire vertical length and it is controlled by the discharge lock feeders.

From the discharge lock feeder installed at the outlet of the dealdehydization tower, the chips drop into the chips cooler, which allows the normal handling and bagging of the product.

Observation:

Even though the party claims superiority for the DHI Process, no plant is operating with this technology from this party and they are not offering conventional plants with CP+SSP.

Conclusion:

So this party has not been considered for this project.

5. OERLIKON BARMAG (OB):

Paste preparation

PTA is transferred to the day silo via a Big bag unloading system equipped with a vibrating screen, metal filter and an exhaust system connected to the feed hopper. PTA and IPA are dosed by means of a feed screw to the slurry preparation tank via a coriolis type weighing device. Re-circulated EG from process split-off together with the required amount of virgin EG is metered continuously to the PTA in a stoichiometric ratio to prepare the paste.

The ready-mixed slurry is pumped continuously to the first esterification reactor by a dosing pump, flow and mole-ratio (calculated via density and temperature) are controlled by a coriolis type meter.

Esterification

The PTA / EG slurry containing the catalyst solution is fed continuously to the first esterification reactor. The esterification of PTA and EG to BHET takes place simultaneously with the formation of low molecular weight PET, Diethyleneglycol (DEG) and reaction- or process water.

From the outlet of the first esterification-reactor the product is transferred to the second esterification-reactor by gravity. Here the esterification is completed under slight overpressure. From the second reactor stage the product will be transferred via a product level control-valve to the prepolycondensation reactor.

The process water is collected in a reflux vessel, wherefrom it is sent to the process water stripper system. There the process water organic- and volatile components are stripped off

and the remaining process off-gas or vapors are routed to the HTM heaters for off gas incineration.

The certain portion of the process water is returned to the process column as reflux or sent-off as process waste water stream outside battery limit to the waste water treatment plant.

The process columns bottom product - non-reacted EG - is recycled partly to the slurry tank and partly to the first and second esterification reactor via pump pressure.

Blow-Down System and Off-Gas System

The esterification-reactors and process-column are equipped with safety pressure relief devices in order to avoid any dangerous overpressure.

In case of excess overpressure in these equipments hot and flammable vapor will be released via rupture discs, safety-valves and vapor-lines into the blow-down vessel. The off-gas system is a long pipe routed next to all relevant emission-points in the plant which transfers the collected off gas via a fan to the HTM-furnace.

The individual emission-points are connected mainly via flame-arrestors (when necessary) to this off-gas header.

As some glycol and acetic-aldehyde is included in this gas-flow and those gases are burned in the furnace the consumptions for natural-gas or fuel-oil consumptions are reduced.

Prepolycondensation

The product of the second esterification stage is transferred via jacket-heated product pipe and control-valve first to the prepolycondensation reactor 1 and then to the prepolycondensation reactor 2. The prepolycondensation reactors are designed to generate a maximum of product-volume and -surface regarding the reactor-volume. Here EG is removed under vacuum and elevated product-temperature, so that the polymer-chains can grow further.

The product from the prepolycondensation reactor 2 is discharged continuously by gear pump(s) to the final polycondensation reactor, the "cage-finisher".

The main portion of the EG vapors out of the prepolycondensation reactor is condensed in the spray condensing system, with seal tank, circulation pump and cooler. Possible contaminations from the EG loop accumulate at the bottom of the immersion tank and are removed from time to time via a separation device. The spray condenser itself is equipped with a cleaning device for removing possible agglomerates. Excess EG is routed to the immersion vessel tank. The non-condensable from the spray condenser are removed by the vacuum system.

Polycondensation

In this specially designed polycondensation reactor, a big surface area is generated. To generate this surface, an agitator, equipped with different types of net-elements dip into the sump of the reactor. Moving up the prepolymer is drawn via paddles to the agitator elements, from where it is flowing back to the sump. While flowing down the nets elements, a big surface is generated and the prepolymer is exposed to the vacuum inside the reactor.

The finisher allows a precise adjustment of the desired degree of polycondensation and the required viscosity by varying vacuum, temperature, residence time and agitator speed. An on-line viscometer is located downstream the polymer pump. The viscosity of the final product is controlled by adjusting the vacuum inside the "finisher" for controlling the desired viscosity by managing the finisher's vacuum.

This type of finisher provides the following advantages:

- Large surface to volume ratio which enhances the material and heat exchange
- Very short residence time (prevents side reactions and degradation)
- Continuous cleaning and scraping of reactor surface since the gap between the rotating internals and reactor-shell is very small
- Very thin layer of reaction mass
- No inner shaft where the product can accumulate and degrade
- Narrowest possible residence time distribution
- Defined average residence time

All joints in the finisher vacuum system are sealed with welding lip gaskets in order to avoid degradation of the product due to contact with oxygen.

All these above-mentioned features promote excellent product quality figures, such as good color, low degradation, a minimum increase of COOH-groups due to degradation process and a very good melting homogeneity.

For an optimized heating, the cage-finisher temperature is controlled by liquid HTM, which is adjusted by HTM circulation pumps.

The EG vapor formed during the final polycondensation reaction is sucked from the reactor by the vacuum system and is condensed in the second spray condensing system, with seal tank, separation pot, circulation pump and cooler as described above. The spray condenser is equipped with a special cleaning device. The non-condensables are also removed by the vacuum system.

Chips Production: The polymer melt is discharged from the "finisher" by a gear pump via a polymer filter to the pelletizing units. Thus the produced chips are conveyed pneumatically to amorphous chip storage silos.

Observations:

1. Oerlikon Barmag has been a good name in Spinning & Textile industry for last 50 years i.e. in the downstream of CP.
2. For last 5 years, Oerlikon Barmag Engineering Service has been offering Polyester Plants inclusive of CP process by sourcing CP process technology & Equipments from China.
3. Raw material consumption figures are comparable to other competitors.
4. Power and Utility consumption are lower than the other technologies.
5. Oerlikon Barmag had also tie-up with SSP technology suppliers and can implement total project on turnkey basis and they stand guarantee for the total plant performance & quality of products.

Conclusion:

Oerlikon Barmag has been short listed for commercial negotiation.

Raw Material Consumption:

SL	CP Tech Supplier	PTA+IPA Cons/ton of product, kg	MEG+DEG cons/ton of product, kg
1	Aquafil, Germany	856	334
2	Chemtex, Italy	859	339
3	CTIEI, China	857	336
4	Lurgi Zimmer, Germany	860	337
5	Oerlikon Barmag, Germany	857	336

Utilities Consumption per Ton of product:

SL	CP Tech Supplier	Elec. Power, kwh/Ton	Heat Value M Kcal/Ton	Nitrogen, Nm ³ /Ton	WCT, Circuln, m ³ /Ton
1	Aquafil, Germany	55	--	5	56
2	Chemtex, Italy	--	--	-	--
3	CTIEI, China	60	0.57	5	45
4	Lurgi Zimmer, Germany	--	--	--	--
5	Oerlikon Barmag, Germany	60	0.547	2	37

SSP Technology Suppliers:

There are four leading technologies for **SSP** in the global PET markets:

1. Buhler, Switzerland.
2. Du Pont, USA
3. Lurgi Zimmer, Germany
4. UOP Sinco, Italy.

1. Buhler SSP Process

The typical features of Buhler's SSP process are: gentle processing of the polymer by using fluid bed and gravity flow reactors, negligible dust generation, narrow residence time distribution and therefore constant product quality, sintering resistant process design, low operation and maintenance costs, wide production range in regard to capacity and product grades. The plants are designed for possible future capacity expansions with minimal cost implications.

Parameters for Bottle Grade Production

The SSP units for bottle grade production are laid out as typical **commodity production facilities**. The key attributes for these systems therefore are:

- Economy of scale
- Constant product quality
- A robust plant operation
- Low utility consumption
- High plant availability

Requirements for Technical Fiber Production

For applications in the field of technical fiber production, the SSP systems are designed to meet the following requirements:

- High production flexibility
- Minimal product hold up in the system
- Extremely sintering resistant process

Drying and Crystallization Processes for PET

Buhler has operating experience and feedback data from more than 250 operating crystallization and drying plants handling a variety of homo and co-polymers for fibers and films.

Buhler supplies continuous-operation processes for Crystallization and Drying of Granular materials. These processes can be used for:

- Virgin PET
- Post consumer material

Buhler's SSP technology is being used by major PET resin producers since 1985. In the past decade it became the leading technology for bottle grade resin and technical fiber manufacture.

Buhler supplied over 50% of worldwide installed capacity up to 2004. Buhler supplied more than 100 PET SSP lines with a total capacity of 7.4 MTPA with single line capacities from 20 to the world's largest SSP installation of 1000 TPD.

Advantages of Buhler's SSP Processes

- Narrow residence time distribution and therefore consistent product quality
- Sintering resistant process design
- Low operation and maintenance costs
- Extremely gentle processing of the polymer by using fluidized-bed and gravity flow reactors only
- Less dust generation
- Wide production range in regard to capacity and product grades

2. Du Pont's NG3 Technology

DuPont and Fluor Daniel launched the NG-3 technology, which uses a continuous polymerization process specifically developed for packaging resin. The technology providers claim that they are focusing on licensing the technology to Asian producers. **Reliance Industries'** 220,000 TPA plant at Hazira, India was the first to use the technology in 2003.

NG3™ PET Resins Process Technology Licensing:

NG3™ is specifically designed to produce high molecular weight PET for the bottle resin market. It produces an enhanced PET resin product and results in cost reductions to the PET bottle producer, ultimately delivering significant improvements to the bottom line.

The NG3™ process uses a patented pre-polymerizer to produce a low molecular weight polymer intermediate product with a degree of polymerization of 20-30. This is then subsequently solid stated to the desired levels of intrinsic viscosity. The **reactive distillation column** uses a **closed loop nitrogen circulation system** to increase the degree of polymerization. The by-products, ethylene glycol and water, are recovered from the system with the water being purged and the ethylene glycol being recycled to the **slurry preparation area**. This system is nitrogen driven and operates under slight pressure, which reduces the potential for oxidative degradation possible with the conventional vacuum system. The proprietary particle formation step simultaneously forms and crystallizes the low molecular weight intermediate into robust pellets, called **pastilles**.

The NG3™ approach eliminates the **finisher stage** in the conventional melt process and **one crystallization stage** in the solid state polymerization (SSP) process. The elimination of the finisher and the subsequent reduction in the melt phase residence time reduces thermal degradation, which results in improved product quality that benefits the end users.

The characteristics of NG3™ resin are differentiated from product produced by conventional technologies in the following ways:

- Equivalent or better mechanical strength, clarity and acetaldehyde generation
- Significantly narrower molecular weight distribution
- Significantly lower branching and therefore higher tenacity
- Lower cyclics (trimers and tetramers) and lower chained oligomer concentrations, thus improving operability of downstream conversion processes

3. Lurgi Zimmer SSP Process

Zimmer is a leading engineering, procurement and construction company with a clear focus on process technology operating worldwide in the polymers and the synthetic fiber space. Zimmer designs, supplies and builds turnkey plants or plant units for the production of polymers and synthetic fibers (polyester, polyamides, acrylic, cellulose etc) including the complete off-sites for utility supply. Projects performed by the company are on the average worth Euro 500 million.

As a global technological contractor, Zimmer AG can draw on a broad range of proprietary processes. Its technology portfolio spans the complete lifecycle of polymers, synthetic fibers and thermoplastics from production via further processing through to recycling. Worldwide, plants built by Zimmer generate products as diverse as textile filaments, staple fibers, tire cord, carpet yarn, engineering plastics, packaging films, bottles and engineering foils and films.

Ever since 1950 when Zimmer came into business, it had won 800 contracts for polymer and synthetic fiber projects in 50 countries worldwide. Roughly half of all projects are follow-up contracts. The company is the market leader in the construction of polyester and polyamide plants. On the world market, production capacities installed by Zimmer account for a market share of

- 30 per cent for polyester and
- 23 per cent for polyamide - 6.

Zimmer is the current technology partner for SAPL in its Haldia plant.

4. UOP Sinco Process

The **UOP Sinco SSP** process was initially developed by the PET resin producer to meet producer's objectives of making the highest quality resin at the lowest possible cost. It is a successful technique with over 70 SSP licensed units around the globe with a total capacity of 5 million MT of resin per year.

UOP Sinco offers batch and continuous SSP processes for a variety of polymer upgrade applications, with capacities ranging from 1 (pilot plant) to 800 metric tons per day:

- Bottle grade PET from conventional batch and continuous melt polymerization process (homo- and copolymers)
- PBT, PEN, PTT, Polyamides
- C-PET for heated food trays
- High tenacity technical yarns
- R-PET for recycling of PET industrial waste and post-consumer material.
- High production flexibility
- Low operation and maintenance costs
- Wide production range in regard to capacity and product grades

To sustain profitable operations, UOP Sinco supplies engineering, equipment, and services for new and existing SSP plants worldwide, including: new SSP unit design, process unit revamps / upgrades, melt phase plant modifications, development services, and field technical services.

SSP Technology Selection:

- UOP Sinco is 100% subsidiary of Honeywell, USA.
- UOP Sinco has flexibility in engineering their plant height between 40 to 49 m, to meet the local government departments' restrictions, if any, compared to the other prospective technology suppliers.
- UOP sinco has a Pilot Plant and R&D department to support after sales technical services.
- UOP Sinco plants have low operation and maintenance costs

Conclusion:

UOP Sinco has been chosen as SSP Plant Supplier.

Technology Selection by Sponsors for the proposed project

After due consideration of all economic and operational parameters and their experience with Zimmer's SSP Process, the sponsors have selected UOP Sinco **SSP technology** for the proposed project.

Since Oerlikon Barmag had a tie-up with UOP Sinco for supply of SSP process technology, they also offered SSP plant with UOP Sinco process technology along with their CP process and are taking complete responsibility in fulfilling overall performance, process guarantees & equipment warranties.

The relative key attributes for the CP, SSP Technology as represented by the management that have driven their choice of technology providers for the proposed project are summarized as follows:

CP

Attributes	Zimmer	CTIEI	Oerlikon Barmag
Technology	Melt to Resin Technology. Not Proven	Proven technology and supplied CP for bottle grade Chips.	Have offered 600 TPD conventional technology.
Repeat Customers	World wide.	Highest in China. Supplied more than 50 plants. Supplied CP up to 1200 TPD single line.	Highest in China. Supplied more than 30 plants. Max. supplied capacity 450TPD only.
Raw Material Consumption: kg per Ton of product	PTA: 860 and MEG: 337	PTA:857 and MEG- 336	PTA: 857 MEG: 336
Elec. Power consumption per MT of product	-	60 kwh	60 kwh
Heat Value M Kcal per MT of product	-	0.57	0.547

Source: Management

SSP

Attributes	Zimmer	Buhler	UOP SINCO
Technology	Well proven but only 10 % of worldwide capacity	Well proven- about 60% of world SSP capacity based on Buhler Technology.	Well proven. About 30% of world capacity based on UOP SINCO Technology
Crystallisation Process	Demonstrates mechanical agitation resulting into deformation of polymer pellets and polymer dust generation which gives operational problems sometimes such as agglomeration etc.	Demonstrates no mechanical agitation and therefore no pellet deformation and less polymer dust formation problem during bottle blowing.	Mechanical agitation through Rotary Crystallizer.
Utility consumption per ton of SSP chips	Elec. Power: 75 KWH Nitrogen: 18Nm ³ /MT	Elec. Power: 60 KWH Nitrogen: 14N m ³ /MT	Elec. Power: 60 KWH Nitrogen: 9Nm ³ /MT
IV sensitivities	Slight IV drop during final crystallization.	No IV drop during crystallization.	No I.V. drop during crystallization
Annealer	No separate annealer in the process leading to rise in variation in degree of crystallization. This creates operational problem when product grade or plant capacity is being changed.	Better annealing in annealer avoids sticking of polymer chips in the reactor.	No separate annealer
Modified Polymer Processing	Difficult to process highly modified polymers due to agglomeration of chips.	In the reactor no pellet agglomeration even for highly modified polymers.	Reactor pre-cooling at the outlet of reactor.
Precooling	None	Reactor pre-cooling at the outlet cone to avoid degradation of polymer in chips cooler.	Pre-cooling at the outlet of the reactor

Source: Management

Project Management

Attributes	Zimmer	CTIEI	Oerlikon Barmag
Turn Key	Not accepting turn-key contract. High price	Ready to undertake turnkey projects and has experience of turn-key projects	Ready to undertake turnkey projects and has experience of turn-key projects
Utilities and Auxiliaries	Not supplying utility & auxiliary plant and machinery.	Included	Included
Project implementation schedule	27 months	21 months	23months

Source: Management

Production Capacity

The Production Capacity of the proposed PET Resin plant will be 525,000 TPA. Site Design will account for further capacity expansions – both in terms of production volume and in terms of backward and forward integration.

Licensing

Licensing of the technology will be provided by the technology provider Oerlikon Barmag for both CP and SSP. They in turn take SSP process technology from UOP Sinco, Italy and integrating with the CP process and Utilities to have a single point responsibility.

Completion Schedule

	Task	time [month]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	Effective date		◆																													
2	1.st Design Conference	0.6	◆																													
3	Basic Engineering	3.5		■	■	■																										
4	Delivery of Equipment Layout		◆																													
5	Building Layout		◆																													
6	Kick-off Civil Engineering		◆																													
7	Civil Engineering	8.0		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
8	Detail Engineering	8.0			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
9	2.nd Design Conference				◆																											
10	Civil Construction	14.0		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
11	Building ready for erection															◆																
12	Procurement	8.0				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
13	Preshipment Inspection	4.0										■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
14	Equipment Delivery (fob)	4.0											■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
15	3.rd Design Conference									◆																						
16	Transport to Site	4.0											■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
17	Delivery Documentation												◆																			
18	Prefabrication	5.0											■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
19	Erection	7.0												■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
20	Precommissioning (no load tests)	2.0																				■	■	■	■	■	■	■	■	■	■	■
21	Mechanical Completion																						◆									
22	Commissioning	1.0																					■	■	■	■	■	■	■	■	■	■
23	Start up																							◆								
24	Performance test																								◆							
25	Performance test (latest date)																									◆						
	Task	time [month]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

**EGYPTIAN INDIAN
POLYESTER COMPANY
(EIPET)**

**Quantitative Risk Assessment
For PET Plant in Sokhna Area**

Prepared by:



June 2010

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1. INTRODUCTION

Egypt Indian Polyester Company (EIPET) is envisioned to erect a Polyethylene terephthalate (PET) plant in The Eldorado Integrated Development and Free Zone S.A.E Company site, which is at Sector-2 of the Southern Region of the Economic and Industrial Zone, North West of the Suez Gulf at Ain Sokhna. The present report is concerned with the quantitative risk assessment for this PET plant and its associated facilities

This study, the Quantitative Risk Assessment (QRA) is carried out in order to identify the potential risks associated with the different processes to draw conclusions about the acceptability of the on-site/offsite risk exposure. The QRA addresses mainly acute, rather than chronic, hazards. This means that emphasis is placed on rare but potentially hazard incidents resulting in fatalities and/or severe injuries, whereas chronic impacts are addressed in detail in the ESIA study. Within this context it is important to note that other risks, such as financial loss and bad publicity may also be significant, however, the scope of this study is mainly concerned with life threatening incidents.

It should be pointed out that the facility is still in the design phase and detailed information will not be available before the end of the detailed engineering phase. Therefore, this QRA is mainly targeted towards the quantification of risks based on typical industry process data and the basic available information and the experience of the QRA team regarding the operation activities.

1.1 Project Location

The proposed project site is located at The Eldorado Integrated Development and Free Zone S.A.E Company site, which is at Sector-2 of the Southern Region of the Economic and Industrial Zone, North West of the Suez Gulf at Ain Sokhna.

- **Surrounding Landuse**

Figure (1) presents the location of the project and the surrounding area.

- **To the North:** 470m bordered by the plot of land allocated to the Egyptian Chinese joint Venture Company.
- **To the South:** Cleopatra ceramic company chemical Store and carpentry workshop away from EIPET border about 40 meter.
- **To the East:** Under establishment workers temporary residence away from EIPET border about 200 meter and then Suez – Sokhna highway.
- **To the West:** 300m bordered by a vacant plot of land owned by Ceramica Cleopatra Group.

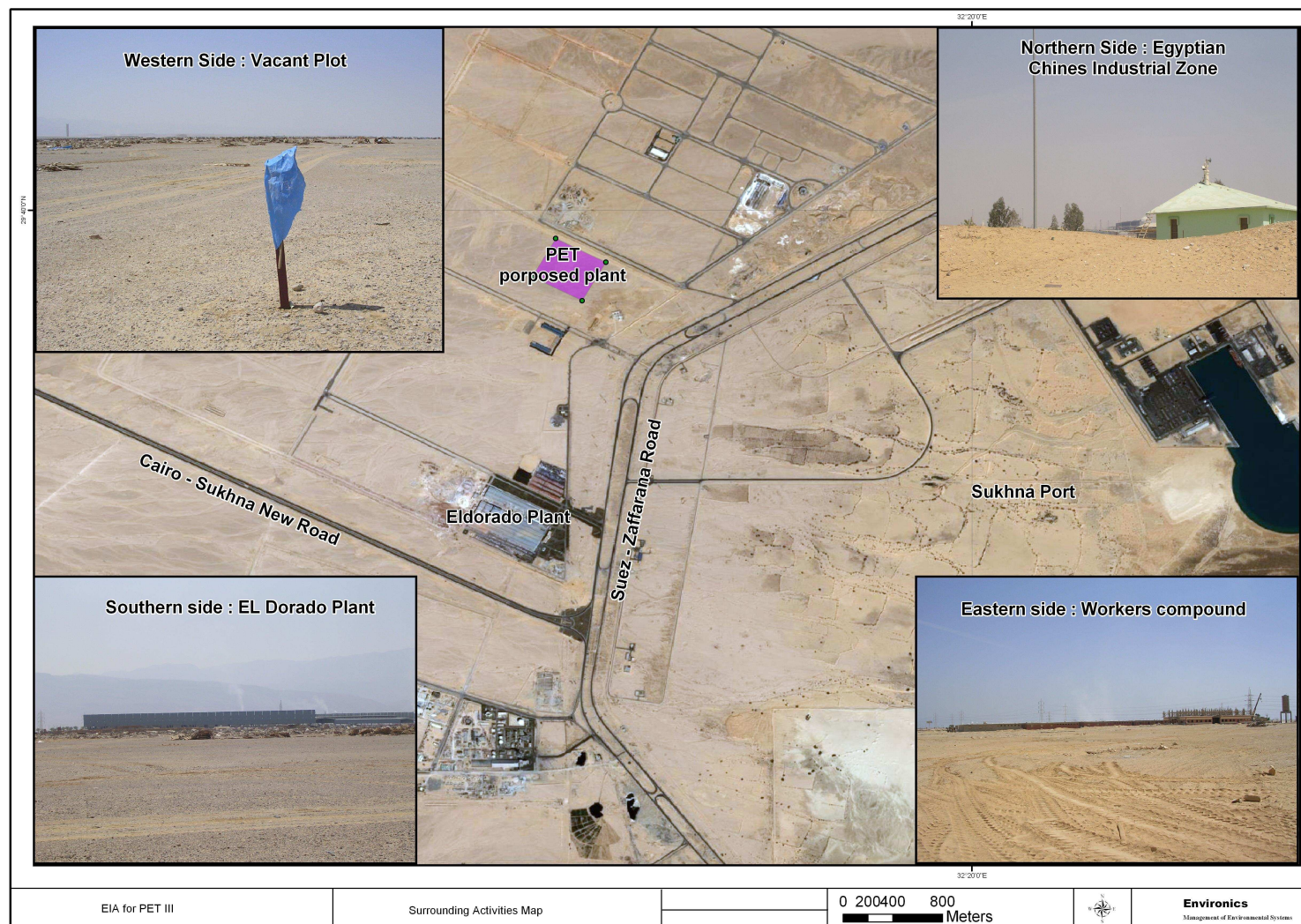


Figure (1): Presents the location of the project and the surrounding area

2. Study Methodology

The Quantitative Risk Assessment is a methodology designed to quantify risk, analyze risk reduction strategies, and provide the facility management with a tool to help evaluate overall process safety within the different process units as well as the surrounding receptors. The first step for developing the QRA is to identify the hazards relevant to the system under consideration and the risk it represents to the employees, the neighboring public, and the facility. The QRA study ends by analyzing and prioritizing the risks associated with the occurrence of undesirable basic events. The purpose is to provide the basis for controlling, preventing, and reducing the risk of major hazards and accidents. Risk prioritization provides the basis for contingency planning or risk communication with the local authority or the surrounding communities.

2.1 Scope and Objectives of the QRA study

Determining the objective of the QRA study is a crucial parameter for developing the QRA. Generally, QRA objectives are determined based on need for management decisions regarding

- prioritization of safety instruments,
- estimating financial risks,
- estimating employee/public risks
- meet regulatory requirements, or
- assist with cumulative emergency planning

For this QRA study the main objective is to estimate employee and public risks within the framework for developing of the project's Environmental and Social Impact Assessment (ESIA) to ensure safety of the surrounding communities as per the requirements of EEAA¹. Within this context, the QRA will investigate the hazards associated with the different units within the facility. The QRA is targeted towards the identification of the major hazards within the facility and the quantification of risks based on typical industry process data and the basic available information and the types and quantities of materials handled

¹ The Egyptian regulatory system does not have clear requirements for QRA studies.

This QRA is only concerned with the risks associated with the inside battery limit activities (ISBL) within the PET plant premises, thus the storage of raw materials at the Port, particularly MEG, and the transportation of the raw materials from the Port to the facility, do not fall within the scope of this study. The study methodology was carried out according to the steps outlined in Figure (1) below.

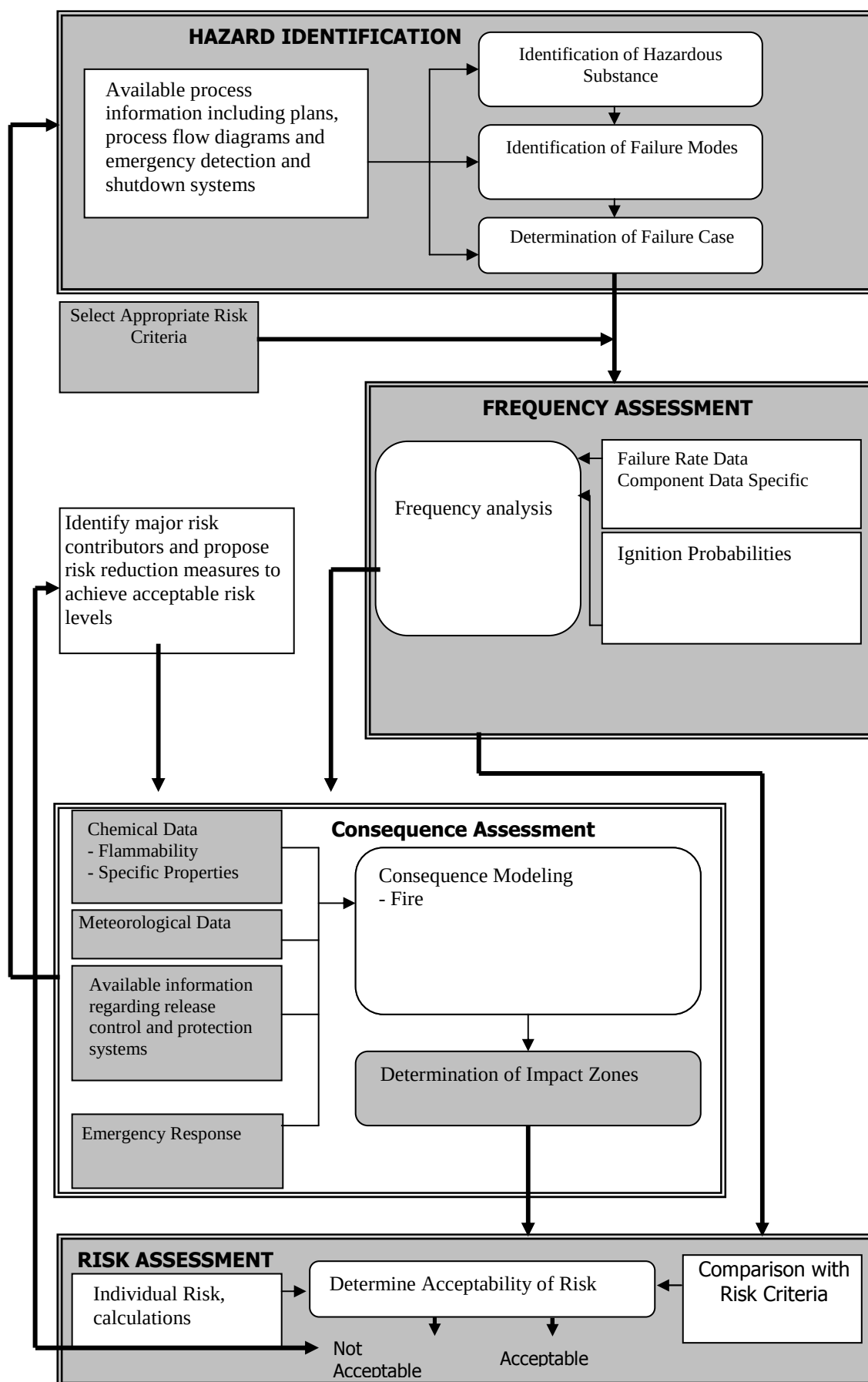


Figure (2): QRA Methodology

2.2 Hazard identification

Hazard identification is carried out by reviewing the different operations and materials handled, in order to identify the equipment and pipelines containing potentially hazardous materials and to define representative hazardous scenarios.

There are a number of techniques that could be adopted for hazard identification. It may be necessary to use a variety of approaches to improve the hazard identification process. The different techniques and approaches may also be used in isolation or to complement each other. In this QRA, Preliminary Hazard Assessment Method (PrHA) was used for hazard identification. PrHA is a broad hazard-screening that includes review of the different activities taking place in a facility and identifies the potential hazards associated with those activities. PrHA is normally used on new facilities where detailed information is not available to get an overall view of where the major areas of hazardous concerns exist. The results of the PrHA can be used to determine the need for additional hazard analysis; they also serve as a baseline for a more comprehensive hazard analysis subsequent to this study.

Since the Egyptian regulations do not have clear criteria for QRA studies, international systems have been reviewed regarding the type and scope of hazard to be included in QRA calculations. The European commission has identified in Article 9, para.6 of Council Directive 96/82/EC (Seveso Directive) on the control of major accident hazard involving dangerous substances, criteria for particular substances in a state incapable of creating a major accident hazard that can be excluded from the QRA calculations as follows:

- A hazardous substance can be excluded if at least one of the following criteria is fulfilled:
 - Physical form of substance
 - Containment and quantities
 - Location and quantities
 - Classification and characteristics

2.3 Frequency assessment

Once the hazard has been identified and the incident scenarios established, the occurrence likelihood of such accidents in practice and its consequence can be estimated. The aim of frequency estimation is to predict the expected probabilities of occurrence of hazardous consequence events. There are two possible approaches:

1. When available, relevant historical frequency of the hazardous event is used directly predict the required frequency; or
2. Where relevant historical frequencies are *not* available, event development is then estimated to predict the required frequencies.

In this study frequency was determined using both approaches, as relevant, the available historical data as well as failure and event frequency assessment

2.4 Consequence assessment

The outcome of severe accidents of a hazardous nature may cause death, injury, property damage or damage to the environment and can be considered under the broad headings of fire, explosion, toxic effects, etc.... The process of estimating quantitatively the effects of such outcomes is the consequence analysis.

SuperChems v6.2mp software founded by former Arthur D. Little Inc. has been used for consequence modeling component of the QRA. It provides a standard and validated set of consequence models to predict the effects of a release of hazardous materials from different type of equipment. Where possible, the effects of existing mitigation measures at the facility are taken into account in the consequence assessment.

2.5 Risk assessment

The frequency and consequence assessments are combined to calculate individual risk for fatality. The risk results are presented as contours on a site

plan. The risk results are assessed against selected risk criteria to determine risk acceptability, either through relative ranking of risk reduction strategies or through comparison with specific risk targets.

Risk = Consequence of incident x Frequency at which incident occurs

2.6 Risk Criteria

A risk analysis provides measures of the risk resulting from a particular facility or activity. A comparison of the risk against an appropriate target or criterion is required in order to assess the acceptability of that risk. Two types of risks criteria are identified, namely individual and societal risks that could be defined as follows:

Individual Risk Criteria

Individual risk is the frequency at which an individual may be expected to sustain a given level of harm from realisation of specified hazards.

Societal Risk Criteria

Societal risk is a measure of risk to a group of people in the effect zones of incidents. It is most often expressed in terms of the frequency distribution of multiple fatality events. One common graphical presentation shows the frequency of events resulting in N or more fatalities. This type of graph is commonly known as an F/N plot.

There are no Individual Fatality/Injury Risk Criteria adopted nationally. In this context, different international risk criteria were investigated such as the EU, the UK and the Australian systems. Annex (1) presents an outline for the risk criteria adopted internationally. In this context, the risk criteria accepted internationally, and used in the study, is presented in Figure (2) below.

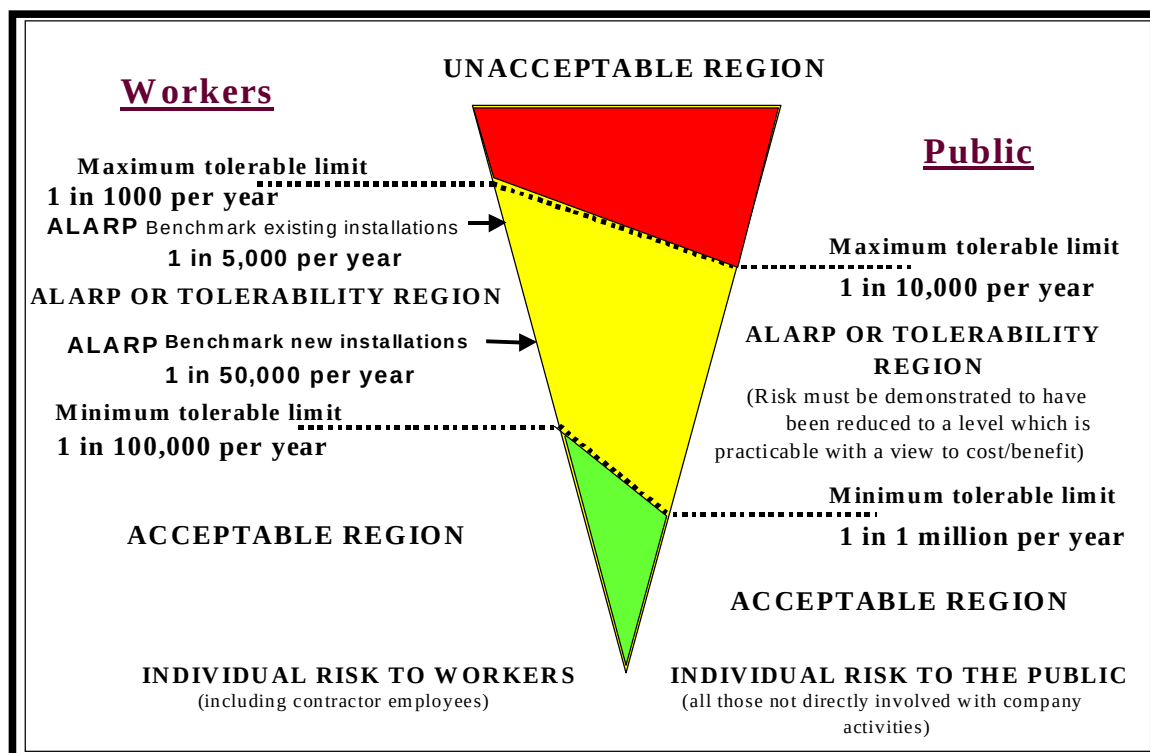


Figure (3): Internationally Accepted Risk Criteria, UK HSE

3. Facility Location and Operation Description

This section briefly describes project location and the surrounding land use and the refining units and processes. It also presents the Preliminary Hazard Assessment (PrHA) carried out for the different operations. In this respect, based on the type of material handled, type of process and operating conditions for the different units the potential hazards are identified

3.1 Surrounding Landuse

Figure 3.1 presents the location of the project and the surrounding area. The closest sensitive receptor is the Cleopatra industrial zone workers temporary housing used by third shifts workers at about 200m south of the site. As a conservative option, the number of 500 employees is selected to present the on-site population resulting in an onsite population density of $(500/140000\text{m}^2) = 0.004$ individual per square meter distributed within the site. The majority of the workforce is concentrated in the administration buildings and control rooms, almost no labour is continuously present within the operation units. Therefore the population density is expected to be less than 0.004 individual/ m^2 . For the purpose of this QRA the outdoor population is estimated to be about 1/5 of the calculated population resulting in 1.8×10^{-2} person per m^2 .

3.2 Description of Process and potential sources of hazard

This section describes the different process activities carried out at the PET plant. This description helps the identification of the incidents resulting from potential process releases or failure.

The proposed PET facility uses Purified Terephthalic Acid (PTA), Monoethylene Glycol (MEG) and Purified Isophthalic Acid (IPA or PIA) to produce bottle grade Polyethylene Terephthalate Polymer (PET). Other raw materials include DEG (Diethylene glycol), catalyst and additives. The production process is performed in two steps, namely producing amorphous polymer chips followed by final crystalline resin. The production encompasses esterification and polycondensation reactions followed by solid state polycondensation to produce a polymer with the required viscosity.

3.2.1 Production of amorphous polymer chips

- ***Paste preparation***

The raw materials, PTA and IPA, in powder form, are conveyed into the paste preparation tank via storage/feed silos. MEG and DEG, in liquid form, and the catalyst dissolved in MEG are mixed with PTA and IPA in the paste preparation tank at a particular mole ratio. The prepared paste is fed to the esterification reactor.

- ***The Esterification reaction***

In this stage, esterification reaction takes place between MEG, PTA and IPA in presence of a catalyst to produce an esterification product. As result of the esterification reaction, water is generated as by-product in addition to the excess MEG. The MEG is recycled back to the process and water, contaminated with organic constituents, is transferred to the Effluent Treatment Plant (ETP).

- ***Polycondensation reaction***

The polycondensation reaction takes place in two steps i.e. pre and final polycondensation, under vacuum at high temperature (about 280 – 290°C).

Pre-polymer melt is transferred to the polycondensation reactor via pre-polymer gear pumps. The low molecular weight PET is polycondensed to high molecular weight PET in the final reactor. The desired degree of polymerization of the melt and thus its viscosity is achieved through this reaction. MEG vapor liberated during these reactions is condensed and recycled back for paste making.

- ***Chip production***

The final polymer melt from the polycondensation stage, with higher molecular weight is filtered and transferred to the chip production units where the molten polymer is cooled down by means of a loop of demineralized water then cut into chips of uniform size. The resulting amorphous PET chips are subsequently dried and screened for removing over-size and fines then sent to intermediate storage silos prior to being fed to the SSP unit. The used demineralized water is filtered, cooled and recycled.

- ***Production of crystalline PET resin***

This process involves implementing solid state polymerization (SSP) to upgrade the amorphous PET produced from the polycondensation stage to high quality bottle grade resin. The process is typically conducted at high temperatures and under inert-gas conditions, such as nitrogen to prevent degradation of the polymer at high temperatures. The SSP stage includes:

- ***Crystallization (pre-crystallization)***

In the precrystallizer the adsorbed moisture on chips is removed by passing hot air counter currently. The pre-crystallizer also performs a dedusting operation to remove the fine PET particulates, if any, from the surface chips. The dust generated during fluidization process is separated by cyclone separators.

- ***Annealing (crystallization)***

This is similar to pre-crystallization where the chips are heated up to the required temperature in an inert environment, hot nitrogen, which prevents thermal and oxidative degradation of the chips. Nitrogen

flows countercurrent to the flow of chips to remove moisture, acetaldehyde and other volatile organic compounds released during heating and crystallization.

Potential Hazards: *High molecular weight resin is generally associated with decreased volatility. The resin components have very low vapor pressures and they are present no particular hazard in industrial processing.*

- **SSP reaction**

This is carried out in the SSP reactor at about 200 – 225⁰C where sufficient residence time, about 10 -12 hours, is given to polymer in the reactor to build up the polymer chain. The product from SSP Reactor is transferred to the cooler around 180⁰C for cooling.

- **Polymer Cooling**

The solid-stated resin needs to be cooled for storage and packaging. The maximum temperature for packaging is typically less than 60°C. Since the polymer temperature exiting the reactor is below 180°C the cooling can be performed in an air environment. Polymer dust generated during SSP and cooling operations is removed at this stage before sending for packing of the product.

- **Packaging**

The final product is packed in 1 MT jumbo bags in preparation for export or distribution in the local market. Provision will be made to pack the product in 25 kg bags for local market purpose, if required.

Potential Hazards: *High molecular weight solid PET presents no particular hazard in industrial processing.*

3.2.2 Utilities

The PET plant uses various utility units which serve either to provide the polycondensation and SSP plants with the required utilities or to handle/treat process effluents.

- **Nitrogen Purification System**

The nitrogen, providing inert conditions in the annealing and SSP stage, is contaminated with moisture and volatile organic hydrocarbons. The circulated gas needs to be purified to maintain reaction efficiency and minimize nitrogen make up. The nitrogen purification system consists of catalytic converter where the contaminants are oxidized to carbon dioxide and water. The wet nitrogen is dried by adsorption of water in desiccant beds.

Potential Hazards: Nitrogen is an inert gas thus it presents no particular hazard in industrial processing.

- **Water Utilities**

The water requirement for the plant is about 1700m³/day for industrial and domestic activities. The process water is distributed as follows for the different plant activities:

Cooling System: Cooling system consists of a cooling tower and auxiliary pumps which circulate the cooling water to the piping system. The cooling water quality is adjusted by chemical dosing, blowdown and fresh water addition (make-up water). The blow down is characterized by high TDS content of about 1500ppm.

RO Unit: is a desalination unit using Reverse Osmosis Technology (RO) to produce demineralized water for chips cooling and filter cleaning. The reject from the RO backwash is characterized by high TDS content, about 2000ppm.

Potential Hazards: the water utilities present no particular hazard.

- **Effluent Treatment Plant (ETP) and MBR**

The facility uses Anaerobic-Aerobic-Bio-Carbon (AABC) effluent treatment process. The principle for treatment depends on degradation of the organic components in the waste water under anaerobic conditions. The organic components are further decomposed under aerobic conditions. The treatment conditions allow for digestion of the bio-sludge resulting from the decomposition of organics. The sludge generated from the ETP is recycled as digested sludge for wastewater treatment. The treated wastewater is directed to the MBR for further treatment to produce water suitable for reuse as makeup for the cooling tower. The reject/backwash from the MBR will be discharged into the industrial zone sewer network.

Potential Hazards: *When water is contaminated by hydrocarbons or volatile organic constituents, flammable vapors can be evaporated into the air. If a source of ignition is present, or if lightning occurs, a fire may start. However, the type of organic constituents in the wastewater from the PET plant, namely MEG, are not volatile organic compounds and are dissociated upon the treatment process in the ETP unit and are completely removed after the MBR unit. Therefore, the wastewater treatment unit presents no particular hazard.*

- **The HTM System/steam generation**

The facility uses high and low pressure steam for filter cleaning and off gases stripping. The different steam requirements are generated through the heat exchange in the HTM heaters. The HTM System provides the different units in the facility with the necessary thermal energy by means of fluid heat transfer medium (Therminol 66) in a closed system to the different heaters. Three heaters are available at the PET facility, one stand-by and two operating. HTM is maintained at a constant outlet temperature (320°C) by means of natural gas used as fuel in the heaters.

Potential Hazards: the HTM is used in relatively small quantities and is managed in a totally closed system. A leak of hot therminol from the heating system can result in pool fire in presence of ignition source.

- **Tank Farm**

The facility includes storage tanks for the main liquid raw materials namely the MEG and the DEG.

- **MEG storage Tanks**

There are four tanks each of capacity of about 6000m³. The stored MEG is sent to the different processes in the polymerization plant. MEG is stored under atmospheric pressure and temperature. The tanks are located at the south western side of the facility. The construction material is stainless steel and include dyke wall for containment of any potential leakages.

Mono-ethylene glycol is the single liquid chemical which will be handled most frequently and will have the largest storage capacity on site.

The chemical is combustible, and has a high flash point 111°C, high boiling point 197.6°C and an auto ignition temperature of about 410°C.

Potential hazard: Due to its frequent handling on site and its large storage inventory, there is a potentially significant chance of an accidental leak during repeated unloading operations. A major leak from unit storage tank can lead to a large loss of containment and if an active source of ignition is simultaneously present, there could be a pool fire.

- **The DEG storage Tank**

The facility uses liquid DEG as raw material. It is stored in a storage tank of capacity of about 200m³ under atmospheric temperature and pressure. The construction material is stainless steel and include dyke wall for containment of any potential leakage.

DEG is a color less liquid used as additive for the continuous polycondensation reaction. DEG is a combustible liquid with a boiling point of 244⁰C (at 1013hPa), a flash point 154⁰C and an ignition temperature of 700⁰C.

Potential hazards. A leak from unit storage tank can lead to loss of containment and if an active source of ignition is simultaneously exist; there could be a pool fire.

3.2.3 Process Chemicals

The manufacture of PET resin requires the use of various operation chemicals listed in Table 1.

Table (1): List of Process Chemicals

Chemical	Physical State	Regulatory Hazard Classification (According to the lists of ministry of industry for the hazardous substances issued by the ministerial decrees 7/1999 and 851/2006)			
		F Flammable	E Explosive	R Reactive	T Toxic
Isophthalic Acid	Powder	No	No	No	No
Antimony Trioxide	Powder	No	No	No	No
Cobalt Acetate	Powder	No	No	No	No
PET product	Resin	No	No	No	No

The following sections present the characteristics of the chemicals of concern.

- **Isophthalic Acid**

Their powders can lead to dust explosions in handling and storage areas if uncontrolled dust accumulation and dense suspension in air were to occur. Their effects will be local. The plant will employ by design nitrogen blanketing and efficient dust control measures as well as residual dust extraction and recovery systems which will ensure that conditions of

dust explosion do not occur. Such measures will eliminate the risk of dust explosion. In addition, workers will be provided with eye and respiratory protection and long arm gloves to reduce the risk of health hazard.

- **Antimony trioxide**

Antimony trioxide is only weakly absorbed by the digestive system, and the main route of exposure is by inhalation of the dust. Acute poisoning is very rare, and the signs are fairly non-characteristic. These symptoms are more often associated with ingestion of other more water soluble compounds. Chronic poisoning by antimony trioxide is also rare. The facility uses about 85t/yr of antimony triacetate. In this context, it is not expected that this chemical is a source of potential off-site risks.

- **Cobalt acetate**

It is in a form of solid, odour less, water soluble crystals. The facility uses cobalt acetate and is used as additive for the continuous polycondensation reaction. It can cause fire if come into contact with strong oxidizers. In its solid form, cobalt acetate is harmful if swallowed or inhaled. Given the small quantities used of this material and the absence of strong oxidizing substances at the facility, it is not expected that this chemical is a source of major risk.

Potential hazard: *Based on a qualitative assessment carried out for the different process chemicals taking into consideration the types and quantities none of them present particular hazard off-site accident hazard.*

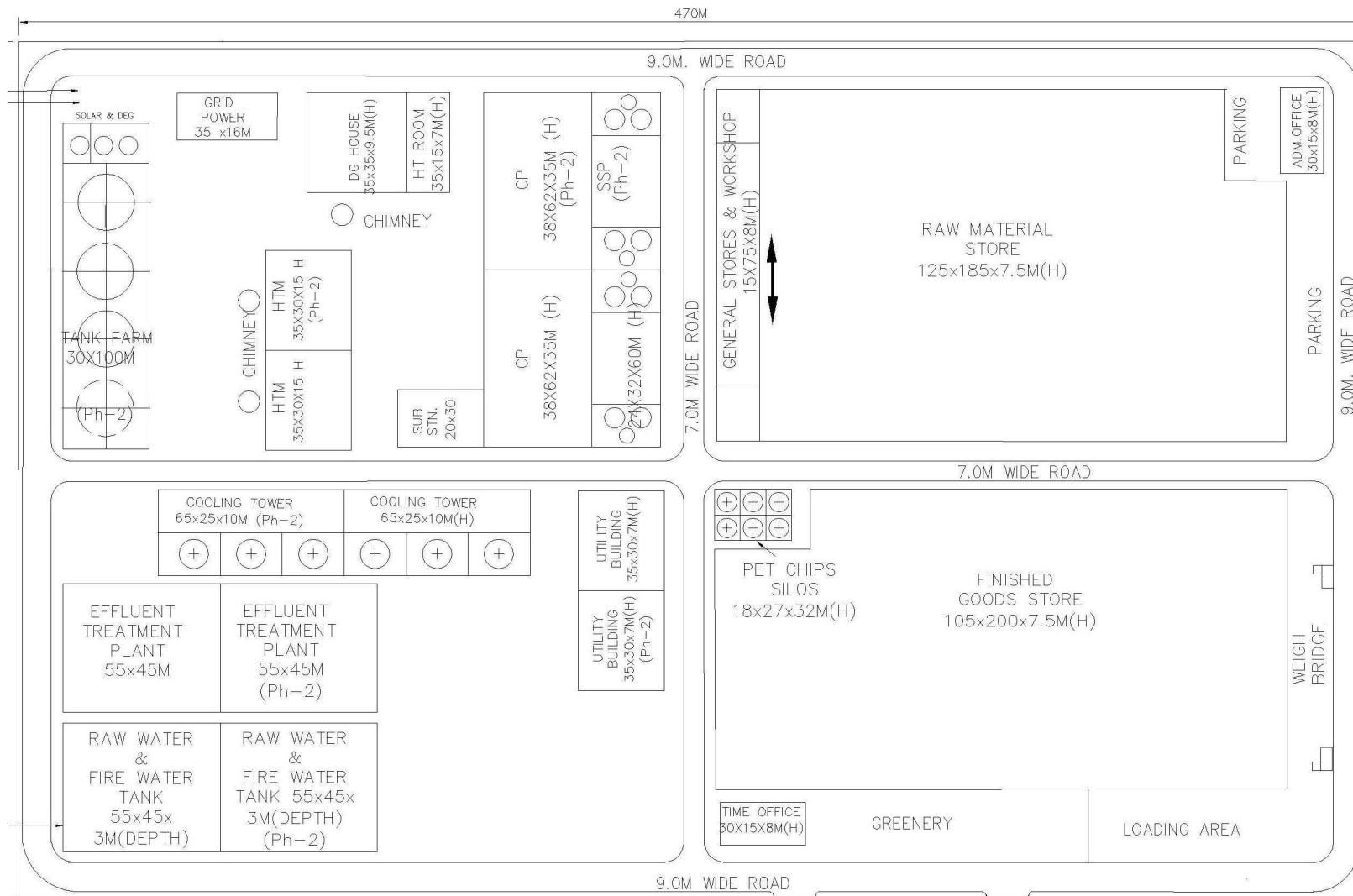


Figure (5): Plant Layout

4. Meteorological Conditions in Sokhna Area

Climate

The meteorological Data relevant to this study consists of different weather conditions in the form of combinations of wind -speed, temperature, humidity and atmospheric stability. The weather conditions are an important input into the model calculations that would potentially affect the dispersion pattern of the hazardous materials. The climate in Sokhna is generally characterized by warm and dry weather during most of the year. The climatic data presented herein regarding temperatures and rainfall was extracted from the "Climatic Atlas of Egypt", issued by the Egyptian Meteorological Authority (EMA, 1996) The climatic data is an average of 30 years (1968-1996) covering a complete climatic cycle which includes successive wet and drought periods. Other metrological data sources for wind speed and directions include the World Meteorological Organization, the National Center for Environmental Predictions (NCEP), US, and World Area Forecast centers (WAFS).

Temperature: In the Sokhna area, the highest maximum air temperatures occur during the month of July and August, while the lowest minimum temperatures take place in February, as shown in the following Table (2) below.

Table (2): Average Temperatures in Sokhna

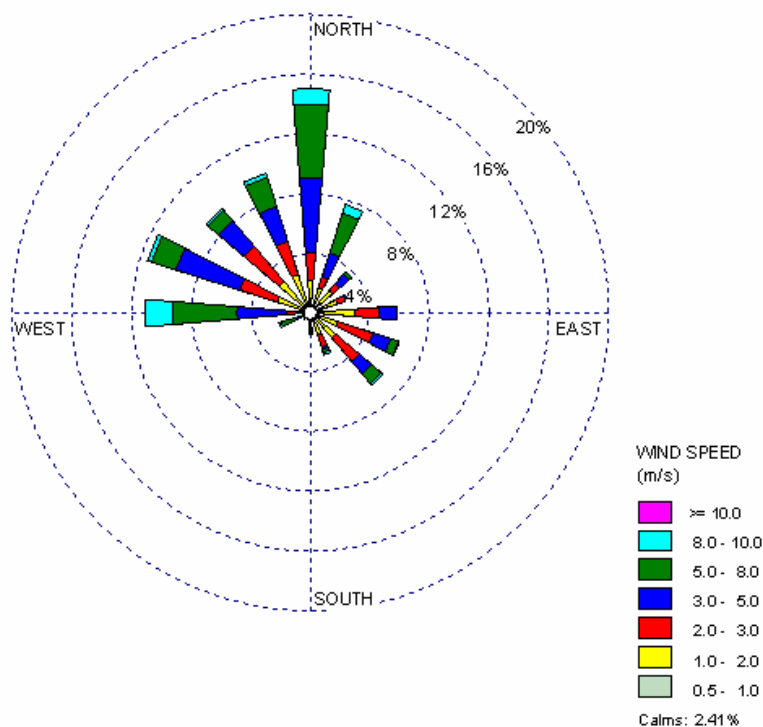
Air Temperature	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Maximum (°C)	20	21	24	28	32	35	36	36	33	32	26	21
Average Minimum (°C)	9	10	12	15	18	21	22	23	21	19	15	11

Humidity: Relative humidity peaks in July and decreases as the spring months approach. The 12 pm relative humidity readings are lower than the 06 am readings throughout the year. The 9 am relative humidity has an average annual range of approximately 68.5% with a minimum of 65% in March and a maximum of 72% in July.

Rainfall: December and January are the wettest months of the year, receiving a mean monthly rainfall of 52.7mm and 52.8mm respectively. Summer Months are dry having zero rainfall amounts

Wind: The meteorological data for Sokhna area for the year 2009 include wind speed and direction and air temperature were collected to represent different climatic conditions. The following figure presents the annual wind rose for the area.

Figure (6) Annual-average wind rose for the year 2009



The following figures presents the percentage distribution of wind speed.

	Directions / Wind Classes (m/s)	0.0 - 1.0	1.0 - 3.0	3.0 - 5.0	5.0 - 8.0	8.0 - 10.0	≥ 10.0	Total
1	00	170	554	644	737	154	0	2259
2	45	161	308	148	65	1	0	683
3	90	124	623	172	18	1	0	938
4	135	96	646	155	128	33	0	1058
5	180	77	166	14	16	3	0	276
6	225	48	65	6	53	8	0	180
7	270	68	329	554	540	189	0	1680
8	315	112	895	438	206	35	0	1686
	Sub-Total	856	3586	2131	1763	424	0	8760
	Calms							0
	Missing/Incomplete							0
	Total							8760

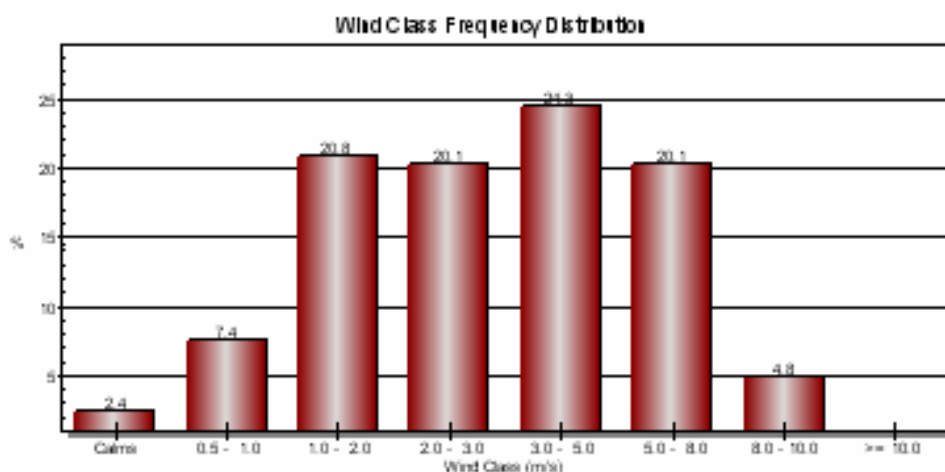


Figure (7) Percentage distribution of wind speed

Stability categories: Atmospheric stability is a major parameter in affecting the dispersion modeling and calculations. Stability classes are measure of atmospheric turbulence. They are categorized into six stability classes named A, B, C, D, E and F with class A being the most unstable or most turbulent class, and class F the most stable or least turbulent class.

Table (3): The Pasquill Stability Classes

Stability class	Definition	Stability class	Definition
A	very unstable	D	neutral
B	unstable	E	slightly stable
C	slightly unstable	F	stable

The atmospheric stability in the project area were investigated. Figure (7) below presents the average atmospheric stabilities for Sokhna area.

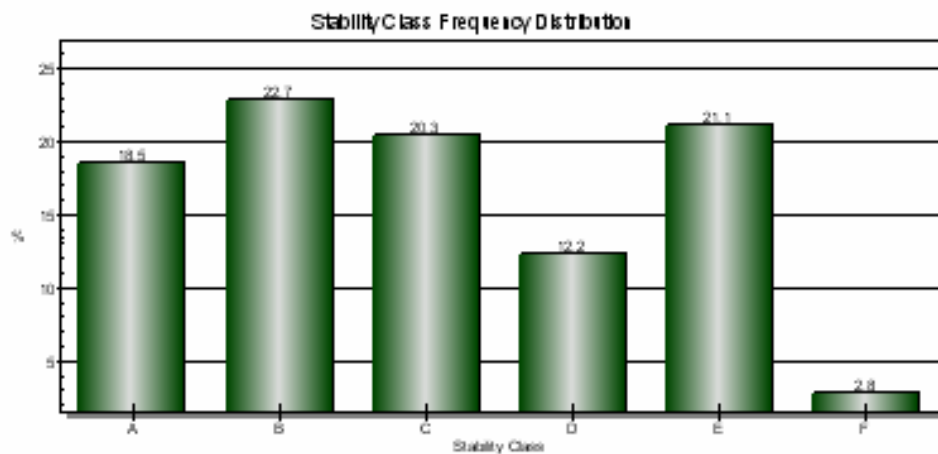


Figure (8): Atmospheric stabilities

For the purpose of this study, the stability class (D presenting the neutral stability) was selected as a conservative assumption to represent the climatic stability allover the year.

5. Hazards Identification and Frequency Assessment

The different production processes take place in closed processes and under moderate temperatures and pressures, besides most of the raw materials and the products are in solid forms which are not expected to result in leaks or spills. Thus, the potential for a fire resulting from a leak or release of such material is not expected. On the other hand, the potential for a fire exists should a leak or release occur from the liquid materials storage tanks in presence of a significant source of ignition. However, with the implementation of stringent control measures, isolation philosophies and contingency procedures, potential leaks are minimized.

By studying the layout of the facility, the different process and utilities and the process materials handled, the basic available information, and the international requirements for conducting QRA, it is indicated that:

- **The MEG Storage Tanks:** present the largest inventory of hazardous materials. In case of failure can result in large inventory loss leading to fire in presence of significant ignition source. The MEG will be considered in this QRA.
- **The DEG storage tanks:** is used in small quantities (one storage tank 200m³) and therefore will not be considered in this QRA.
- **The HTM system:** HTM is used in relatively small quantities and is managed in a totally closed system. Therefore will not be considered in this QRA study.

Identification, Enumeration and Selection of Incidents

One method for defining a list of incidents is to consider all possible breaks, ruptures of items of equipment which would lead to loss of containment. Releases from lines or vessels can take place in an infinite number of ways resulting in different incident outcomes. However, given the available level of information, releases caused by different incidents leading to similar incident outcomes were combined to reduce the complexity and time requirement of the process. In this respect, representative incidents are selected to meet the goal of the study. The processes selected to represent the identified hazards incident are selected if they meet one or more of the following criteria:

- representing the potential incidents of concern, mainly fire hazard
- presenting the largest inventory of the hazardous material handled on-site

Accordingly, the MEG storage tanks meet the criteria for hazard incidents and therefore will be the focus of this QRA study.

6. Hazardous Scenarios

The hazardous scenarios identified for the operation under consideration are associated with the release of MEG from the tanks. Such a scenario would result in the formation of a pool fire in presence of significant ignition source. In case the tank is surrounded by secondary containment, the potential exists to extend to the full surface area of the bund. This is the only scenario considered, as other scenarios are improbable.

Full Surface tank fire escalated from rimseal fire is not expected take place as the MEG tanks are fixed roof tanks. Moreover, BLEVE (Boiling Liquid Expanding Vapour Explosion) or jet fire incident do not apply.

BLEVE and jet fires address a special case of catastrophic rupture of a pressure vessel. BLEVE generally occurs when a material is being released from a pressurized units when exposed to prolonged period to fire resulting in increasing the vapour pressure in the vessel leading to strength loss of the vessel material and eventually rupture¹. Blast or pressure from BLEVEs is usually small, although they might be important in the near field.

As the MEG is a relatively viscous material stored under atmospheric temperature and pressure, where the tank design takes into consideration the tank inbreathing/outbreathing requirements as well as the emergency venting² the case of BLEVE is not likely to take place for the MEG tanks.

6.1 Selecting Hole Sizes

In order to carry out risk calculation in a practical manner, a set of representative set of hole sizes within the different equipment and pipelines need to be used. Experience showed that limiting the number of hole sizes allows for an analysis that is manageable yet still reflects the range of possible outcomes. The range of hole sizes is chosen to address potential onsite and offsite consequences. For onsite effects, small and medium hole-size cases usually dominate the risk

¹ Guidelines for Chemical Process Quantitative Risk Analysis, Second Edition, CCPS 2000 – Lees' Loss Prevention in the Process Industries, Third Edition 2005- Risk-Based Inspection Technology API Recommended Practice 581 Second Edition, September 2008

² API STD 2000, Venting Atmospheric and low pressure storage tanks, Non-refrigerated and Refrigerated 5th Edition, 1998

because of their much higher likelihood and potential for onsite consequences. For offsite effects, medium and large hole-size cases will dominate the risk. To address both onsite and offsite risk, and to provide good resolution between equipment items. For atmospheric storage tanks, hole sizes and locations assumed are: 1-inch (25mm), and 4-inch (100mm) leaks from above-ground sides of the tank to address potential on-site and off-site consequences.

6.2 Release duration

The duration of a release depends on the following:

- a. The inventory in the equipment item.
- b. Time to detect and isolate.
- c. Any response measures that may be taken.

For the purpose of this QRA, the release duration has been selected based on the categorization of the detection and isolation systems. As a **conservative approach**, detection class (C) and isolation class (C) were selected. Table ... below outlines the rating guide for detection and isolation systems.

Table (.....) Isolation and Detection Categories

Class	Detection classification	Isolation Classification
A	Instrumentation designed specifically to detect material losses be changed in operating conditions (i.e loss of pressure or flow) in the system	Isolation or shutdown systems activated directly from process instrumentation or detectors, with no operator intervention
B	Suitably located detectors to determine when the material is present outside pressure-containing envelope	Isolation or shutdown systems activated by operators in the control room or other suitable locations remote from the leak
C	Visual detection, cameras, or detectors with marginal coverage	Isolation dependant on manually-operated valves

Table (...) Leak Durations Based on Detection and Isolation Systems

Detection System Rating	Isolation System Rating	Leak Duration
A	A	20 minutes for 1/4-inch leaks 10 minutes for 1-inch leaks 5 minutes for 4-inch leaks
A	B	30 minutes for 1/4-inch leaks 20 minutes for 1-inch leaks 10 minutes for 4-inch leaks
A	C	40 minutes for 1/4-inch leaks 30 minutes for 1-inch leaks 20 minutes for 4-inch leaks
B	A or B	40 minutes for 1/4-inch leaks 30 minutes for 1-inch leaks 20 minutes for 4-inch leaks
B	C	1 hour for 1/4-inch leaks 30 minutes for 1-inch leaks 20 minutes for 4-inch leaks
C	A, B, or C	1 hour for 1/4 inch leaks 40 minutes for 1-inch leaks 20 minutes for 4-inch leaks

Source: (Risk-Based Inspection Base Resource Document API PUBLICATION 581 FIRST EDITION, MAY 2000)

It is important to mention that the domino effect on the neighbouring tanks resulting from a pool fire accompanying the selected release duration is unlikely to occur. This because of two main issues described as follows:

- Vessel failure due to material loss as result fire engulfment, that that would result in superheating of the stored volume of MEG ($\sim 5000 \text{ m}^3$ assuming 85% fill level) above its boiling point (197.6°C) is not likely to take place as the liquid inside the vessel is effective in cooling that part of the vessel wall which is in contact with it, but the vapour not. The proportion of the vessel wall which benefit of liquid cooling falls as the liquid vapourizes. After a time (depending on type of stored material, level of vessel fill, and vessel design temperature, it can take from 5-48 minutes for flammable substances such as LPG, filled vessels take longer time), metal which is not cooled by liquid is exposed to the fire, the metal becomes hot and weakens and may rupture. In this respect the time required for the volume of the vessel to reaches its boiling point and continue evapouration will be significantly long. Besides, as the boiling point of MEG is 197°C , even if the whole volume reaches the state of

evaporation it will not result in increasing the vessel shell temperature to above its maximum design temperature namely above 260°C.

- On the other hand, based on Superchems model output, the MEG pool from a 100mm hole size is formed with a discharge rate of about 4000 kg/min. When ignited, this pool burns with an average burning rate of about 2.4 kg/m²/min resulting in complete combustion of the whole pool size in about 10 minutes which is not sufficient exposure time to cause loss of integrity of the neighbouring vessels.

6.3 Selected Release Scenario

The hazardous scenarios identified for the MEG storage tanks are associated with the release of the MEG from the tanks. The size of the pool formed depends on the amount of inventory released. In case the tank is surrounded by secondary containment, the potential exists to extend to the full surface area of the bund. In presence of ignition sources a pool fire can result. It should be pointed out that the potential fire will emit dense acrid smoke and irritating fumes of carbon monoxide and carbon dioxide as products of combustion of MEG, which will have an adverse impact on the air quality. However, for the risk assessment purpose, the modeling of how these fumes disperse in case of a fire is not relevant as they not impact on life and property (i.e do not result in fatalities). However, the fire fighters will be at risk of injury unless they wear heat reflective suits and breathing apparatus for respiratory protection. For the purpose of this QRA study, it has been assumed that no bunding is available. The selected scenarios are presented in the following table.

Table (4) selected hazardous scenarios

Tank	Scenario
MEG Tanks Quantity: 4 Fixed roof Capacity: 6000 m ³ Di: 20 m H: 16	Release followed by a pool fire

Figure (8) below present the release scenarios from liquid storage tanks and the events associated with that release

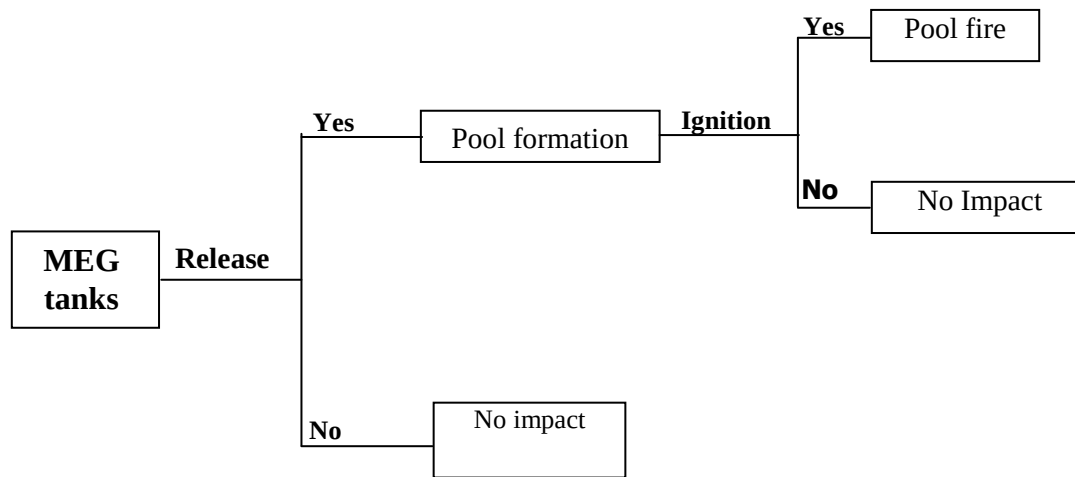


Figure (9): Release scenarios from liquid storage tanks and the associated hazard events

7. Failure Frequency and Frequencies Assessment

This chapter discusses the frequency assessment of the different identified scenarios. In this respect, it is essential to point out that as result of absence of national data on frequency the different hazard events, the data presented in the study is derived by adapting the data available in different international documents and case studies to the national context taking into account the expected management, safety and operation practices to estimate a frequency for the different events. It is important to note that although the facility is implementing stringent safety and emergency measures that would result in decreasing significantly the estimated equipment failure and consequently the risk, besides the workers will be highly trained and will be equipped with the necessary PPEs, **this QRA is based on conservative conditions** in calculating the risks as it is assuming worst case conditions.

As described earlier in section 2.2, there are different approaches to assess the incident frequency these include historical incidents data, failure frequency assessment and event tree analysis. In this QRA, a combination of the different methods was used, as data permits, for the different incidents.

7.1 Failure Frequency

The potential for the release of product is attributed to the potential for the failure of any item of equipment within the process causing a release. The frequency assessment step involved the calculation of the likelihood (ie. frequency) of releases from the MEG storage tanks. The failure frequencies were estimated using Superchems Hazard identification procedures as well as generic failure frequency data obtained from industry databases. According to the results of the Superchems model, the failure frequency of the storage tanks is 1×10^{-5} and 1×10^{-4} for 100mm and 25mm holes sizes respectively, which is corresponding to the frequencies determined by the API 581 – Table 8.1, as shown in table(...) below.

Table (5): Generic Equipment Failure Frequencies

Equipment Type	Data Source (References)	Leak Frequency (per year for four hole sizes)			
		1/4 in.	1 in.	4 in.	Rupture
Centrifugal Pump, single seal	1	6×10^{-2}	5×10^{-4}	1×10^{-4}	
Centrifugal Pump, double seal	1	6×10^{-3}	5×10^{-4}	1×10^{-4}	
Column	2	8×10^{-5}	2×10^{-4}	2×10^{-5}	6×10^{-6}
Compressor, Centrifugal	1		1×10^{-3}	1×10^{-4}	
Compressor, Reciprocating	6		6×10^{-3}	6×10^{-4}	
Filter	1	9×10^{-4}	1×10^{-4}	5×10^{-5}	1×10^{-5}
Fin/Fan Coolers	3	2×10^{-3}	3×10^{-4}	5×10^{-8}	2×10^{-8}
Heat Exchanger, Shell	1	4×10^{-5}	1×10^{-4}	1×10^{-5}	6×10^{-6}
Heat Exchanger, Tube Side	1	4×10^{-5}	1×10^{-4}	1×10^{-5}	6×10^{-6}
Piping, 0.75 in. diameter, per ft	3	1×10^{-5}			3×10^{-7}
Piping, 1 in. diameter, per ft	3	5×10^{-6}			5×10^{-7}
Piping, 2 in. diameter, per ft	3	3×10^{-6}			6×10^{-7}
Piping, 4 in. diameter, per ft	3	9×10^{-7}	6×10^{-7}		7×10^{-8}
Piping, 6 in. diameter, per ft	3	4×10^{-7}	4×10^{-7}		8×10^{-8}
Piping, 8 in. diameter, per ft	3	3×10^{-7}	3×10^{-7}	8×10^{-8}	2×10^{-8}
Piping, 10 in. diameter, per ft	3	2×10^{-7}	3×10^{-7}	8×10^{-8}	2×10^{-8}
Piping, 12 in. diameter, per ft	3	1×10^{-7}	3×10^{-7}	3×10^{-8}	2×10^{-8}
Piping, 16 in. diameter, per ft	3	1×10^{-7}	2×10^{-7}	2×10^{-8}	2×10^{-8}
Piping, > 16 in. diameter, per ft	3	6×10^{-8}	2×10^{-7}	2×10^{-8}	1×10^{-8}
Pressure Vessels	2	4×10^{-5}	1×10^{-4}	1×10^{-5}	6×10^{-6}
Reactor	2	1×10^{-4}	3×10^{-4}	3×10^{-5}	2×10^{-5}
Reciprocating Pumps	7	0.7	.01	.001	.001
Atmospheric Storage Tank	5	4×10^{-5}	1×10^{-4}	1×10^{-5}	2×10^{-5}

7.2 Event Tree Analysis

It is a graphical procedure used to determine the potential consequence events that may result for a given release scenario. In general, probabilities of a hazard event occurring during a given time interval can be derived from the probabilities (frequencies) of each of the contributory events whose occurrence, individually or in conjunction with other events, could lead to the occurrence of the hazardous event. Event tree analysis provides a systematic means of determining which factors will influence the release, in addition to the probability associated with each of those factors. The outcomes of a release scenario are dependent on the following factors:

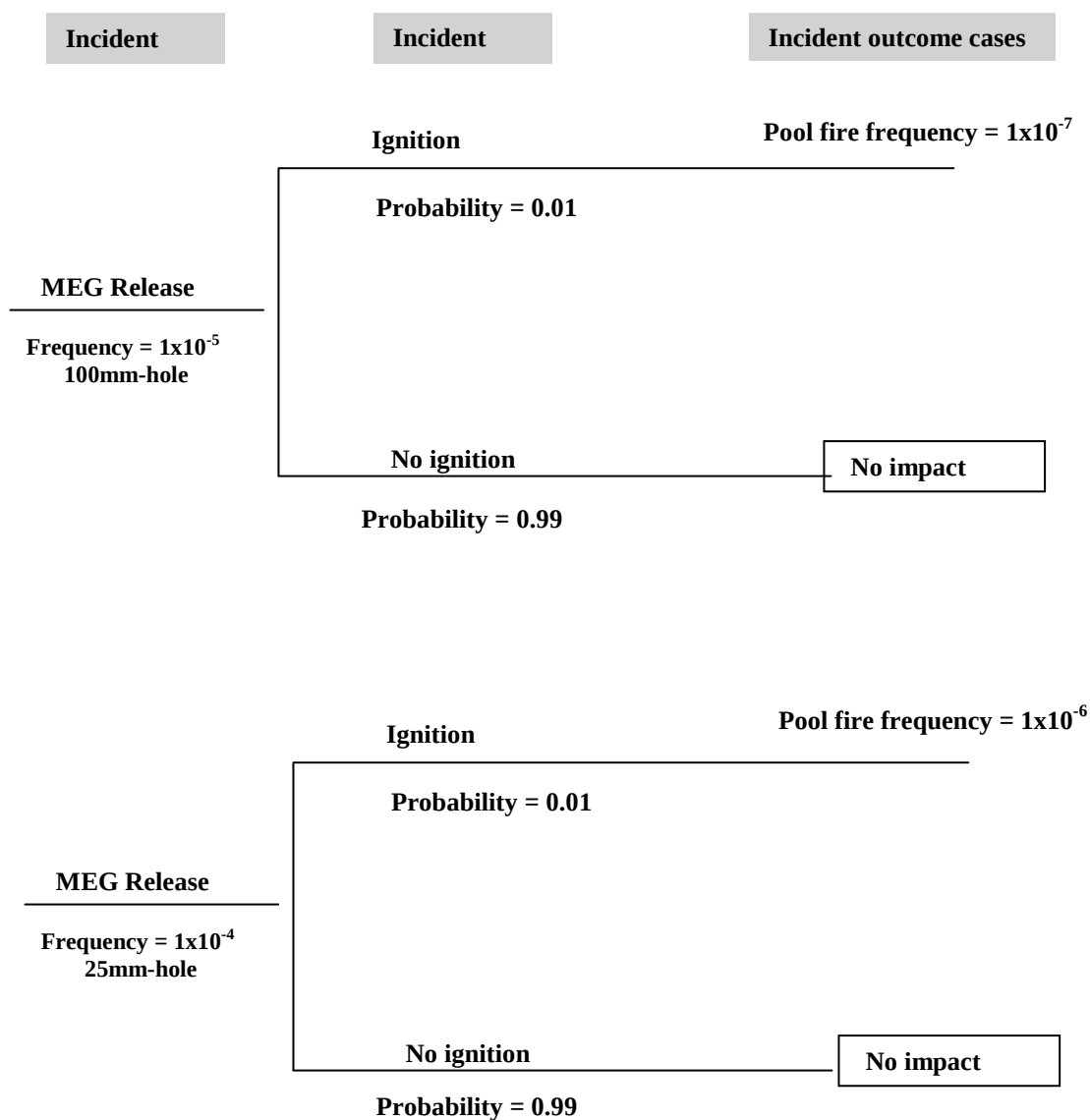
- Characteristics of the release (e.g. hole size, product released etc.)
- Release conditions (e.g. temperature, pressure)
- Release detection systems
- Intervention systems (i.e. to isolate or contain a release)
- Ignition sources
- Consequence mitigation measures

A release may have many event outcomes, depending on the timing and type of ignition. For example, a released substance may be ignited immediately at the point of release, or it may be ignited after the cloud has been dispersing for a certain amount of time, or it may not ignite at all. For a liquid material, a pool may be formed and pool fire may occur if it ignites, or the substance may be evaporated and disperse away from the release centre following the wind direction. Frequencies of the event outcomes for given scenarios are calculated by multiplying the initial frequency with the associated branch probabilities of the event tree diagram.

7.3 Frequency assessment for the hazard scenarios

7.3.1 Pool fire

As per section 7.1 above, the release frequency from a 100mm is 1×10^{-5} per year. For the purpose of this QRA a conservative approach will be adopted in estimating the probability of ignition following a release. In this respect, a **significantly conservative ignition probability** of 1×10^{-2} has been assumed. This would result in an incident frequency, namely pool fire, of 1×10^{-7} . On the other hand, the incident frequency from a 25mm hole is 1×10^{-6} taking into consideration the release conditions and characteristics. The figure below provides the frequency estimate for the fire incident, the incident outcome and incident outcome cases.



8. Consequence Modeling

The consequence scenarios associated with the storage tanks were modelled to determine their potential impact on the surrounding area. The modelling took into account the chemical and physical properties of the product released and the meteorological conditions.

For Fire models

The release rate provides a measure of the magnitude of the spill/leak. For liquid releases that are banded, the release would be contained, thereby limiting the magnitude of any subsequent pool fire. Bund fire will not be considered for worst case scenario. The results of the analysis were used to determine the impact on personnel (fatality rate).

For the case of fire scenarios, the release has been considered to be from a 1-inch and 4-inch hole size. The heat flux exposure was calculated at 1 m above ground level, to represent an upper limit of heat flux exposure to a person present near the flame. The general effect of heat radiation is summarized are presented in table (6) below.

Table (6) Effect of thermal radiation *

Permissible design level K kW/m ² (Btu/h·ft ²)	Effect
9.46 (3 000)	Maximum radiant heat intensity at any location where urgent emergency action by personnel is required. When personnel enter or work in an area with the potential for radiant heat intensity greater than 6.31 kW/m ² (2 000 Btu/h·ft ²), then radiation shielding and/or special protective apparel (e.g. a fire approach suit) should be considered.
6.1 (2 000)	Maximum radiant heat intensity in areas where emergency actions lasting up to 30 s can be required by personnel without shielding but with appropriate clothing ^a
4.73 (1 500)	Maximum radiant heat intensity in areas where emergency actions lasting 2 min to 3 min can be required by personnel without shielding but with appropriate clothing ^a
1.58 (500)	Maximum radiant heat intensity at any location where personnel with appropriate clothing ^a can be continuously exposed
^a Appropriate clothing consists of hard hat, long-sleeved shirts with cuffs buttoned, work gloves, long-legged pants and work shoes. Appropriate clothing minimizes direct skin exposure to thermal radiation. It is important to recognize that personnel with appropriate clothing ^a cannot tolerate thermal radiation at 6.31 kW/m² (2 000 Btu/h·ft²) for more than a few seconds	

Source: Pressure-relieving and Depressuring Systems, ANSI/API STANDARD 521 FIFTH EDITION, JANUARY 2007.

* As a basis of comparison, the intensity of solar radiation is in the range of 0.79 kW/m² to 1.04 kW/m² (250 Btu/h·ft² to 330 Btu/h·ft²) depending on geographical location and time of year.

Since the allowable radiation level is a function of the length of exposure, factors involving reaction time and human mobility should be considered. In emergency releases, a reaction time of 3 s to 5 s may be assumed. Perhaps 5 s more can elapse before the average individual seeks cover or departs from the area, which would result in a total exposure period ranging from 8 s to 10 s. In evaluating the emergency procedures, consideration may also be given to an exposed individual becoming incapacitated during an attempt to exit the area.

Personnel are commonly protected from high thermal radiation intensity by restricting access to any area where the thermal radiation can exceed 6.31 kW/m² (2 000 Btu/h·ft²).

In most cases, equipment can safely tolerate higher degrees of heat density than those defined for personnel. However, if any items vulnerable to overheating problems are involved, such as construction materials that have low melting points (e.g. aluminium or plastic), heat-sensitive streams, flammable vapour spaces and electronic or electrical equipment, then the effect of radiant heat on them might need to be evaluated.

Box 1: Mitigation/prevention of Pool Fires

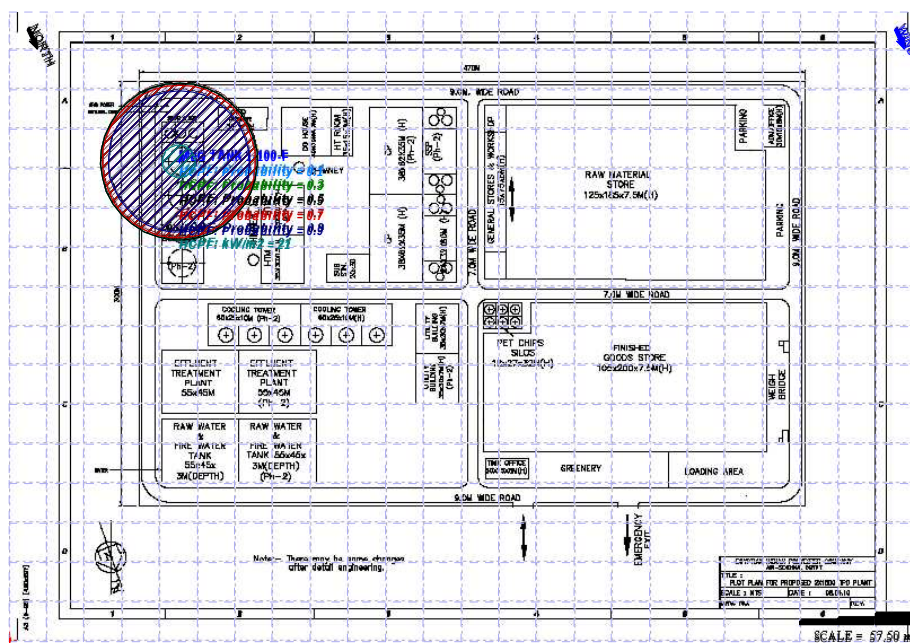
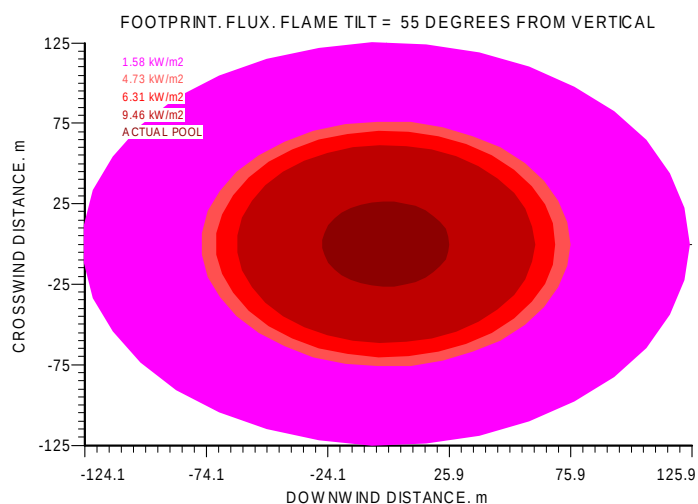
Environmental consequences are mitigated by:

- physical barriers act to contain leaks on-site,
- isolation and leak detection systems limit the duration of the leak
- drainage of material to safe location
- implementation of preventive and proactive maintenance programmes

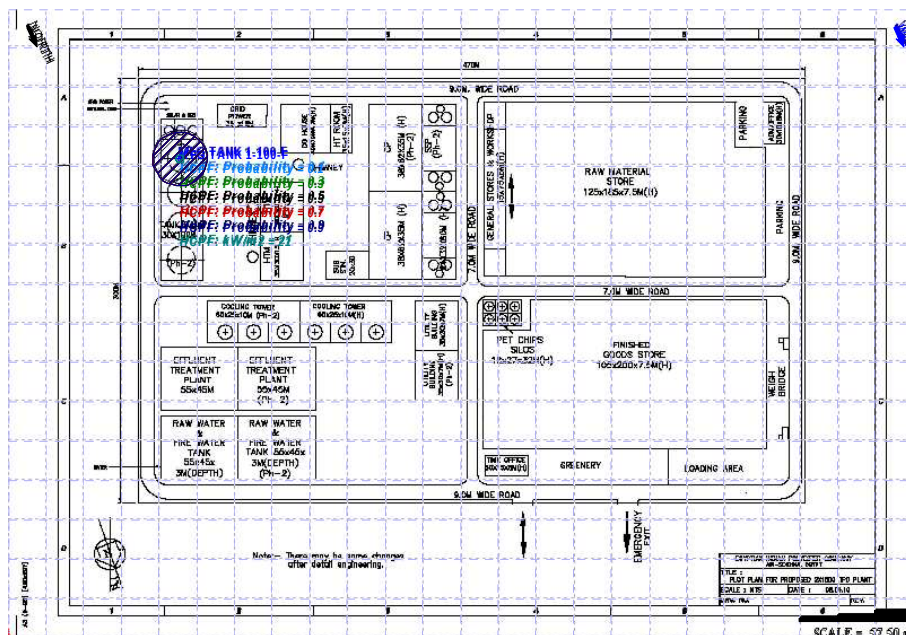
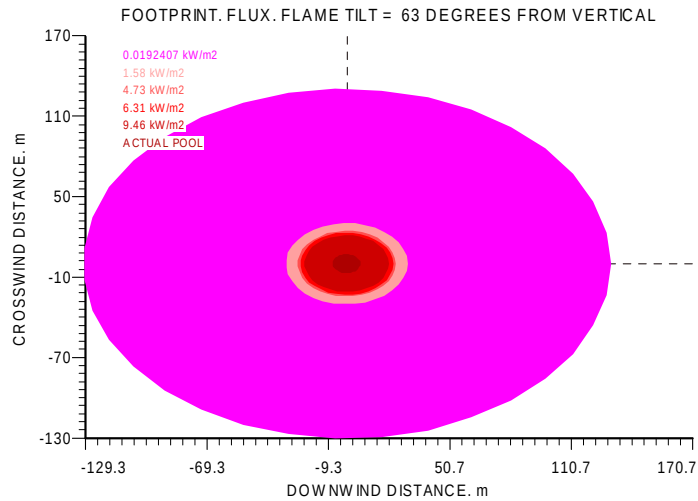
8.1 Pool Fire

For consequence modelling for MEG tanks, the heat radiation contours from the pool fire were determined taking into consideration the type and amount of material and the climatic conditions

- **100mm- hole**



- 25mm- hole



The model results indicate that the highest radiation heat intensity requiring 9.46kW/m^2 in severe adverse impacts where urgent emergency action is required, is at distances of about 60 meters from fire origin for 100mm hole size and 20 meters from fire origin for 25mm hole size.

9. Risk Assessment

The overall risk was determined by combining the frequency and consequence data for the scenarios examined.

9.1 Impact Models

The previous chapters of the QRA provided the representative incidents and their modeled consequences. The fire models predicted the radiant flux generated from the incident. The model relies on the general principle that the severity of the outcome is a function of distance from the source of release.

The next step in this QRA is to assess the consequences of these outcomes on human beings, expressed mainly as deaths or injuries.

One method of assessing the consequence of an outcome is the direct effect model, which predicts effects on people based on predetermined criteria (e.g., death is assumed to result if an individual is exposed to a certain thermal radiation level). In reality, the consequences may not take the form of discrete functions (i.e., a fixed input yields a singular output) but may instead conform to probability distribution functions. Therefore, a statistical method of assessing a consequence (called dose-response method) is more appropriate. This method is coupled with a probit equation to linearize the response. The probit (probability unit) method described by Finney (1971) reflects a generalized time-dependent relationship for any variable that has a probabilistic outcome that can be defined by a normal distribution. The probability of fatality (P), i.e. percentage fatality (lethality level), is given by equation (1) below which relates the probit variable Y to the probability P .

$$(1) \quad P = 50 \left[1 + \frac{Y - 5}{|Y - 5|} \operatorname{erf} \left(\frac{|Y - 5|}{\sqrt{2}} \right) \right]$$

where:

P : is the probability or percentage fatality (or lethality level)

Y : is the probit variable

erf: is the error function

The probit variable (*Y*) is determined using different equations for different incidents as presented below.

9.1.1 Thermal Impacts

The purpose of the thermal impact models is to estimate the likely fatality to people from the thermal radiation of incidents. Thermal impacts of fire on humans depend on the rate at which heat is transferred from the fire to the person, and the time the person is exposed to the heat radiation. Even short-term exposure to high heat flux levels may be fatal.

Eisenberg et al. (1975) developed a probit model to estimate fatality levels for a given thermal dose from pool and flash fires.

$$Y = -14.9 + 2.56 \ln \left(\frac{t \cdot I^{4/3}}{10^4} \right) \quad (2)$$

where:

Y = probit value

t = exposure time (seconds)

I = radiation intensity from fire (W/m²)

Lethality levels (%) of the thermal radiation impacts from pool fire to people are calculated from the equation above. It is worth mentioning that although large storage tank fires are very hazardous events, if managed correctly, the likelihood of fatality is low. The most likely mechanism for fatality is when a person is involved in the initial flash that ignites the fire. The likelihood of fatalities for members of the public or fire fighters is extremely low and such fatalities are rare.

9.2 Measurement, Calculation and Presentation of Risk Estimates

Risk shall be determined for both workers and public using international risk management guidelines as a reference. The risk will be compared with international risk acceptance criteria. As earlier discussed in the report, risk assessment will comprise the following items:

Failure rate: is the failure frequency of equipment.

Incident Probability: is the likelihood of a release to result in a fire, explosion or toxic gas dispersion.

Occupancy: is the personnel presence in the area.

Vulnerability: is the likelihood that the specific person will be fatally injured by the effect of the event.

9.2.1 Individual Risk to workers

Individual risk can be estimated for the most exposed individual, or groups of individuals at particular places or for an average individual in an effect zone. For a given incident, these individual risk measures have different values. For this QRA study, individual risk is calculated indicating the expected frequency of an event capable of causing the specified level of harm at specific location, regardless of whether or not anyone is present at that location to suffer that harm. The individual risk assumes that somebody will be present and subject to the risk 100% of the time.

Table (7) below presents the individual risk assessment for the hazard scenarios.

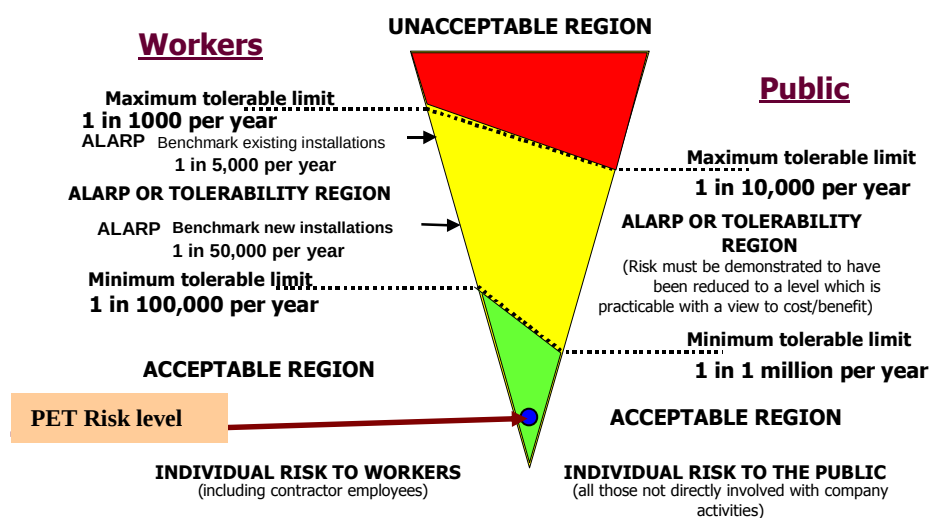
Table (7): Individual Risk Assessment

Hazard scenario	Hole size	Frequency	Percentage fatality	Individual Risk
Pool fire	25mm:	1×10^{-6}	1.18×10^{-8} (for 9.46 kW/m^2)	2.12×10^{-16} +
	100mm	1×10^{-7}	6×10^{-13} (for 6.31 kW/m^2)	1.08×10^{-20} 2.12×10^{-17} +
				1.08×10^{-21}

From the above it is clear the potential risks are much lower than the ALARP. However, as precautionary procedures personnel admittance to, and work within, the restricted access area should be controlled administratively upon a work permit. It is essential that personnel within the restricted area have immediate access to thermal radiation shielding or protective apparel suitable for escape to a safe location.

The boundary of a restricted access area should be marked with signage warning of the potential thermal radiation exposure hazard.

It should be noted that the risk zone have not been provided as the calculated risk is much smaller than the minimum risk limits of the Superchems software, namely 5×10^{-8} /year.



9.2.2 Societal Risk

From the different consequence modelling of the selected hazard scenario and based on the individual risk calculations, it can be indicated that the potentially severe outcomes of the fire hazard is limited to the on-site boundaries. Thus, the potential off-site risks are extremely insignificant.

10. Recommendations for Risk Reduction

Further risk reduction measures (Recommendations) may include reducing the risk or maintaining low risk, may be carried out by several technically feasible methods, generally are as follows:

- Measures to eliminate the risk.
- Measures to reduce the exposure of personnel to the hazards.
- Measures to reduce the frequency of occurrence.
- Measures to mitigate the consequences if the event does occur.
- Measures to improve evacuation in case of emergency (event occurs).

It has been concluded that the risk falls within ALARP limits for the individual risk hence, the following risk recommended reduction measures are outlined in order to maintain the risk to the acceptable limit. These include:

Management Measures

- Developing a comprehensive Emergency Response plan (ERP) including effective means for detection of gas/liquid leaks as well as means for escape, evacuation and rescue.
- Effective Communication channel set between different units in the facility and the central control room as well as the neighbouring companies and the local civil protection authorities to ensure prompt action during emergency situations.
- Regular inspection of the fire and leak detection and alarm systems.
- Regular inspection and maintenance for tanks and pipings to prevent/avoid corrosion
- Regular inspection of the escape, evacuation and rescue system.
- Periodic escape and evacuation drills.

Design Integrated Measures

- Construction of bund area around the storage tanks
- Provide shielding area near the tank farm
- The dike walls to be higher than the receptor height assumed in the study (1meter)
- Increase the height of the facility fences to 3 meters in this area
- Ensure proper breathing systems and emergency vents and increase size/number of vents, as and if necessary.

Implementing the above measures, the risk will be maintained within the lowest practical limit and the residual risk will be within the acceptable limits.

Annex (1)
Risk Criteria

Risk Criteria

There are no Individual Fatality/Injury Risk Criteria adopted nationally. In this context, different international risk criteria were investigated such as the EU, the UK and the Australian systems..

The EU¹

There is a single EU Directive (Seveso 2) on the control of major accident hazards involving chemicals which applies to every member state and clearly the level of safety across the EU should be very similar if not the same in many countries.

Individual Risk Criteria

Individual risk is the frequency at which an individual may be expected to sustain a given level of harm from realisation of specified hazards. The following table presents the comparison of the risk criteria in use in the UK, The Netherlands, Hungary and Czech Republic.

	UK	The Netherlands	Hungary	Czech Republic
10^{-4}	Intolerable limit for members of the public			
10^{-5}	Risk has to be reduced to the level As Low As Reasonably Practicable (ALARP)	Limit for existing installations. ALARP principle applies	Upper limit	Limit for existing installations. Risk reduction must be carried out
3×10^{-6}	Land Use Planning limit of acceptability (converted from risk of dangerous dose of 3×10^{-7})		Lower limit	Limit for the new installations
10^{-6}	Broadly acceptable level of risk	Limit for the new installations and general limit after 2010. ALARP applies		

¹ Risk criteria in EU, Risk Support Limited, London, U.K, 2004

10^{-7}	Negligible level of risk			
10^{-8}		Negligible level of risk		

Societal Risk Criteria

In the Netherlands there are no norms for SR, and it has been decided, for now, to use societal risk values as non-legal orientation norms when assessing external safety. The values for orientation are the upper tolerable level as $10^{-3}/N^2$ and the negligible level as $10^{-5}/N^2$, in the FN space. The upper tolerability criterion in the Czech Republic for the existing installations is the same as the “non legal” Dutch criterion ($10^{-3}/N^2$), while for the new installations it is more stringent, i.e. $10^{-4}/N^2$. (Risk criteria in EU, V.M. Trbojevic *Risk Support Limited, London, U.K*)

Australian Risk Criteria

The criteria are based on a principle that "if the risk from a potentially hazardous installation is less than most risks being experienced by the community (e.g. voluntary risks, transportation risks), then that risk may be tolerated". This principle is consistent with the basis of risk criteria adopted by most authorities internationally. The individual risk criteria are as follows:

- Hospitals, schools, child-care facilities and old age housing development should not be exposed to individual fatality risk levels in excess of half in one million per year (0.5×10^{-6} per year)
- Residential developments and places of continuous occupancy, such as hotels and tourist resorts, should not be exposed to individual fatality risk levels in excess of one in a million per year (1×10^{-6} per year)
- Commercial developments, including offices, retail centres, warehouses with showrooms, restaurants and entertainment centres, should not be exposed to individual fatality risk levels in excess of five in a million per year (5×10^{-6} per year)
- Sporting complexes and active open space areas should not be exposed to individual fatality risk levels in excess of ten in a million per year (10×10^{-6} per year).

The above criteria apply to new industry and surrounding land use proposals. The 1×10^{-6} per year individual fatality risk level is an appropriate criterion to be used.

UK system

The Risk criteria for Land Use Planning in the vicinity of Major Industrial Hazard UK has been set out by the HSE (Health and Safety Executive). The criteria have been based on the Royal Society Study Group Report (RSSG report) that sets out some possible quantitative guidelines for risk. The RSSG defines an upper bound of risk above which the risk is unacceptable in all circumstances. It also defines a lower bound below which risks may be legitimately regarded as trivial by decision makers. Between the two bounds there lies a region where risk need to be assessed and the necessary steps taken to reduce it. The RSSG suggests that insignificant risk would be below about 10^{-6} /year. For the upper bound, a risk of 10^{-3} /year is agreed upon. In the region between the two bounds the concept of reducing risk as low as reasonable practicable (ALARP) applies.

Individual Risk Criteria

Individual risk is widely defined as the risk of fatality (or serious injury) experienced by an individual, noting that the acceptability of individual risks should be based on that experienced by the most exposed (i.e. 'worst-case') individual.

The UK HSE criteria as follows.

- The maximum tolerable individual risk for workers is taken as 10^{-3} per year (i.e. 1 in 1,000 per year).
- The maximum tolerable individual risk for members of the public is 10^{-4} per year (i.e. 1 in 10,000 per year).
- The acceptable criterion, for both workers and public, corresponding to the level below which individual risks can be treated as effectively negligible, is 10^{-6} per year (i.e. 1 in 1,000,000 per year)
- Between these criteria the risks are in the 'ALARP' or tolerability region. In this region the risks are acceptable only if demonstrated to be As Low As Reasonably Practicable (ALARP).

Societal Risk Criteria

Societal risk is a measure of risk to a group of people *in the effect zones of incidents*. It is most often expressed in terms of the frequency distribution of multiple fatality events. One common graphical presentation shows the frequency of events resulting in N or more fatalities. This type of graph is commonly known as an F/N plot.

Annex (6)
Individual Scoping meetings

Individual Scoping Meetings

- **Water and Wastewater**

- Water

- Dr. Laila El Kholy inquired about the source of water for the process. It was clarified that the company will obtain its process and domestic water requirements from the public water network in the area through the water line provided to the industrial zone.

- Wastewater

- Dr. Laila El Kholy inquired about the process of wastewater treatment and discharge. It was clarified that the PET project will implement maximum wastewater recycling measures. In this respect, the generated wastewater will be treated in an aerobic/anaerobic treatment followed by an MBR treatment. The treated wastewater will be used as make-up for the cooling tower, The backwash of the MBR unit will be used for landscaping within the industrial zone in accordance with the requirements of article 15 of decree 44/2000 regarding use of treated wastewater for irrigation. small and medium.

- **Project Location and approvals**

The issue of selecting Cleopatra Zone for establishing the project has been raised by Dr. Laila El-Kholy, Head of Suez RBO. In addition, she had inquired about the reasons for not considering the area of Al-Adabiya Port. Finally, she had asked about the administrative approval of the project.

It was clarified that the PET project has investigated different locations however, the main constraints were the available land sizes and the stack heights

- **Impact of the neighbouring activities on the project**

Dr. Laila had highlighted that the company is located close to Cleopatra facility, which has various sources of dust and particulate emissions that can potentially have negative impacts on the industrial processes in PET facility.

It was clarified that the Company is aware with this issue and that stringent precautionary measures will be implemented that would significantly minimize the potential impacts.

On the other hand the issue of potential impacts from the neighboring industrial zones has been discussed with Eng. Mohamed Fathy of the Egyptian Chinese industrial zone. He stated that the Chinese Zone is hosting small and medium type industries comprising minimal pollution sources. The industries include:

- Readymade garments.
 - Manufacturing of drilling rigs
 - Phosphate fertilizer packaging
 - Cutting Marbles
 - Electric Transformers

- **Site Visit**

Environics team has then visited the site. The coordinates of the land had been taken. It had been visually observed that the site is currently a vacant land, having some packaging waste and no other activity was noticed.

Meeting was held afterwards with Eng/ Ezzat from Cleopatra Group – projects manager, he had stated that there is no currently industrial waste water system in the Cleopatra Zone and that they use the industrial waste water after treatment in plantation activities and landscape, and that it is expected that PET will use their own waste water for the same purpose after treatment. He had stated also that the PET site is currently connected with the other utilities such as, Water pipelines and Natural Gas pipes.

- **Community Social Responsibility:**

Dr. Laila had also emphasized on the importance of community development. She advised the governorate has identified various development issues that could be investigated with the different industries in the area.

- **Conclusion of the Scoping meetings**

All interviewees expressed their support to the different types of industrial development in Egypt provided that such development projects do not have adverse impacts on the public health or the environment and that they contribute to the improvement of social and economic status of the surrounding communities

- **Meeting with the Higher Environmental Committee of Suez Governorate**

The time and date for the higher committee meeting will be determined by Suez Governor, where the project will be presented to the committee members and their inquiries and concerns addressed. Based on the decision of the committee, the company may proceed with the ESIA process and submit the report to EEAA for review and feedback.