Hagler Bailly Pakistan

ECPL Fertilizer Plant Expansion Project

Ambient Air Quality Modeling

HBP Ref.: D0A02DEE

February 12, 2010

Engro Chemical Pakistan Limited

Daharki

Contents

Exhibits

1. Introduction

Engro Chemical Pakistan Limited (ECPL) plans to enhance its existing urea manufacturing capacity by setting up a new world scale Ammonia Urea complex within its existing facility in Daharki Sindh. The subject installations will be state-of-the-art and is claimed to be the most environment-friendly in the country. The proposed project will increase the existing annual production of 975 kilotons (KT) of Urea by 1,267 KT resulting in a total annual production of 2,242 KT.

1.1 Project Area

The project area refers to the geographical area in which the activities related to the construction and operation of the plant are proposed to take place and in which the environmental impact of the activities are likely to happen. The project area and its surroundings are shown in **Exhibit 1.2**.

1.2 Objectives of the Air Quality Study in the EIA

The objectives of this EIA are to:

- Assess the existing environmental conditions in the project area, including the identification of environmentally sensitive areas
- Propose appropriate mitigation and monitoring measures that can be incorporated into the design of the proposed activities to minimize any damaging effects or any lasting negative consequences identified by the assessment
- Assess the proposed activities and determine whether they comply with the relevant environmental regulations in Pakistan
- Prepare an EIA report for submittal to the Sindh Environmental Protection Agency (SEPA) and the project financing institutions.

1.3 Organization of this Report

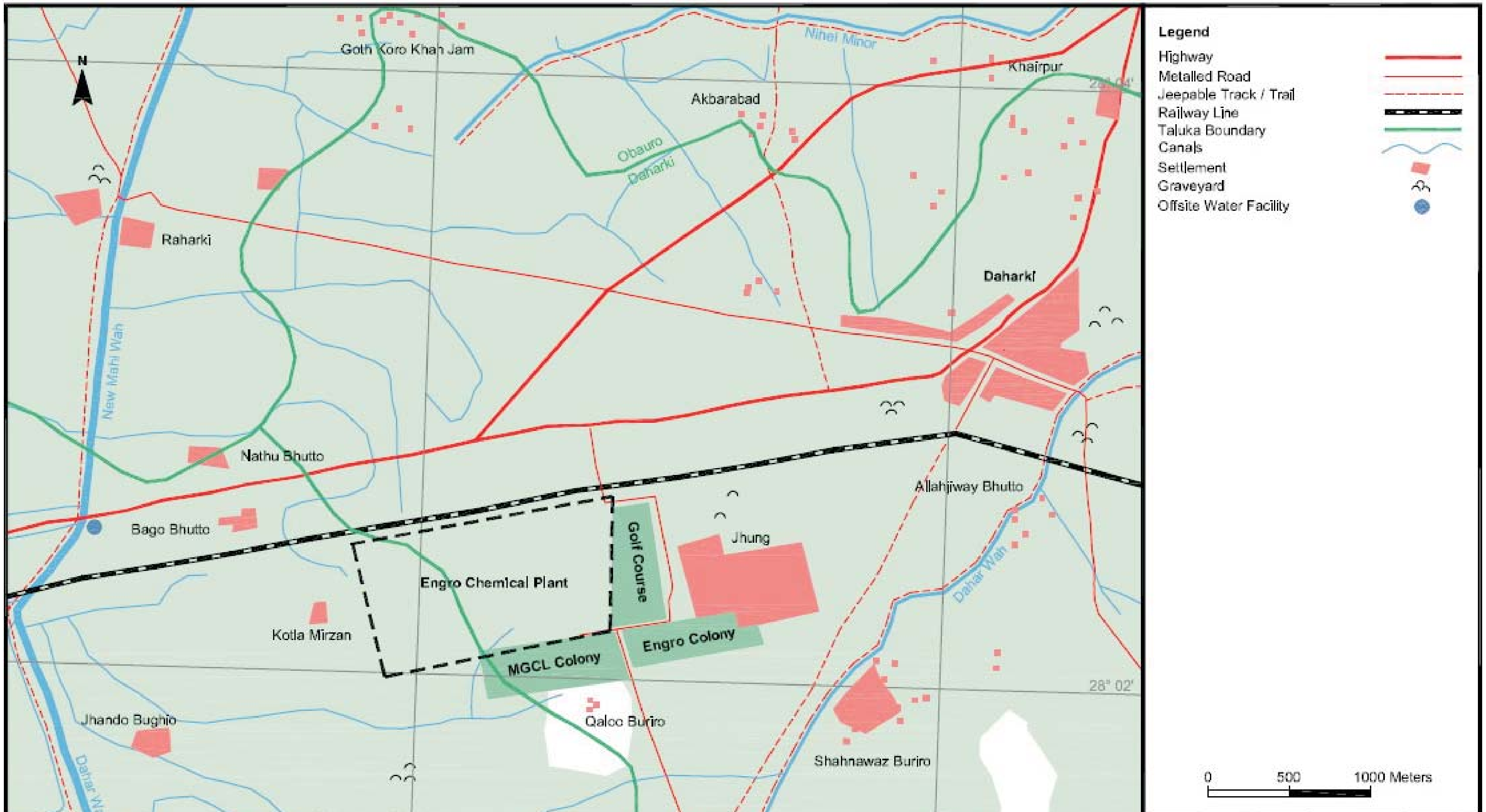
Section 2 (*Statutory, and Institutional Framework*) describes the applicable air quality standards.

Section 3 (*Project Description*) describes the proposed Fertilizer Expansion Project in the context of the gaseous emission

Section 4 (*Description of the Environment*) details the project area's existing air shed.

Section 5 (*Project Impacts and Mitigation*) the assessment of the project's impact on air quality.

Finally, in **Section 6** (*Conclusion*) the conclusions of the projects are summarized, followed by **Section 7** (*References*).



EIA of ECPL Expansion Project

Exhibit 1.1

Project Area and Surroundings

Scale	1 : 40,000
Source	SoP and Field Visit
Drawing	W7E02DEE
Date	May 2007
Client	Engro Chemicals Pakistan Limited

Hagler Bailly Pakistan

2. Statutory Framework

2.1 Pakistan Environmental Protection Act 1997

The PEPA 1997 is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The act is applicable to a broad range of issues and extends to air, water, soil, marine, and noise pollution, as well as to the handling of hazardous wastes. A national environmental air quality standards (NEQS) has been promulgated under the PEPA 1997.

2.2 National Environmental Quality Standards

Section 11(1) of the Act states that "Subject to the provisions of this Act and the rules and regulations made there under, no person shall discharge or emit, or allow the discharge or emission of, any effluent or waste or air pollutant or noise in an amount, concentration, or level which is in excess of the National Environmental Quality Standards." The Pakistan Environmental Protection Agency has published National Environmental Quality Standards (NEQS) that will be applicable to the proposed project. The NEQS were first promulgated in 1993 and were amended in 1995 and 2000.

The NEQS for gaseous emission from industrial sources as applicable to the project are provided in **Exhibits 2.1** and **2.2**.

2.3 Requirement of the Equator Principles

The Equator Principles require that all projects funded under these principles to be constructed and operated in an environmentally responsible manner. All projects that receive funding from signatories of the equator principles must therefore comply with appropriate World Bank/IFC environmental policies and guidelines. As the project proponents are likely to seek funding under these principles for the proposed expansion project, the EIA has been carried out to comply with both national and IFC guidelines. The key documents of the IFC are discussed below.

2.4 World Bank Guidelines on Environment

The Pak-EPA recommends using World Bank (WB) environmental guidelines for areas where there may be a gap in the national guidelines. The principal World Bank publications that contain environmental guidelines are listed below.

- World Bank Group Environmental, Health, and Safety Guidelines (known as the 'EHS Guidelines') 2007[1]

[1] These guidelines released in April 2007, replace those documents previously published in Part III of the Pollution Prevention and Abatement Handbook and on the IFC website.

- Pollution Prevention and Abatement Handbook 1998: Towards Cleaner Production[2]
- Environmental Assessment Sourcebook, Volume I: Policies, Procedures, and Cross-Sectoral Issues[3]
- Environmental Assessment Sourcebook, Volume II: Sectoral Guidelines[4]

2.5 Target Standards

The target standards for the gaseous emissions and ambient air quality for the proposed project are based on the NEQS and the World Bank Guidelines. The relevant parameters are shown in **Exhibits 2.3** to **2.4**.

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[2] World Bank, UNIDO, and UNEP. 1999. *Pollution Prevention and Abatement Handbook, Towards Cleaner Production*. Environment Department, The World Bank; UNIDO; UNEP.

[3] World Bank. 1991. *Environmental Assessment Sourcebook*, *Volume I, Policies, Procedures, and Cross-Sectoral Issues*. World Bank Technical Paper No. 139. Environment Department, The World Bank.

[4] World Bank. 1991. *Environmental Assessment Sourcebook,* Volume III, Sectoral Guidelines. World Bank Technical Paper No. 140. Environment Department, The World Bank

Exhibit 2.1: National Environmental Quality Standards for Gaseous Emissions

No.	*Parameter*	*Source of Emission*	*Standards*
1.	Smoke	Smoke opacity not to exceed	40% or 2 on Ringlemann Scale or equivalent smoke number
2.	Particulate matter[1]	(a) Boilers and furnaces:	
		i) Oil-fired	300
		ii) Coal-fired	500
		iii) Cement kilns	300
		(b) Grinding, crushing, clinker coolers and related processes, metallurgical processes, converters, blast furnaces and cupolas	500
3.	Hydrogen chloride	Any	400
4.	Chlorine	Any	150
5.	Hydrogen fluoride	Any	150
6.	Hydrogen sulphide	Any	10
7.	Sulphur oxides[2, 3]	Sulfuric acid/sulphonic acid plants	5,000
		Other plants except power plants operating on oil and coal	1,700
8.	Carbon monoxide	Any	800
9.	Lead	Any	50
10.	Mercury	Any	10
11.	Cadmium	Any	20
12.	Arsenic	Any	20
13.	Copper	Any	50
14.	Antimony	Any	20
15.	Zinc	Any	200
16.	Oxides of nitrogen[3]	Nitric acid manufacturing unit	3,000
		Gas-fired	400
		Oil-fired	600
		Coal-fired	1,200

1. Based on the assumption that the size of the particulate is 10 micron or more.
2. Based on 1 per cent sulphur content in fuel oil. Higher content of sulphur, will cause standards to be pro-rated.
3. In respect of emissions of sulphur dioxide and nitrogen oxides, the power plants operating on oil and coal as fuel shall in addition to National Environmental Quality Standards (NEQS) special above, comply with the following standards.

Exhibit 2.2: Pakistan Standards for Sulfur Dioxide and Nitrogen Oxides for Power Plants Operating on Oil and Coal

A. Sulfur Dioxide

Sulfur Dioxide Background Levels (mg/m^3)			*Standards*	
			Criterion I	*Criterion II*
Background Air Quality (SO_2 basis)	*Annual Average*	*Maximum 24- Hour Interval*	*Max. SO_2 Emissions (TPD)*	*Max. Allowable 1-Year Average Ground Level Increment to Ambient (mg/m^3)*
Unpolluted	<50	<200	500	50
Moderately polluted[1]				
Low	50	200	500	50
High	100	400	100	10
Very polluted[2]	>100	>400	100	10

1. For intermediate values between 50 and 100 $\mu g/m^3$ linear interpretation should be used.
2. No project with sulfur dioxide emissions will be recommended.

B. Nitrogen Oxides

Annual arithmetic mean of ambient air concentrations of nitrogen oxides (expressed as NO_2) should not exceed		100 $\mu g/m^3$ (0.05 ppm)
Maximum emission levels for stationary source discharges, before mixing with the atmosphere: For fuel fired steam generators		
	Liquid fossil fuel	130 ng/J of heat input
	Solid fossil fuel	300 ng/J of heat input
	Lignite fossil fuel	260 ng/J of heat input

Exhibit 2.3: Target Emission Standards

Parameter	*Source*	*Units*	*Target Standard*
Nitrogen oxides	NEQS	mg/Nm^3	400
	WB*	mg/Nm^3	300
Ammonia	WB*	mg/Nm^3	50
Urea	WB*	mg/Nm^3	50
Sulfur oxides	NEQS	mg/Nm^3	1,700
Particulate Matter	WB	mg/Nm^3	50

* mg/Nm^3 (dry, 15% O_2)

Exhibit 2.4: Target Ambient Air Quality Standards

Parameter[a]	*Averaging Period*	*Target Limits ($\mu g/m^3$)*
Sulfur dioxide	Annual	80
	24-hr	150
Nitrogen oxides	Annual	100
Carbon Monoxide	1-hr	40,000
Particulate Matter	Annual	80
	24-hr	230

[a] based on the World Bank Guidelines except that of Carbon Monoxide, which is from United States National Ambient Air Quality Standards

3. Project Description

ECPL intends to set up an additional urea and ammonia plant at its fertilizer manufacturing facility in Daharki. The new development will include the addition of 2,194 metric tons per day (MTD) ammonia plant, a 3,835 MTD urea plant, new offsite facilities, incremental utilities & residential facilities. ECPL envisions adding 1,267 kilotons (KT) per year of production to its existing 975 KT per year production of fertilizer.

In addition to the plants, the incremental utilities and offsite facilities which include water intake and storage facilities, addition in water treatment and cooling facilities, gas turbine with heat recovery steam generator, air compressor, nitrogen generator, and a new gas supply pipeline from Qadirpur to Daharki delivering 100 MMscfd of natural gas will also be developed. The existing housing colony will also be expanded to accommodate the increased staff strength.

3.1 Project Location

The new fertilizer plant will be installed within existing boundaries of the existing ECPL facility in Daharki and adjacent to the existing fertilizer manufacturing plant. However, 60 acres land would be acquired for expansion in residential facilities and 6 acres for new water intake off site facility The ECPL complex is located about 300 m south of the national highway. Major industrial units in the vicinity of the existing plant are the Liberty Power Plant and the Fauji Fertilizer Company (FFC) plant located 3 km and 13 km west of the ECPL plant respectively. The ECPL housing colony and Mari Gas Company Limited housing colony are located adjacent to the ECPL plant. The project site and its vicinity are shown in **Exhibit 1.1**.

3.2 Existing Plant Facilities and Operations

The fertilizer manufacturing process consists of two stages: Ammonia production and subsequently urea production. ECPL currently have one operational ammonia plant and two urea plants.

The ammonia plant being used was initially designed to produce 1,060 metric tons (MT) of liquid anhydrous ammonia per operating day from natural gas, steam and air but its production capacity was enhanced to 1,650 MT through major equipment modifications. The sequence of steps involved in ammonia production is as follows:

- Feed gas compression through Natural Gas Booster Compressor.
- Feed Gas Desulfurization
- Pre-Reformer
- Primary Reforming
- Secondary Reforming

- Carbon Monoxide shift conversion
- Carbon Dioxide removal
- Methanation
- Removal of residual carbon dioxide (CO_2) and water
- Synthesis gas compression
- Catalytic conversion of synthesis gas to ammonia
- Condensation of ammonia

3.3 Proposed Development Project

Expansion of the existing Ammonia and urea manufacturing plants include the installation an ammonia plant, a urea plant, additional gas pipeline from Qadirpur, additional utilities unit, off-site water facility, expansion of existing ECPL residential colony, and an effluent treatment plant. A brief description of the proposed ammonia and urea plants follows.

3.3.1 Proposed Ammonia Plant

The proposed ammonia plant will be one of the largest in the world and is based on Holder Topsoe design. The rated daily capacity of the plant is 2,194 tons. Most of the drivers are steam turbines so electrical power requirement of the unit will be much lesser as compared with others of its kind. The plant will include following facilities:

- Desulfurization Unit
- Primary Reformer
- CO Conversion Unit
- Ammonia Synthesis Unit
- Refrigeration

The waste gas emission in the ammonia plant can be categorized into continuous and intermittent emissions. The continuous emissions include the primary reformer flue gas. Carbon monoxide, SO_x, and NO_x content in this gas will be well below the NEQS and World Bank standards. These will be released into the atmosphere. Intermittent emissions resulting from process upsets will be flared at the front end and back end flares.

3.3.2 Proposed Urea Plant

Urea is produced by synthesis from liquid ammonia and gaseous carbon dioxide. In the Urea Reactor, the ammonia and carbon dioxide react to form ammonium carbamate, a portion of which dehydrates to urea and water. The liquid ammonia feed to the Urea Unit, coming from the relevant Ammonia Unit, is filtered through NH_3 Filters and is collected in the Ammonia Receiver Tank. The liquid mixture of NH_3 and carbamate enters the urea reactor bottom where it reacts with the carbon dioxide compressed feed.

The waste gas emission in this urea plant would be sent to continuous and discontinuous flares which will be employed to burn-off the gases. The total flow to the continuous flare would be 1,378 Nm^3/hr with 1.7% ammonia. This gas will be flared as compared with direct venting, in earlier technologies.

4. Description of Air Shed

The climate and air quality of the project area is briefly described in this section. The project area is defined as the areas where the project related activities are to be carried out and include the proposed project site and surroundings and the areas that can interact with the project's positive and negative externalities in the long run. The description provided in this section is based on published information and field survey data that was collected specifically for this study. The field surveys were conducted in March and April of 2007.

4.1 Climate

Meteorology

The weather station closest to the project area is located at Sukkur (27° 42′ N, 68° 54′ E), approximately 60 km southwest of the project site. The climatic description of the project area presented in this section is based on weather data for Sukkur.

Rainfall

The project area receives approximately 88 mm of rain annually (Pakistan Meteorological Department, 1992). Most of the rain is concentrated in the monsoon months of July and August.

Climatic Classification

The climate of the project area is broadly described as hot and arid. Various meteorologists have developed classification schemes to describe the local climatic features of Pakistan. Classification based on two of the schemes is described below.

Shamshad (1956) has classified the climate of Pakistan on the basis of characteristic seasons found in the country. Taking into account topography, proximity to the sea, rainfall, temperature, and winds, he has defined eleven climatic zones for Pakistan. Under his scheme, the climate of the project area is classified as 'subtropical double season hotland.' The characteristic features of this climatic zone are low rainfall (less than 250 millimeters per annum), hence the absence of a well-defined rainy season, and high temperatures that increase from east to west. The region west of the Indus River experiences the highest temperatures, as it is cut off from the westerly summer breeze by neighboring hills.

Kazi (1952) divides Pakistan into four major climatic regions, which are further subdivided into 18 micro-regions. Under this classification, the project area falls into the central irrigated plains of the sub-tropical Indus lowlands. The region is characterized by aridity and continentality, with high summer temperatures and late summer rains. Rainfall is less than 250 mm and concentrated in June to September. July and August are the hottest months and October and November the driest. June and January are the hottest and coldest months, respectively. The presence of irrigated fields mitigates the summer heat to some extent.

Seasons

Broadly speaking, there are four seasons in Pakistan:

- Winter (December to March)
- Summer (April to June)
- Monsoon (July to August)
- Post-Monsoon Summer (September to November).

These seasons are defined on the basis of temperature and the changes associated with the southwest monsoon. The southwest monsoon is a wind system that prevails from April to October in the Indian Ocean, and is characterized by a reversal in wind direction and heavy rainfall over most of the Indian subcontinent. Within Pakistan, considerable variation is found in temperature and monsoonal changes. Thus, the specific characteristics and duration of seasons depend on geographic location. Monthly temperature, humidity, rainfall and wind data are provided in **Exhibits 4.1** to **4.3**.

4.2 Ambient Air Quality

The ECPL's existing fertilizer plant, the Liberty power plant, and the Fauji Fertilizer Company (FFC) fertilizer plant are the significant sources of gaseous emission in the project area. Other sources of gaseous emissions are the vehicular exhaust emissions from the highway traffic in the area.

To assess the ambient air quality for the project area, ambient air quality was recorded at two separate locations around the project site from March 8 to 9, 2007. Detailed results of the measurements are included as **Exhibits 4.4** and **4.5**. The average concentrations of pollutant that is assumed to represent the ambient conditions in the project area are shown in **Exhibit 4.6.** As long-term measurement data is not available, a conservative approach is taken and the measured values are used both for short-term and long-term concentration.

Exhibit 4.1: Seasonal Characteristics of Climate of the Project Area

Season	*Temperature*	*Humidity*	*Rainfall*	*Wind*
Summer (Mid March to mid June)	March is the transition period from winter to summer. Daily maximum increases from about 27°C at the start of the month to 34°C at the end. It continues to increase and peaks at 44°C just before the onset of monsoon in late June.	Morning (Evening) humidity decreases from 65% (28%) in March to about 52% (23%) by mid April. It stays around this figure for about a month and starts increasing in late May and reaches 65% (25%) by June.	5-7 mm of rain falls in February. The rest of the season is dry—monthly rainfall is less than 5 mm.	Wind starts changing direction, from NE to S-SW, near the end of March. The average speed also increases from 3 knots to 4.5 knots by mid June.
Monsoon (Mid June to mid September)	High winds and subsequent rainfall lowers the temperature by 4-5°C in July. The maximum temperature remains around 38°C in August and September.	Moisture associated with monsoon increases humidity to more than 75% in the morning and 40% in the evening during July, August and most of September.	More than 55 mm of rain falls during this period; this accounts for more than 60% of the total rainfall received in the area.	Throughout this period, wind blows from the south at an average speed of 3.5 knots.
Post-Monsoon Summer (Mid September to November)	The daily maximum temperature drops by more than 10°C from early October to end of November.	Morning (evening) humidity decreases slightly; however, it remains above 70% (30%).	The season is dry. Monthly average rainfall is less than 5 mm.	Average wind speed drops below 2.5 knots. The direction starts changing back to NE by the end of September.
Winter (December to mid March)	The daily maximum and minimum temperatures averages around 24° and 9°C, respectively.	Morning (Evening) humidity increases to nearly 75% (35%) in December but drops to 65% (30%) by end of February.	The season is dry. Monthly average rainfall is less than 5 mm, except February when 5-7 mm of rain is received in the project area.	Mild wind (less than 2.5 knots) blows from northeast throughout this season.

Exhibit 4.2: Monthly Temperature Data for Sukkur (in °C)

Month	*Mean Daily*		*Maximum Recorded*		*Minimum Recorded*	
	Maximum	*Minimum*	*Value*	*Date*	*Value*	*Date*
January	22.8	8.4	31	25/1932	-4	31/1929
February	25.3	10.9	38	27/1953	-1	01/1929
March	31.2	16.4	42.2	16/1969	4	02/1936
April	37.6	22.0	47	28/1979	10	03/1989
May	42.4	26.2	49	29/1981	16	08/1989
June	43.6	28.4	50	11/1979	19	13/1990
July	40.8	27.9	47	02/1976	17.5	26/1989
August	38.7	26.7	47	09/1987	17.5	28/1989
September	38.0	24.9	43.3	23/1968	16.5	27/1989
October	35.3	20.3	44	05/1951	9.5	28/1989
November	29.9	14.4	38	06/1990	5	30/1938
December	24.0	9.6	33	01/1953	-1.5	15/1986

Source: Pakistan Meteorological Department (1992)

Exhibit 4.3: Mean Monthly Relative Humidity at Sukkur

Month	*Relative Humidity at 5:00 am (%)*	*Relative Humidity at 5:00 pm (%)*
Jan	73	35
Feb	67	32
Mar	63	28
Apr	52	22
May	52	20
Jun	65	26
Jul	75	40
Aug	77	46
Sep	77	41
Oct	71	32
Nov	74	34
Dec	76	38

Source: Pakistan Meteorological Department (1992)

Exhibit 4.4: Air Quality Measurement Results at ECPL Colony

Time	*SO_2 (ppb)*	*NO_x (ppb)*	*CO (ppm)*	*Dust (µg/m^3)*
13:00	9.3	14.3	0.98	75
13:15	9.2	14.2	0.95	74
13:30	9.3	14.3	0.96	75
13:45	9.4	14.4	0.86	74
14:00	9.6	14.6	0.87	76
14:15	9.2	14.2	0.65	74
14:30	9.3	14.3	0.64	78
14:45	9.4	14.4	0.63	85
15:00	9.9	14.9	0.62	87
15:15	9.2	14.2	0.65	74
15:30	8.9	13.9	0.68	78
15:45	9.3	14.3	0.63	85
16:00	9.3	14.3	0.64	86
16:15	9.4	14.4	0.68	74
16:30	9.6	14.6	0.69	75
16:45	9.3	14.3	0.68	78
17:00	10.4	15.4	0.65	74
17:15	10.6	15.6	0.63	78
17:30	11.6	16.6	0.62	77
17:45	12.5	17.5	0.63	79
18:00	12.6	17.6	0.67	79
18:15	12.7	17.7	0.74	74
18:30	12.3	17.3	0.84	78
18:45	12.6	17.6	0.89	75
19:00	13.2	18.2	0.85	74
19:15	13.3	18.3	0.96	76
19:30	13.1	18.1	1.24	74
19:45	12.2	17.2	1.23	78
20:00	12.9	17.9	1.25	74
20:15	12.2	17.2	1.23	75
20:30	13.1	18.1	1.26	74
20:45	13.9	18.9	1.32	78

Time	*SO_2 (ppb)*	*NO_x (ppb)*	*CO (ppm)*	*Dust (µg/m^3)*
21:00	13.4	18.4	1.35	74
21:15	12.3	17.3	1.23	75
21:30	10.1	15.1	1.25	78
21:45	9.8	14.8	1.23	74
22:00	9.2	14.2	1.25	75
22:15	9.6	14.6	1.24	74
22:30	10.6	15.6	1.23	78
22:45	10.5	15.5	1.13	74
23:00	11.1	16.1	1.11	75
Minimum	8.9	13.9	0.6	74.0
Maximum	13.9	18.9	1.4	87.0
Average	10.9	15.9	0.9	76.6

Exhibit 4.5: Air Quality Measurement Results in the Plant Area

Time	*SO_2 (ppb)*	*NO_x (ppb)*	*CO (ppm)*	*Dust (µg/m^3)*
0:00	10.4	15.4	0.87	78
0:15	10.9	15.9	0.74	74
0:15	10.9	15.9	0.74	74
1:00	7.8	14.3	1.3	98
1:15	7.5	13.2	1.4	96
1:30	7.9	13.5	1.2	98
1:45	7.4	13.2	1.5	95
2:00	7.8	12.3	1.3	96
2:15	7.6	12.1	1.2	97
2:30	7.4	13.4	1.3	96
2:45	7.3	12.6	1.2	95
3:00	7.4	13.5	1.4	98
3:15	7.2	13.4	1.2	96
3:30	7.6	12.6	1.3	98

Time	*SO_2 (ppb)*	*NO_x (ppb)*	*CO (ppm)*	*Dust ($\mu g/m^3$)*
3:45	6.8	12.5	1.3	96
4:00	6.4	12.7	1.2	95
4:15	7.3	12.6	1.5	96
4:30	6.9	12.4	1.4	96
4:45	8.4	12.3	1.3	94
5:00	7.5	12.7	1.2	96
5:15	7.6	12.5	1.3	98
5:30	8.4	12.4	1.1	96
5:45	8.3	12.3	1.2	98
6:00	6.4	12.4	1.3	96
6:15	6.2	12.6	1.5	85
6:30	7.3	12.9	1.2	96
6:45	6.8	11.3	1.2	98
7:00	7.8	11.5	1.3	96
7:15	8.4	12.8	1.1	98
7:30	8.3	11.4	1.2	96
7:45	8.2	13.1	1.3	92
8:00	7.9	11.6	1.1	93
8:15	7.5	11.2	1.0	91
8:30	7.6	11.3	1.1	98
8:45	7.4	11.4	1.3	96
9:00	8.4	11.2	1.2	95
9:15	8.4	11.6	1.3	93
9:30	8.6	11.5	1.4	94
9:45	7.5	11.3	1.2	96
10:00	6.8	11.2	1.3	95
10:15	6.4	11.9	1.2	93
10:30	6.3	12.4	1.4	95
10:45	6.9	12.6	1.3	93
11:00	6.7	12.4	1.2	86
11:15	8.5	12.9	1.2	94
11:30	8.9	12.1	1.2	96
11:45	7.6	12.6	1.3	96
12:00	7.5	12.4	1.1	97
12:15	6.8	12.3	1.2	95
12:30	8.2	12.1	1.2	95

Time	*SO_2 (ppb)*	*NO_x (ppb)*	*CO (ppm)*	*Dust (µg/m^3)*
12:45	6.2	12.4	1.3	96
Minimum	6.2	11.2	0.7	74.0
Maximum	10.9	15.9	1.5	98.0
Average	7.7	12.6	1.2	94.1

Exhibit 4.6: Average Air Concentration of Pollutants in the Ambient Air

Parameter	*Average Concentration*	
Sulfur Dioxide (SO_2)	9.10 ppb	23.76 µg/m^3
Nitrogen Oxide (NO_X)	14.03 ppb	26.37 µg/m^3
Carbon Monoxide	1.09 ppm	1.25 µg/m^3
Particulate Matter	86.30 µg/m^3	86.30 µg/m^3

5. Air Quality Impacts and Mitigations

This section discusses the potential air quality impacts of the proposed activities, predicts the magnitude of the impact, assesses the significance, recommends mitigation measures to minimize adverse impacts, and identifies the residual impacts of the project. Impacts Associated with Plant Operations.

To assess the impact on the ambient air quality, the increase in concentration of the pollutants described above due to each individual stack was assessed using the ISC 3 air dispersion model.

5.1 Brief Description of the Dispersion Model

To model the ambient air concentrations in the area, the widely used Industrial Source Complex Short-Term Air Dispersion Model Version 3 (commonly called ISCST3) was used. This model provides hourly as well as annual averages of pollutants in ambient air and complies with USEPA's guidelines on air quality models. The model has the following features:

- It is ideal for a typical industrial source complex.
- It is a steady-state Gaussian plume model that can be used to estimate emission from point, area or volume sources in flat or gently rolling terrain with elevations below emission release height.
- It incorporates the effects of building downwash, building cavity, settling and dry deposition of pollutants.
- It can be used to model multiple point source emission from stacks, multiple vents, storage piles and conveyor belts.
- It uses actual hourly meteorological data to define the conditions for plume rise, transport, and dispersion.
- It estimates the concentration or deposition value for each source-receptor combination for each hour of input meteorology, and calculates user-selected short-term averages, such as one-hour, three-hour, 24-hour and annual averages.

5.2 Modeling Operations

To run the ISCST-3 Air dispersion model an input file is to be made which contains all the relevant data inputs.

5.2.1 Input Parameters

Source Data

Location, emission rate, physical stack height, stack gas exit velocity, stack inside diameter, and stack gas temperature. Optional inputs include source elevation, building dimensions, particle size distribution with corresponding settling velocities, and surface reflection coefficients. The information was collected on sources:

- A plot plan showing proposed location of all structures and emission points; property line and fence line; orientation to true north; and longitude and latitude of a benchmark
- Dimensions of all structures in close vicinity of pollutant emitting stacks
- Stack details for all emission points:
  - Stack height (above ground level)
  - Stack diameter
  - Stack gas velocity (or flow rate)
  - Stack gas temperature
- Pollutant emission rates

Meteorological Data

ISCST requires hourly surface weather data from the preprocessor program RAMMET, which provides hourly stability class, wind direction, wind speed, temperature, and mixing height. For ISCLT, input includes stability wind rose (STAR deck), average afternoon mixing height, average morning mixing height, and average air temperature.

Hourly meteorological data for Multan, which has the nearest observatory that records hourly data, was used. (Ideally, actual meteorological data for the site should have been used, but it was not available.) Data for March 1994 to April 1995 was used It was compared with the data for Sukkur to verify whether the latter could be used for this study; it was found that the two sets generally tally and data for Multan may be used.

The following meteorological information was used:

- Wind speed
- Wind direction
- Cloud ceiling height
- Total cloud cover
- Cloud opacity
- Temperature
- Morning and afternoon mixing heights

Receptor Data

Air quality impacts due to point source(s) are best evaluated by estimating the pollutant concentration at receptors placed outside the plant boundary. Therefore, the receptor grid for the modeling covered a distance of 10 km × 10 km with the stacks as the center. The receptors were placed in a 21 × 21 grid, 500 m apart and at a height of 2 m above ground level.

Model Settings

The ISCST3 can be used to model individual stacks separately or all stacks together (the multiple source option). During this study, the multiple source option was used.

Other model options, that were common in all runs of the model, included:

- Stack-tip downwash
- Buoyancy induced dispersion
- Final plume rise
- Calm winds processing routines
- Concentration estimates for sources without any effects of building downwash from surrounding buildings or structures
- Concentration estimates for sources influenced by building downwash from buildings or structures
- Rural setting
- Default rural values for wind profile exponents and vertical potential temperature gradients
- Flat terrain (no elevated terrain greater than emission height)
- Multiple sources
- Receptor array of 21 × 21 receptors.

The input parameters for all the four cases are listed in **Exhibit 5.1**.

5.2.2 Output Parameters

Printed output options include:

- Program control parameters, source data, and receptor data;
- Tables of hourly meteorological data for each specified day;
- "N"-day average concentration or total deposition calculated at each receptor for any desired source combinations;
- Concentration or deposition values calculated for any desired source combinations at all receptors for any specified day or time period within the day;
- Tables of highest and second highest concentration or deposition values calculated at each receptor for each specified time period during a(n) "N"-day period for any desired source combinations, and tables of the maximum 50 concentration or deposition values calculated for any desired source combinations for each specified time period.

The maximum concentrations for 1, 24, and annual time period were calculated for each pollutant type.

The output files of the ISC 3 model for each of the cases stated in the table above are presented in the following pages.

5.2.3 Results

The results of the air dispersion modeling are given in **Exhibits 7.4** and **7.5**. The results indicate that the ground level concentrations and emissions of all the pollutants are well below the limits provided by the NEQS and World Bank guidelines. Details of the air dispersion modeling are presented as **Appendix F**.

Mitigation Measures

No specific mitigation measures are proposed for general gaseous emission as the emission is within the target standards set by the NEQS and World Bank guidelines.

Residual Impacts

The concentration of pollutants will increase as shown in **Exhibit 7.5**, however, the increase will be well within the limits.

Monitoring Plan

The ambient air quality will be periodically monitored in the vicinity of the plant to ensure that the concentration levels of the gases are within the permissible limits.

Exhibit 5.1: Inputs for Air Dispersion Modeling

Source Number	**1**	2	3	4	5	6	
	Ammonia Plant	E-208 at 50% load	LTSC at 100% load	E-208 at 100% load	Plant Trip IS1	Prill Tower	
Stack height	60.7	90	90	90	90	125	m
Stack diameter	1.68	0.46	0.46	0.46	0.46	18.7	m
Receptor height	2.0	2.0	2.0	2.0	2.0	2.0	m
Urban/Rural option	Rural	Rural	Rural	Rural	Rural	Rural	
Gas flow rate (at stack temperature)	382,765	205,191	410,382	410,382	666,923	1,490,000	Nm^3/hr
Stack Temperature	165	138	138	138	138	74	°C
	438	411	411	411	411	347	K
Mass pollutant emission rate							
SO2	3.72						g/s
NO2	26.58						g/s
CO		7.09	0.36	14.19	14.18		g/s
PM						16.38	g/s

Exhibit 5.2: Plant Emission

Parameter	*Source*	*Target Standard*	*Estimated Plant Emission*
Nitrogen oxides	WB	300 mg/Nm^3	250 mg/Nm^3
Ammonia	WB	50 mg/Nm^3	(no continuous emission)
Urea	WB	50 mg/Nm^3	(no continuous emission)
Sulfur oxides	NEQS	1,700 mg/Nm^3	50 mg/Nm^3
Particulate Matter	WB	50 mg/Nm^3	0.1-0.2 kg/Mg[a]

a estimated using AP-42 Emission Factors (USEPA, 1993)

Exhibit 5.3: Results of Air Dispersion Modeling

Pollutant		*Pollutant Concentration ($\mu g/m^3$)*		
		1 hr	*24 hr*	*Annual*
Sulfur dioxide	**Increase in concentration**		**21**	**6**
	Target		150	80
Nitrogen oxides	**Increase in concentration**			**46**
	Target			100
Carbon Monoxide	**Increase in concentration**	**199**		
	Target	40,000		
Particulate Matter	**Increase in concentration**		**4**	**1**
	Target		230	80

Exhibit 5.4: Cumulative Concentration of Pollutants

Pollutant		*Pollutant Concentration[a] ($\mu g/m^3$)*		
		1 hr	*24 hr*	*Annual*
Sulfur dioxide	**Ambient Concentration**		**21+24=45**	**6+24=30**
	Target		150	80
Nitrogen oxides	**Ambient Concentration**			**46+26=72**
	Target			100
Carbon Monoxide	**Ambient Concentration**	**199+1=200**		
	Target	40,000		
Particulate Matter	**Ambient Concentration**		**4+86=90**	**1+86=81**
	Target		230	80

a Expressed as **Increment + Baseline = Total Ambient Concentration**

6. Conclusion

The gaseous emission from the proposed project was modeled using USEPA model and it was concluded that the ambient concentration of common pollutant would remain well within the target limits. The exception is particulate matter. The ambient air quality concentration for particulate matter is relatively high in the project area. Although, it is not possible to identify the sources separately, however it is consistent with the ambient air concentration of dust in other parts of the country. This is a result of dry and dusty conditions in the country due to which compliance with the World Bank Standard is usually not possible. It may be noted that the Pakistan Environmental Protection Agency (EPA) has recently proposed new standards for ambient air quality (not yet promulgated). The proposed standards are 400 $\mu g/m^3$ and 550 $\mu g/m^3$ for annual and 24-hr periods, respectively. The concentration of particulate matter would be well within Pakistan EPA proposed limits.

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7. References

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