Environmental Impact Assessment (Annexes 11–12)

May 2016

Bangladesh: Power System Expansion and Efficiency Improvement Investment Program (Tranche 3)
Ashuganj 400 MW Combined Cycle Power Plant (East)

Prepared by Ashuganj Power Station Company Limited (APSCL) for the Asian Development Bank. This is an updated version of the draft EIA posted in October 2015 available on http://www.adb.org/projects/documents/ashuganj-400mw-ccpp-east-updated-eia

Annexure-11

Monitoring Test Report

Adroit Environment Consultants Ltd.
A House of Complete Environmental Management

Adroit Environment Consultants Ltd. Mohammadpur Dhaka-1207 Bangladesh 10/17, Iqbal Road

AECL LABORATORY ANALYSIS REPORT
AMBIENT AIR QUALITY TEST REPORT

Memo # AECL : 433
Enterprise : Ashuganj 400 MW CCCP (East) Project
Project address : Ashuganj, Brahmanbaria-3402, Dhaka.

Description of Sample : Ambient air quality analysis report
Sample Collector : Adroit Environment Consultants Ltd (Monitoring team).
Sampling date : 30th April, 2015.
Reporting date : 9th May, 2015.

Description of analysis

SN	*Sample Description*		Ambient Air Pollution Concentration in micro gram/cubic meter (µg/m³)				
		$PM_{2.5}$	PM_{10}	SPM	SO_2	NO_X	CO
01	Method of analysis	Gravimetric	Gravimetric	Gravimetric	West-Geake	Jacob and Hochheiser	Indicator Tube
02	Test Duration (Hours)	24	24	8	24	24	8
03	Bangladesh (DoE) Standard for ambient Air	65	150	200	365	100 annual	10000
04	**International /World Bank Standard**	75	150	NF	125	NF	NF
05	Test result in near Hyundai Office area. N- 24°02'41.3" E- 091°01'06.2" (Date :30/4/2015)	38	73	157	22	26	110
	Remarks		Pollution source from normal activities				

Note: This monitoring report was accomplished by - Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550)

1. *Fine Particulate Matter ($PM_{2.5}$).*
2. *Respirable Dust Content (PM10).*
3. *Suspended Particulate Matter (SPM).*
4. *Oxides of Nitrogen (NO_X).*
5. *Sulphur Di-Oxide (SO_2).*
6. *Carbone Mono-Oxide (CO).*

The weather was sunny and the wind direction was from the south- west to north-east.

17.05.2015
Md. Hasanul Islam
Sr. Manager (Engineering)

Sultana 17.05.2015
Nigar Sultana
Sr. Chemist

17.5.15
Syed Hosney Jahab
Sr. Environmental Engineer (Lab)

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Adroit Environment Consultants Ltd. Mohammadpur Dhaka-1207 Bangladesh 10/17 Iqbal Road

AECL LABORATORY ANALYSIS REPORT

AMBIENT NOISE QUALITY TEST REPORT

Memo # AECL : 483
Enterprise : **Ashuganj 400MW CCPP (East) Project**
Project address : APSCL, B-Baria, Bangladesh.

Description of Sample : Ambient noise quality analysis report
Sample Collector : Adroit Environment Consultants Ltd (Monitoring team).
Sampling date : 30th April, 2015.
Reporting date : 9th May, 2015.

Description of analysis

Concentration present (LA_{eq}) dBA.

Site Description: Test result near Hyundai Office area
Location Coordinated : N- 24°02'41.3" E- 091°01'06.2"

SN	Time	Minimum	Maximum	Average	Remark
01	06.00 AM	61.3	75.7	68.5	Noise source from near power plant activities.
02	07.00 AM	62.1	75.4	68.75	Noise source from near power plant activities.
03	08.00 AM	61.5	75.5	68.0	Noise source from near power plant activities.
04	09.00 AM	62.6	76.3	69.45	Noise source from near power plant activities.
05	10.00 AM	65.8	77.5	71.65	Noise source from near power plant activities.
06	11.00 AM	63.7	77.4	70.55	Noise source from near power plant activities.
07	12.00 PM	66.2	78.9	72.55	Noise source from near power plant activities.
08	01.00 PM	63.3	77.3	70.3	Noise source from near power plant activities.
09	02.00 PM	61.1	76.8	68.95	Noise source from near power plant activities.
10	03.00 PM	66.8	78.0	72.4	Noise source from near power plant activities.
11	04.00 PM	68.7	79.4	74.05	Noise source from near power plant activities.
12	05.00 PM	66.6	76.8	71.7	Noise source from near power plant activities.
13	06.00 PM	62.7	76.5	69.6	Noise source from near power plant activities.
14	07.00 PM	61.4	75.5	68.45	Noise source from near power plant activities.
15	08.00 PM	60.9	75.3	68.1	Noise source from near power plant activities.

16	09.00 PM	61.5	75.9	68.7	Noise source from near power plant activities.
17	10.00 PM	59.4	74.0	66.85	Noise source from near power plant activities.
18	11.00 PM	58.7	74.2	66.45	Noise source from near power plant activities.
19	12.00 AM	58.9	74.6	66.75	Noise source from near power plant activities.
20	01.00 AM	58.5	74.9	66.7	Noise source from near power plant activities.
21	02.00 AM	57.8	74.7	66.25	Noise source from near power plant activities.
22	03.00 AM	57.6	75.2	66.4	Noise source from near power plant activities.
23	04.00 AM	59.2	75.8	67.5	Noise source from near power plant activities.
24	05.00 AM	59.7	75.5	67.6	Noise source from near power plant activities.

Bangladesh (DoE) Standard		
Industrial area	75	70
Commercial Area	70	60
Mixed Area	60	50
Residential Area	55	45

World Bank/IFC Standard		
Industrial	70	70
Residential; Intuitional; Educational	55	45

All units are in (LA_{eq}) dBA.

Note: *This noise data was accomplished by – Lutron Sound Level Meter (Model – 4010)*

17.05.2015

Md. Hasanul Islam
Sr. Manager (Engineering)

17.05.2015

Nigar Sultana
Sr. Chemist

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AECL LABORATORY ANALYSIS REPORT

SURFACE WATER QUALITY TEST REPORT

Memo # AECL : 483
Subject : Ashuganj 400 MW Combined Cycle Power Plant (East) Project
Project Location : Ashuganj, Brahmanbaria.

Sample Collector : Adroit Environment Consultants Ltd (Monitoring team).
Description of Sample : Surface water quality analysis report. (River water)
Sample Location : Ashuganj, Brahmanbaria (Near project area).
Sample Collection date : 30th April, 2015.
Reporting date : 17th May, 2015.

Description of analysis

Name of the Parameter	Concentration present	DoE (Bangladesh) Standard *	IFC/World Bank Standard	Method of analysis
Temperature	38°C	40°C	NF	Mercury filled thermometer
Dissolved Oxygen(DO)	7.3 mg/L	4.5-8 mg/l	NF	Azide modification
BOD5	7 mg/L	50 mg/l	50 mg/l	Dilution
COD	32 mg/L	200 mg/l	250 mg/l	COD Refluction
Total Dissolved Solids (TDS)	115.2 mg/L	2100 mg/l	NF	TDS Meter
Total Suspended Solids (TSS)	5.32 mg/L	150 mg/l	NF	Gravimetric method
pH	6.69	6-9	6-9	PH meter
Total Alkalinity	27 mg/L	NF	NF	Standard Titrimetric method
Hardness	96 mg/L	NF	NF	EDTA titrimetric method
Iron	1.5 mg/L	2 mg/l	NF	Colorimetric
Chloride	60 mg/L	600 mg/l	NF	Mercuric nitrate titration
Nitrate	3.75 mg/l	10.0 mg/l	NF	Specific Ion Electrod
Arsenic	0.003 mg/l	0.2 mg/l	NF	AAS(Atomic Absorption spectrometry)
Lead	<0.05 mg/l	0.1 mg/l	0.1 mg/l	AAS
Manganese	<0.1 mg/l	5 mg/l	NF	Colorimetric
Copper	0.01 mg/l	0.5 mg/l	NF	AAS
Calcium	1.9 mg/l	NF	NF	Titration

** Inland Surface Water Body*
*NF-Not Found.

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Adroit Environment Consultants Ltd. Mohammadpur Dhaka-1207 Bangladesh 10/17 Iqbal Road

AECL LABORATORY ANALYSIS REPORT

GROUND WATER QUALITY TEST REPORT

Memo # AECL : 433
Subject : **Ashuganj 400 MW Combined Cycle Power Plant (East) Project**
Project Location : **Ashuganj, Brahmanbaria.**

Sample Collector : Adroit Environment Consultants Ltd (Monitoring team).
Description of Sample : Ground water quality analysis report.
Sample Location : Ashuganj, Brahmanbaria (Near project area).
Sample Collection date : 30th April, 2015.
Reporting date : 17th May, 2015.

Description of analysis

Name of the Parameter	Concentration present	DoE (Bangladesh) Standard *	IFC/World Bank Standard	Method of analysis
pH	**6.9**	6.5-8.5	6.5-8.5	P^H meter
Total Alkalinity(as $CaCO_3$)	**30 mg/L**	NF	NF	Standard Titrimetric method
Hardness(as $CaCO_3$)	**132 mg/L**	200-500 mg/l	NF	EDTA titrimetric method
Iron	**0.4 mg/L**	0.3-1.0 mg/l	0.3 mg/l	Colorimetric
Chloride	**30 mg/L**	150-600 mg/l	NF	Mercuric nitrate titration
Arsenic	**0.003 mg/L**	0.05 mg/l	0.01 mg/l	Colorimetric
Residual chlorine	**<0.2 mg/L**	0.2 mg/l	NF	DPD Ferrous Titrimetric
Total Coliform	**0 n/100 mL**	0 n/mL	0 n/mL	Membrane Filtration
Fecal Coliform	**0 n/100 mL**	0 n/mL	0 n/mL	Membrane Filtration
Ammonia	**0.35 mg/L**	0.5 mg/L	NF	Nesslerization method
Nitrate	**2.15 mg/L**	10 mg/L	50 mg/L	Specific ion electrode
Phosphate	**3.65 mg/L**	6 mg/L	NF	Ascorbic acid

*Standard for drinking water.
*NF-Not Found.

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A HOUSE OF ENVIRONMENT MANAGEMENT

AECL LABORATORY ANALYSIS REPORT
AMBIENT AIR QUALITY TEST REPORT

Memo # AECL : 455
Enterprise : Ashuganj 400 MW CCCP (East) Project
Project address : Ashuganj, Brahmanbaria-3402, Dhaka.

Description of Sample : Ambient air quality analysis report
Sample Collector : Adroit Environment Consultants Ltd (Monitoring team).
Sampling date : 1-2 July, 2015.
Reporting date : 22nd July, 2015.

Description of analysis

SN	Sample Description	Ambient Air Pollution Concentration in micro gram/cubic meter (µg/m³)					
		$PM_{2.5}$	PM_{10}	SPM	SO_2	NO_X	CO
01	Method of analysis	Gravimetric	Gravimetric	Gravimetric	West-Geake	Jacob and Hochheiser	Indicator Tube
02	Test Duration (Hours)	24	24	8	24	24	8
03	Bangladesh (DoE) Standard for ambient Air	65	150	200	365	100 annual	10000
04	International /World Bank Standard	75	150	NF	125	NF	NF
05	Test result in near Old Ferry Ghat, Meghna Bridge N- 24°02'28.1" E- 091°00'02.2"	53	81	163	13	11	102
	Remarks		Pollution source from normal activities				

Note: This monitoring report was accomplished by - Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550)

1. *Fine Particulate Matter ($PM_{2.5}$).*
2. *Respirable Dust Content (PM10).*
3. *Suspended Particulate Matter (SPM).*
4. *Oxides of Nitrogen (NO_X).*
5. *Sulphur Di-Oxide (SO_2).*
6. *Carbone Mono-Oxide (CO).*

The weather was sunny and the wind direction was from the south- west to north-east.

22/7/15
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AECL LABORATORY ANALYSIS REPORT
AMBIENT AIR QUALITY TEST REPORT

Memo # AECL : 455
Enterprise : Ashuganj 400 MW CCCP (East) Project
Project address : Ashuganj, Brahmanbaria-3402, Dhaka.

Description of Sample : Ambient air quality analysis report
Sample Collector : Adroit Environment Consultants Ltd (Monitoring team).
Sampling date : 1-2 July, 2015.
Reporting date : 22nd July, 2015.

Description of analysis

SN	Sample Description	Ambient Air Pollution Concentration in micro gram/cubic meter (µg/m³)					
		$PM_{2.5}$	PM_{10}	SPM	SO_2	NO_X	CO
01	Method of analysis	Gravimetric	Gravimetric	Gravimetric	West-Geake	Jacob and Hochheiser	Indicator Tube
02	Test Duration (Hours)	24	24	8	24	24	8
03	Bangladesh (DoE) Standard for ambient Air	65	150	200	365	100	10000
04	International /World Bank Standard	75	150	NF	125	NF	NF
05	Test result in near APSCL Dormitory N- 24°02'47.6" E- 091°01'07.1"	36	77	149	19	12	98
	Remarks		Pollution source from normal activities				

Note: This monitoring report was accomplished by - Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550)

1. *Fine Particulate Matter ($PM_{2.5}$).*
2. *Respirable Dust Content (PM10).*
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6. *Carbone Mono-Oxide (CO).*

The weather was sunny and the wind direction was from the south- west to north-east.

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AECL LABORATORY ANALYSIS REPORT

AMBIENT NOISE QUALITY TEST REPORT

Memo # AECL : 455
Enterprise : **Ashuganj 400MW CCPP (East) Project**
Project address : APSCL, B-Baria, Bangladesh.

Description of Sample : Ambient noise quality analysis report
Sample Collector : Adroit Environment Consultants Ltd (Monitoring team).
Sampling date : 1-2 July, 2015.
Reporting date : 22nd July, 2015.

Description of analysis

Concentration present (LA_{eq}) dBA.					
Site Description: Test result near APSCL Dormitory **Location Coordinated** : N- 24°02'47.6" E- 091°01'07.1"					
SN	**Time**	**Minimum**	**Maximum**	**Average**	**Remark**
01	06.00 AM	75.8	78.5	77.15	Noise source from near power plant activities.
02	07.00 AM	74.3	79.3	76.8	Noise source from near power plant activities.
03	08.00 AM	74.5	80.1	77.3	Noise source from near power plant activities.
04	09.00 AM	71.2	80.5	75.85	Noise source from near power plant activities.
05	10.00 AM	76.9	82.4	79.65	Noise source from near power plant activities.
06	11.00 AM	79.9	83.6	81.75	Noise source from near power plant activities.
07	12.00 PM	80.1	83.9	82.0	Noise source from near power plant activities.
08	01.00 PM	78.1	84.1	81.1	Noise source from near power plant activities.
09	02.00 PM	78.5	85.0	81.75	Noise source from near power plant activities.
10	03.00 PM	76.6	86.2	81.4	Noise source from near power plant activities.
11	04.00 PM	77.4	85.7	81.55	Noise source from near power plant activities.
12	05.00 PM	79.8	84.6	82.2	Noise source from near power plant activities.
13	06.00 PM	80.3	84.5	82.4	Noise source from near power plant activities.
14	07.00 PM	76.4	81.8	79.4	Noise source from near power plant activities.
15	08.00 PM	74.1	79.7	76.9	Noise source from near power plant activities.
16	09.00 PM	74.3	77.5	75.9	Noise source from near power plant activities.
17	10.00 PM	74.3	77.8	75.9	Noise source from near power plant activities.

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18	11.00 PM	75.1	76.3	75.7	Noise source from near power plant activities.
19	12.00 AM	74.5	76.2	75.35	Noise source from near power plant activities.
20	01.00 AM	74.6	77.9	76.25	Noise source from near power plant activities.
21	02.00 AM	74.5	77.4	75.95	Noise source from near power plant activities.
22	03.00 AM	73.8	76.5	75.15	Noise source from near power plant activities.
23	04.00 AM	74.9	78.9	76.85	Noise source from near power plant activities.
24	05.00 AM	75.7	77.4	76.55	Noise source from near power plant activities.

Bangladesh (DoE) Standard		
	Day	Night
Industrial area	75	70
Commercial Area	70	60
Mixed Area	60	50
Residential Area	55	45
World Bank/IFC Standard		
Industrial	70	70
Residential; Intuitional; Educational	55	45

All units are in (LA_{eq}) dBA.

Note: *This noise data was accomplished by – Lutron Sound Level Meter (Model – 4010)*

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AECL LABORATORY ANALYSIS REPORT

AMBIENT NOISE QUALITY TEST REPORT

Memo # AECL : 455
Enterprise : **Ashuganj 400MW CCPP (East) Project**
Project address : APSCL, B-Baria, Bangladesh.

Description of Sample : Ambient noise quality analysis report
Sample Collector : Adroit Environment Consultants Ltd (Monitoring team).
Sampling date : 1-2 July, 2015.
Reporting date : 22nd July, 2015.

Description of analysis

Concentration present (LA_{eq}) dBA.					
Site Description: Test result near Old Ferry Ghat, Meghna Bridge **Location Coordinated** : N- 24°02'28.1" E- 091°01'02.2"					
SN	**Time**	**Minimum**	**Maximum**	**Average**	**Remark**
01	06.00 AM	61.3	65.3	63.3	Noise source from nearby traffic activities
02	07.00 AM	62.4	65.7	64.05	Noise source from nearby traffic activities
03	08.00 AM	60.7	66.9	63.8	Noise source from nearby traffic activities
04	09.00 AM	62.7	67.1	64.9	Noise source from nearby traffic activities
05	10.00 AM	63.2	70.3	66.75	Noise source from nearby traffic activities
06	11.00 AM	63.8	72.4	68.1	Noise source from nearby traffic activities
07	12.00 PM	66.1	75.9	71	Noise source from nearby traffic activities
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16	09.00 PM	61.8	67.1	64.45	Noise source from nearby traffic activities
17	10.00 PM	59.5	66.2	62.85	Noise source from nearby traffic activities
18	11.00 PM	58.8	66.3	62.55	Noise source from nearby traffic activities

19	12.00 AM	58.9	65.8	63.35	Noise source from nearby traffic activities
20	01.00 AM	57.1	61.2	59.15	Noise source from nearby traffic activities
21	02.00 AM	55.0	61.8	58.4	Noise source from nearby traffic activities
22	03.00 AM	56.1	60.2	58.15	Noise source from nearby traffic activities
23	04.00 AM	58.7	64.5	61.6	Noise source from nearby traffic activities
24	05.00 AM	59.7	64.9	62.3	Noise source from nearby traffic activities

Bangladesh (DoE) Standard		
	Day	**Night**
Industrial area	**75**	**70**
Commercial Area	**70**	**60**
Mixed Area	**60**	**50**
Residential Area	**55**	**45**
World Bank/IFC Standard		
Industrial	**70**	**70**
Residential; Intuitional; Educational	**55**	**45**

All units are in (LA_{eq}) dBA.

***Note:** This noise data was accomplished by – Lutron Sound Level Meter (Model – 4010)*

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A HOUSE OF ENVIRONMENT MANAGEMENT

AECL LABORATORY ANALYSIS REPORT
SURFACE WATER QUALITY TEST REPORT

Memo : 454
Subject : **Ashuganj 400 MW Combined Cycle Power Plant (East) Project**
Project Location : **Ashuganj, Brahmanbaria.**

Sample Collector : Adroit Environment Consultants Ltd (Monitoring team).
Description of Sample : Surface water (Meghna River)
Sample Location : Ashuganj, Brahmanbaria (Near project area).
Sample Collection date : 1st July, 2015.
Reporting date : 1st August, 2015.

Description of analysis

Name of the Parameter	Concentration present	Method of analysis
Oil & Grease	**<5.5 mg/L**	APHA 5520.B

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AECL LABORATORY ANALYSIS REPORT
AMBIENT AIR QUALITY TEST REPORT

Memo # AECL :
Enterprise : Ashuganj 400 MW CCCP (East) Project
Project address : Ashuganj, Brahmanbaria-3402, Dhaka.

Description of Sample : Ambient air quality analysis report
Sample Collector : Adroit Environment Consultants Ltd (Monitoring team).
Sampling date : 12th-13th October, 2015.
Reporting date : 14th October, 2015.

Description of analysis

SN	Sample Description	Ambient Air Pollution Concentration in micro gram/cubic meter (µg/m³)					
		$PM_{2.5}$	PM_{10}	SPM	SO_2	NO_X	CO
01	Method of analysis	Gravimetric	Gravimetric	Gravimetric	West-Geake	Jacob and Hochheiser	Indicator Tube
02	Test Duration (Hours)	24	24	8	24	24	8
03	Bangladesh (DoE) Standard for ambient Air	65	150	200	365	100	10000
04	International /World Bank Standard	75	150	NF	125	200 (1 hr)	NF
05	Test result in near East Dormitory. N- 24°04'57.17" E- 91°01'94.73"	32	68	161	16	20 48 (1 hr)	105
06	Test result in near project site N- 24°02'41.3" E- 091°01'06.2" (1 hr Nox)	-	-	-	-	56 (1 hr)	-
	Remarks		Pollution source from normal activities				

Note: This monitoring report was accomplished by - Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550)

1. *Fine Particulate Matter ($PM_{2.5}$).*
2. *Respirable Dust Content (PM10).*
3. *Suspended Particulate Matter (SPM).*
4. *Oxides of Nitrogen (NO_X).*
5. *Sulphur Di-Oxide (SO_2).*
6. *Carbone Mono-Oxide (CO).*

The weather was sunny and the wind direction was from the south- west to north-east.

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STACK EMISSION DISPERSION MODELING OF 400 MW CCPP (EAST) ASHUGANJ POWER STATION CO LTD.

At

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1. INTRODUCTION

Air Emission Dispersion modelling uses mathematical formulations to characterize the atmospheric processes that disperse a pollutant emitted by a source. Based on emissions and meteorological inputs, a dispersion model can be used to predict concentrations at selected downwind receptor locations. These air quality models are used to determine compliance with National and international Ambient Air Quality Standards.

It orders to estimate the pollutant concentration from a point source emission, USEPA AERMOD view 8.0.5 model have been used. AERMOD view is a Gaussian plume model that incorporates source-related factors, meteorological factors, receptors, terrain and building downwash factors to estimate pollutant concentration from continuous point source emission. The following report describes the prediction of emission of NO_2 from the gas fired engine generated power plant and it's impact on ambient air quality within 5 Km radius.

2.0 METHODOLOGY

2.1 About AERMOD View

AERMOD View is a complete and powerful air dispersion modelling package that seamlessly incorporates the popular U.S. EPA models, AERMOD, ISCST3, and ISC-PRIME into one interface without any modifications to the model. These models are used extensively to assess pollution concentration and deposition from a wide variety of sources.

Features

Create impressive presentations of the model results with the easy and intuitive graphical interface of AERMOD View. We can customize the project using display options such as transparent contour shading, annotation tools, various font options, and specify compass directions.

- Specify model objects such as sources, receptors and buildings graphically.
- Automatically eliminate receptors within the facility property line.
- Import base maps in a variety of formats for easy visualization and source identification.
- Use the major digital elevation terrain formats - USGS DEM, NED, GTOPO30 DEM, UK DTM, UK NTF, XYZ Files, CDED 1-degree, AutoCAD DXF.
- Interpret the effects of topography by displaying the model results with 3D terrain using the powerful 3D visualization built right into the interface.
- Complete building downwash analysis effectively and quickly using the necessary tools that AERMOD View provides.
- Prepare meteorological data quickly and accurately using AERMET view by the step-by-step meteorological pre-processing interface.

- Take advantage of AERMOD View's integrated post-processing with automatic contouring of results, automatic gridding, blanking, shaded contour plotting and posting of results.

The dispersion modelling was conducted to appraise environmental impact assessment (EIA) for the proposed reciprocating engine power plant. In the study, the NO_2 emissions for natural gas fired engine discharged through stack was modelled to obtain maximum possible concentration. This model was also tested in case of area source and showed good correlation with the measured data under Bangladesh condition.

Information required for the model includes:

a) Pollutant emission rate
b) Stack exhaust exist temperature
c) Stack exhaust exist velocity flow
d) Stack diameter
e) Stack height
f) Meteorological data

All the required information was obtained from manufacturer specification. Discharge concentration was estimated at 500m increments from the plant up to minimum 5 km radius.

2.2 Meteorological Condition

The Ashuganj area where the power plant is located has a sub-tropical climate and is under the influence of the strong southwest or summer monsoon and weak northeast or winter monsoon. It has been understood from last few years of air quality monitoring, the air quality level of the area greatly influenced by the Asian monsoon. The air quality characteristic over the area and it's surrounding shows distinct seasonal variations, with high pollution episode observed during winter, while summer has relatively cleaner ambient air. During dry winter and part of the post-monsoon season, the strength of north, northwest wind coming from India, Nepal and Southeast China to the Bay of Bengal through Bangladesh may transport the air pollutants to the city. Moreover, during dry season the wind speed is so low that the pollutants emitted from the local sources cannot travel away from the city.

The use of site-specific meteorological data has been collected from the World Meteorological Organization (WMO) who has provided 1 Year of MM5-Preprocessed site specific Meteorological data for the period of Jan 01, 2013 to Dec 31, 2013 at Latitude: 24.0325 N, Longitude: 90.0033 E, Time Zone: UTC +6. These data contain hourly value of wind speed & direction, wind velocity, surface roughness, bowen ratio, albedo, temperature & reference height, precipitation rate, relative humidity, surface pressure and cloud cover over the period mentioned above. The data then have been analysed and processed through MET processing model AERMET View which uses Samson format to process the data and create surface met data file & profile met data file computable to the USEPA AERMOD view dispersion model. These surface met data file & profile met data file were then used in AERMOD view as Met input data for calculation.

The wind rose plots were drawn from the AERMET view met processor model and shows distinct four wind directional patterns representing four seasons in a year as per air blowing to and from (Figure 2.1 & 2.2). The mixing height in the boundary layer is one of the important factors to assess the influence of meteorology on the dispersion of pollutants.

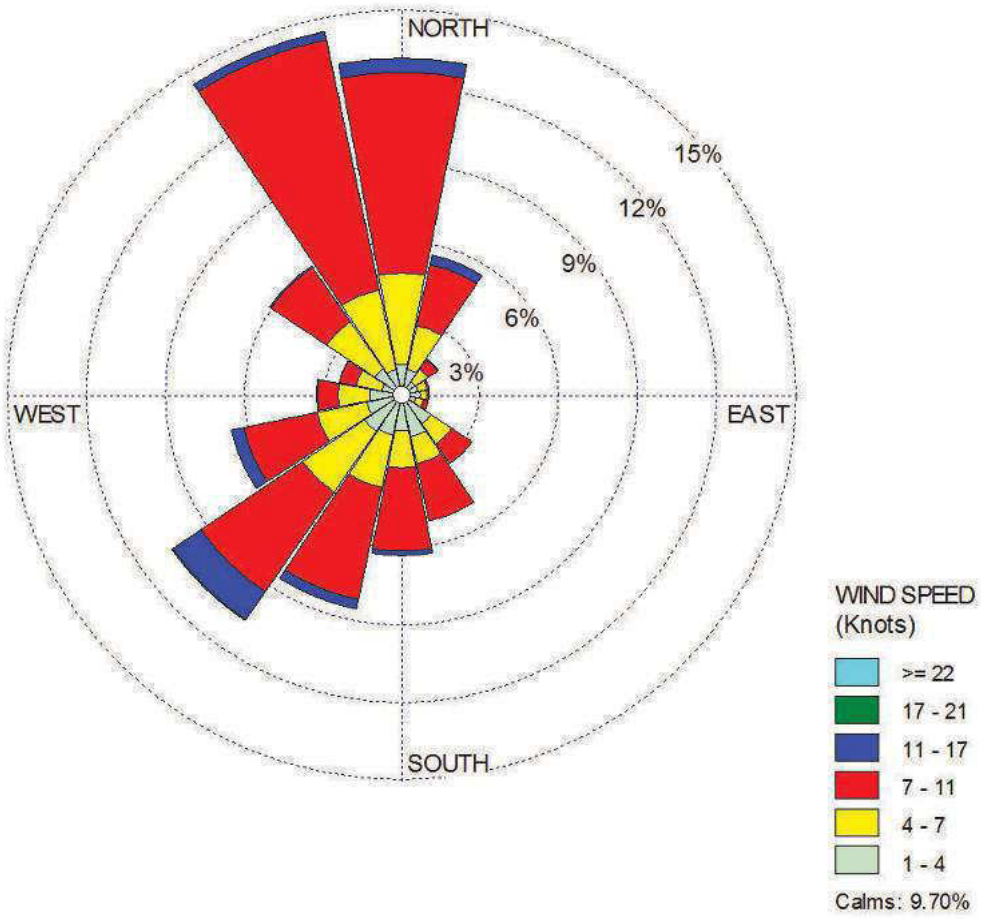

Figure 2.1: Seasonal wind direction (Pre-monsoon, Monsoon, Post-monsoon and winter respectively) blowing to the project location based on Samson data processing obtained from AERMET view.

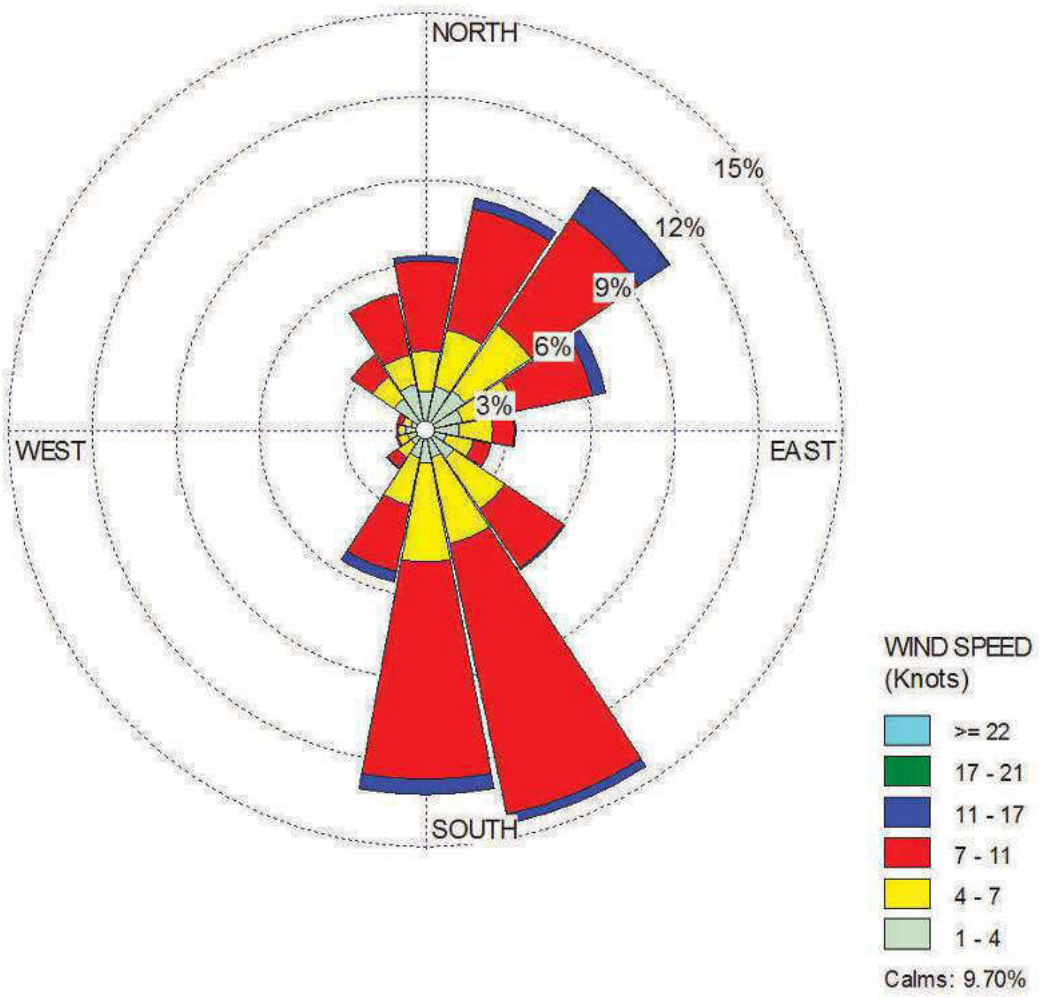

Figure 2.2: Seasonal wind direction (Pre-monsoon, Monsoon, Post-monsoon and winter respectively) blowing from the project location based on Samson data processing obtained from AERMET view.

3.0 STANDARDS AND GUIDELINES

Since natural gas will be used for the proposed engine power plant, the principal air pollutant of concern is nitrogen dioxides (NO_2). The guideline value for NO_2 in case of ambient air is shown in Table 3.1.

Table 3.1: Ambient air quality guideline for NO_2.

Pollutants	Average period	Standard in µg/m^3		
		BNAAQS***	WHO/IFC 2007*	US EPA
NO_2	1 hr		200**	188
	Annual	100	40**	100

* IFC Environmental Health & Safety Guidelines 2007
** Ambient air quality standard for small combustion facility using gas fuel and spark engine
***Bangladesh National Ambient Air Quality Standard

4.0 SOURCE PARAMETERS

An effect on ambient air quality has been assessed based on preliminary air quality modelling results. An advanced air emission dispersion modelling has been conducted for determining the ground concentration of pollutants from the stack and turbine emission. In the study, the NO_2 emissions for the gas turbine stack exhaust system were modelled to obtain maximum possible downward ground concentration. USEPA AERMOD view version 8.8.9 model was used to estimate emission concentration from the plant. The air emission modelling has been done for individual stack emission dispersion from the APSCL 400 MW (east) and also from the cumulative concentration from the under construction power plants of APSCL in the same campus.

A. Ambient Air Quality by considering the individual stack of APSCL 400 MW CCPP (east)

The proposed power project will have a 289 MW gas turbine fitted with 135 MW steam turbine and the model calculates the values in different configurations (single and cumulative) by considering individual stack emissions with 65m stack height of NO_2 emissions from different stacks. The model assumes the stack tip downwash with receptors on flat terrain and no flagpole receptor heights. The NO_2 concentration contour has been analyzed with 500 m interval with a radius of 5000m from the point source. The NO_2 concentration contour of 1 hour and annual average of maximum concentration have been analyzed.

The parameters and corresponding values are summarized in Table 4.1,

Table 4.1: The exhaust specifications and stack parameters for individual stack

Parameters	Values
Stack height (m) =	65m
Stack inside diameter (m) =	6.25m
Stack gas exit velocity (m/s) =	9 m/s
Exhaust temperature (K) =	(90+293) = 383
Exhaust flow rate (m3/sec) =	276.11
NO_2 emission rate as NO_2 (g/s) =	15.38
Ambient temperature (K) =	293
Receptor height above ground=	0.000

B. Ambient Air Quality by considering the cumulative concentration from other proposed projects of APSCL.

An effect on ambient air quality has been assessed based on the cumulative ground concentration of NO_2 emissions together with other proposed power project of APSCL at the same complex. In addition to the 400 MW CCPP east, APSCL is now constructing two 450 MW CCPP north & south, one 225 MW CCPP and one 200 MW reciprocating gas engine power project (by UAEL). USEPA AERMOD view version 8.8.9 model was used to estimate emission concentration from all the plant considering point source emission.

In this calculation, we have considered 20 reciprocating gas generators and 4 combined cycle power plant stack together as point source. The model assumes the stack tip downwash with receptors on flat terrain and no flagpole receptor heights. The NO_2 concentration contour has been analyzed with 500 m interval with a radius of 5000m from the point source. The NO_2 concentration contour of 1 hour and annual average of maximum concentration have been analyzed.

The parameters and corresponding values are summarized in Table 4.2 & 4.3

Table 4.2: The exhaust specifications and stack parameters (for 20 stacks)

Parameters	Values
Stack height (m) =	40m
Stack inside diameter (m) =	1.20
Exhaust temperature (K) =	(170+293) = 463
Exhaust flow rate (m3/sec) =	4.94
NO_2 emission rate as NO_2 (g/s) =	0.988
Ambient temperature (K) =	293
Receptor height above ground=	0.000

Table 4.3: The exhaust specifications and stack parameters (for 450 north & south)

Parameters	Values
Stack height (m) =	50
Stack inside diameter (m) =	6.09
Exhaust flow rate (m3/sec) =	472.12
Exhaust temperature (K) =	384
NO_2 emission rate as NO_2 (g/s) =	24.078
Ambient temperature (K) =	293
Receptor height above ground=	0.000

Table 4.4: The exhaust specifications and stack parameters (for 225 MW)

Parameters	Values
Stack height (m) =	50
Stack inside diameter (m) =	5.8
Exhaust flow rate (m3/sec) =	364.48
Exhaust temperature (K) =	384
NO_2 emission rate as NO_2 (g/s) =	18.88
Ambient temperature (K) =	293
Receptor height above ground=	0.000

5.0 MODELING RESULTS

A. Stack emission dispersion results for APSCL 400 MW CCPP:

The NO_2 concentration contour of 1 hour and annual average of maximum concentration have been analyzed. The maximum of 1 hour concentration of NO_2 (10-18 µg/m^3) has been predicted at a radius of 1000m east, west & south to the power projects. The concentrations will be expected to reduce from 10 µg/m^3 to 3 µg/m^3 uniformly surrounding the project within 4000m from the stack. The concentrations will be further below to 3 µg/m^3 beyond 4000m around the project. The maximum annual concentration of NO2 has been detected as 0.50-0.60 µg/m^3 at 1000m to 5000m west to the project, whereas the concentration are below 0.50-0.10 µg/m^3 at the either sides further down to the project site up to 5000m.

The following are the emission contour maps of the proposed project at 1 hour and annual average of NO_2 concentrations:

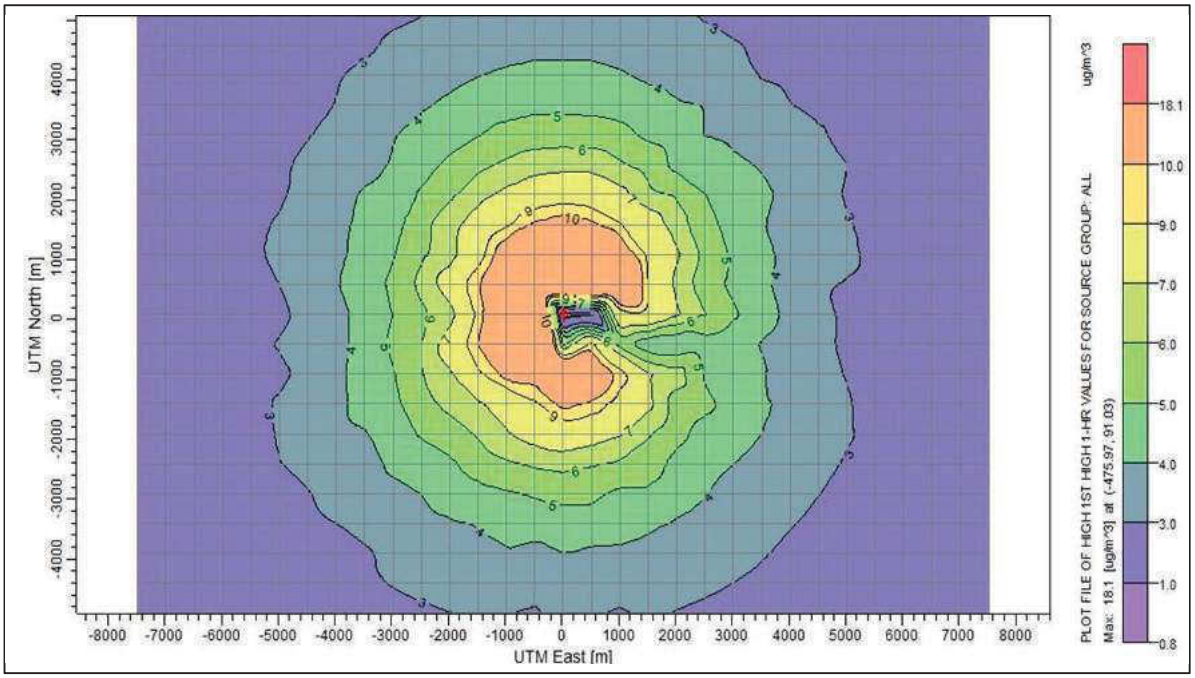

Figure 5.1: Emission contour map showing the NO2 concentration (1 hour average)

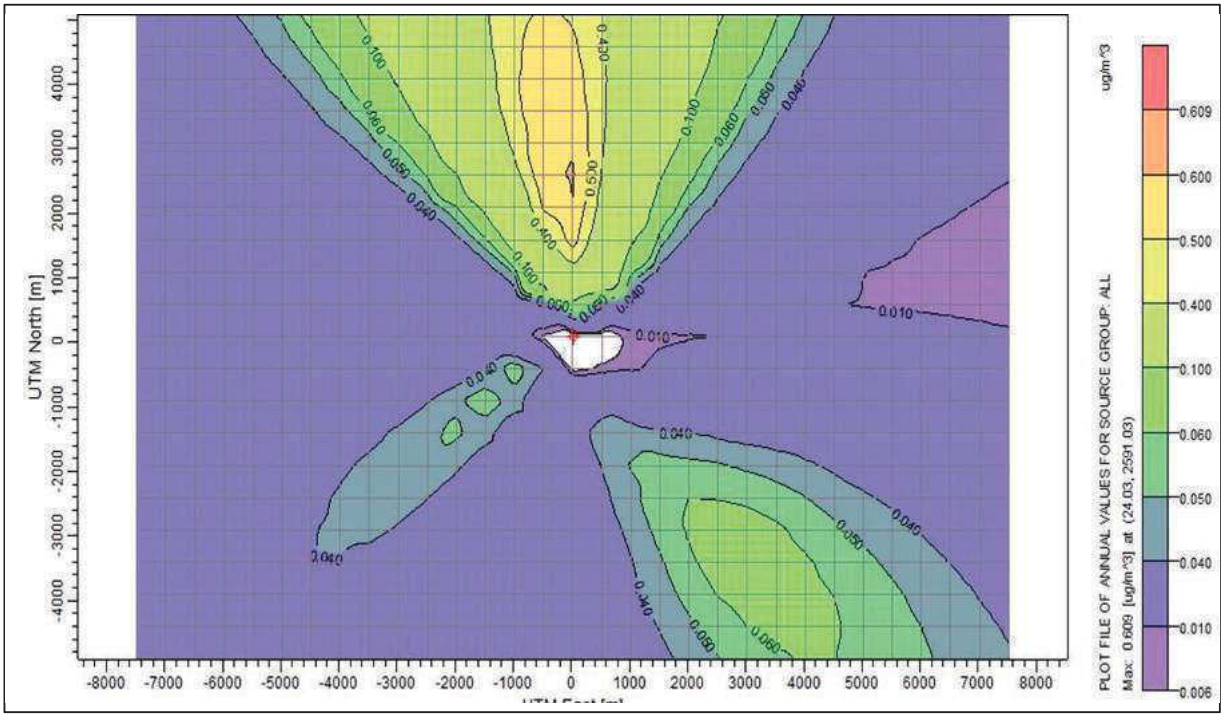

Figure 5.2: Emission contour map showing the NO_2 concentration (annual average)

B. Dispersion model result by considering the cumulative concentration from other proposed projects of APSCL.

The NO_2 concentration contour of 1 hour and annual average of maximum concentration have been analyzed. The maximum of 1 hour concentration of NO_2 has been predicted below 100-153 µg/m^3 at a radius of 0-1000m around the project, whereas the concentrations are within 50-100 µg/m^3 from 1000-3000m around the project site and the concentrations are below 50 µg/m^3 has been predicted at further down beyond 400m radius. The maximum annual concentration of NO2 has been detected as 10-20 µg/m^3 at a radius up to of 3000m west to the project forming a pocket whereas the concentration are within 5-0.30 µg/m^3 at the either sides further down to the project site up to 5000m.

The following are the emission contour maps of the proposed project at 1 hour and annual average of NO2 concentration:

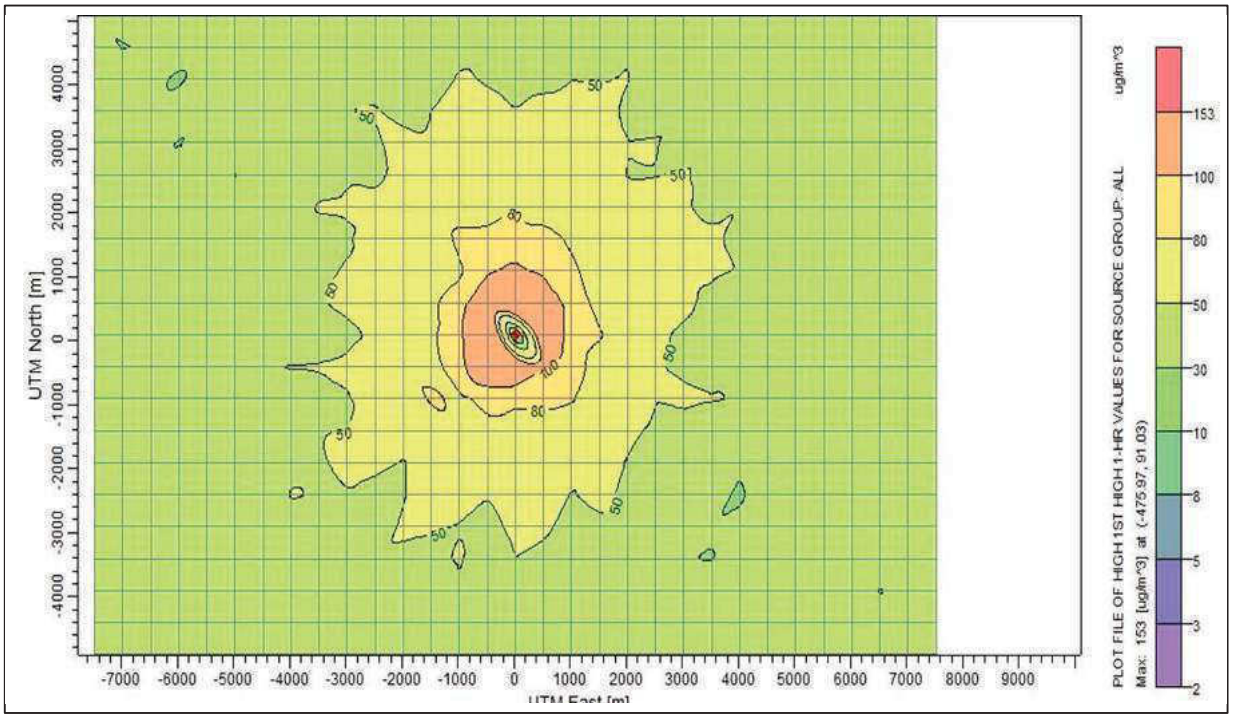

Figure 5.3: Emission contour map showing the NO2 concentration (1 hour average) combined source

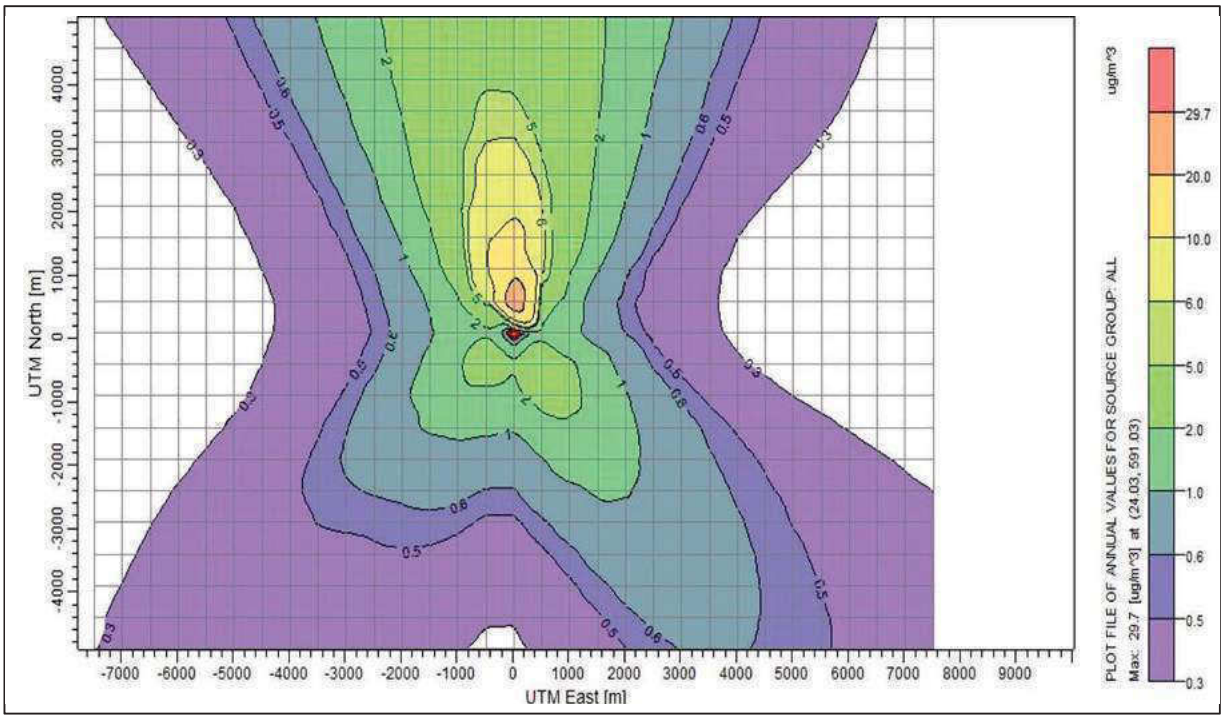

Figure 5.4: Emission contour map showing the NO2 concentration (annual average) combined source

6.0 CONCLUSION

Review of modelling results (single source):

The modelling result shows the 1 hour concentration of NO_2 (10-18 µg/m^3) has been predicted at a radius of 1000m east, west & south to the power projects site which is within the IFC standard (200 µg/m^3) for 1 hour concentration. The maximum annual concentration of NO2 has been found 0.50-0.60 µg/m^3 at 1000m to 5000m west to the project which are also less than the Bangladesh, WHO/IFC and USEPA standard. These indicate that the expected power plant does not have major significant adverse impact on the prevailing air quality of that area.

Table 6.1: Predicted NOx Concentrations (ug/m^3)

Distance Downwind	1-hour (ug/m^3)
0-1500 meters all sides	10-18
1500-4000 meters all sides	3-10
Beyond 400m all sides	>3
	Annual (ug/m^3)
1000-5000m west	0.50-0.60
100-500 meters north-west & south=west	0.40-0.05
1.5000 meters North, South & east	>0.05

ug/m^3 = micrograms per cubic meter

Review of modelling results (cumulative emission):

The modelling result shows the maximum 1 hour ground level concentration of the NO2 is 100-153 µg/m^3 at a radius of 0-1000m around the project which is within the IFC standard (200 µg/m^3) for 1 hour concentration. Since this is not an individual contribution to air shed and no other major NOx polluting sources exists within the air shed, the calculated concentration may be compared with the standard.

The maximum annual concentration of NO2 has been found 10-20 µg/m^3 at a radius up to of 3000m west around the site is also less than the Bangladesh, WHO/IFC and USEPA standard as mentioned in the table 3.1. These indicate that the expected power plant does not have major significant adverse impact on the prevailing air quality of that area.

Table 6.2: Predicted NOx Concentrations (ug/m^3)

Distance Downwind	1-hour (ug/m^3)
0-1000 meters all sides	100-153
1000-3000 meters all sides	50-100
Beyond 3000 all sides	>50
	Annual (ug/m^3)
0-3000m west	10-20
0-1500 north & south	1-5
1.5000 meters Northwest & southwest	1-5

ug/m^3 = micrograms per cubic meter

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Annexure-12 (b)

Thermal Plume Modelling Report

THERMAL PLUMEMODELING
OF

ASHUGANJ POWER STATION CO LTD.
400 MW CCPP (EAST)
At

Ashuganj, Brahmanbaria

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July, 2015

The proposed project is named as 400 MW CCPP East will be established at the APSCL site. The cooling water requirement was estimated to be about 28,500 m^3/hr or 7.91 m^3/second. The total cooling water will be drawn by all plants including the existing and ongoing project would be about 56.4 m^3/sec where the minimum river discharge is 2050 m^3/sec. Adequate water appears available throughout the year from the Meghna River for the proposed 400MW combined cycle which release the heated water at 37.54^{0}C after the condenser cooling.

The Objective of this study is to compliance the thermal plume dispersion with the regulatory mixing zone standard (i.e. 3 deg C at 100m distance from the outfall point) for new power generation unit (400MW CCPP East) after being operation of it's full capacity.

An island (char) is developed in front of 300m distance from the discharge channel. The width of Meghna river width is around 1.5km across the discharge point including 300m width sand bar. This sand bar is diverting a significant volume of river discharge during lean period. This study assumed around 20% of the total river water is flowing through this channel and finally confluence with the main river at downstream.

In order to predict the thermal plume dispersion properly, Cornell Mixing Zone Expert System (CORMIX3) software is used to predict the steady and un-steady state mixing behavior and plume geometry. It is a USEPA-supported mixing zone model and decision support system for environmental impact assessment of regulatory mixing zones resulting from continuous point source discharge. Heated water will be discharged from the APSCL to the river after traveling through an internal canal of APSCL of around 3 discharge canals among which the shortest is 600 m long receive all the cooling water discharge from the power plants and finally discharge to the meghna river at the south east boundary of APSCL. Therefore, around 1^{0}C temperature assumed to be reduced when the thermal plume ultimate discharge to the Meghna river. At present, the recorded temperature besides the discharge channel is 30^{o}C when other units are in operation. A number of input parameters are considered for this modeling process. **Table-XX** shows the input variables for thermal plume modeling.

TableXX: Input parameter for thermal plume modeling

	Unit	Data	Data Source
AMBIENT PARAMETERS:	Dry Period		
Cross-section		bounded	Field observation
Width	m	200	Schematized of Cross section
Channel regularity		2	Field observation
Ambient flow rate	m^3/s	200	20% of the Minimum Flow
Average depth	m	5	Schematized channel depth
Depth at discharge	m	4	Field survey
Ambient velocity	m/s	0.2	Field survey
Manning's Coff.		0.035	Field observation
Wind velocity	m/s	4.1	Literature review
Temperature	deg C	30	Field investigation
Water density	kg/ m^3	995.6	Calculated
DISCHARGE PARAMETERS:	Surface Discharge		
Discharge located on		left bank	
Discharge configuration		flush discharge	
Distance from bank to outlet	m	0	Field investigation
Discharge angle	deg	90	Field investigation
Depth near discharge outlet	m	1.5	Field investigation
Bottom slope at discharge	deg	30	Field investigation
Discharge cross-section area	m^2	15	Field investigation
Discharge channel width	m	15	Field investigation

Discharge channel depth	m	1	Field investigation
Discharge aspect ratio		0.066667	Calculated
Discharge flow rate	m^3/s	7.92	Design Condition
Discharge velocity	m/s	0.53	Calculated
Discharge temperature (freshwater)	degC	36	Design value
Corresponding density	kg/ m^3	993.6812	Calculated value
Density difference	kg/ m^3	1.9658	Calculated value
Buoyant acceleration	m/s^2	0.0194	Calculated value
Discharge concentration	degC	6	Design condition
Surface heat exchange coeff.	m/s	0.000018	Calculated value

After running the CORMX3 simulation for dry period, a continuous thermal plume path has been identified. **Figure-XX** shows the thermal plume dispersion with respect to the changing temperature and distance. Plume will be discharged from the left bank of the river and dispersed to the downstream. It will attach with the left bank downstream of the river. At this situation, the centerline temperature will reduce to 32.4 deg C at 100 m distance from the outfall.

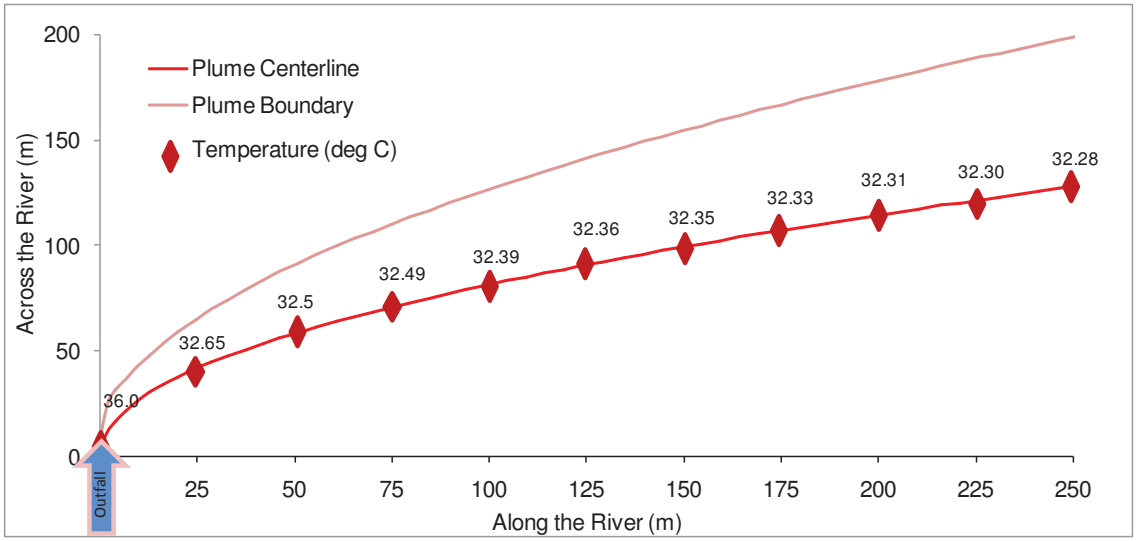

Figure-XX: Thermal plume dispersion from upstream to dowstream

This result is confirmed that the increase of river water temperature around the discharge point do not exceeds 3^OC near the mixing zone boundary in the river. It will be reduced by 3^0C near (x=10m, y=27m) to the discharge point. Moreover, all the thermal plume related issues are considerably confined inside the sub channel (i.e. left bank of Meghna river near APSL to the island/char). After certain distance when the channel water will join with the main river water, the effect of thermal plume becomes significantly minuscule. From field investigation and modeling output of thermal plume, it is evident that the thermal plume of this project will satisfy the international standards adequately.