Environmental Monitoring Report

Project No. 38164-013
Annual Report
Jan-Dec 2015

2622-BAN: Natural Gas Access Improvement Project,
[ Environmental monitoring Report of Compressor
Station Project at Ashuganj, Brahmanbaria]
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Yearly Environmental Monitoring Report

of Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

JANUARY - 2016

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Yearly Environmental monitoring of Bangladesh Compressor Station Project at Ashuganj, Brahmanbaria

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Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

Abbreviations

ADB - Asian Development Bank
AEC - Atomic Energy Centre
API - American Petroleum Institute
BOD - Biochemical Oxygen Demand
CO - Carbon Monoxide
COD - Chemical Oxygen Demand
CS - Compressor Station
dBa - DeciBels Adjusted
DPHE - Department of Public Health Engineering
DO - Dissolved Oxygen
DoE - Department of Environment
EMP - Environmental Management Plan
EPT - Environmental Perimeter Tests
GPS - Global Positioning System
GTCL - Gas Transmission Company Limited
HEC - Hyundai Engineering Company Ltd.
JTU - Jackson Turbidity Unit
MEMC - Miah Environmental Monitoring Center
mg/L - milligram per liter
NOx - Oxides of Nitrogen
OWS - Oily Water Separator
SCC - Special Condition of Contract
SO2 - Sulphur dioxide
SPM - Suspended Particulate Materials
SRDI - Soil Resources Development Institute
WHO - World Health Organization
Executive Summary

Gas Transmission Company Limited (GTCL) - a Company of Bangladesh Oil, Gas and Mineral Corporation (Petrobangla), incorporated in 1993 under the Companies’ Act with the objective of establishing a balanced and reliable national gas transmission network with effective and unified control to ensure transportation of gas. The Employer commenced its formal operation from March 1994 and is responsible for the construction, operation and maintenance of the high-pressure gas transmission network in the country.

Most of the gas fields are located in the northeast and central regions of the country while the load centers are located throughout the country. Most of the load centers and thus the consumers are still not covered by natural gas. The government’s development goals are (i) to provide energy for sustainable economic growth and for maintaining energy security in the country, (ii) to provide energy to all socio-economic groups of the country specially the less developed areas, (iii) to diversify use of indigenous energy, and (iv) to contribute to the protection of the environment.

In order to facilitate the expansion of natural gas in less developed areas the Government intends to develop the energy sector with adequate upstream and downstream investments. Under this context, the Employer undertook a network analysis to identify the most cost-effective facility option (pipeline and/or compression) required to meet projected demand of natural gas from the national gas transmission grid. The network analysis reviewed the existing gas transmission network to determine future requirements for meeting the projected peak daily demands by taking into account cost, operation and expandability. The analysis concluded that installing compression for expansion of the gas transmission system would be cost effective and will provide better operational flexibility and better line-pack management.

On request from the Government, Asian Development Bank (ADB) had provided technical assistance (TA) to prepare a loan project that would finance priority investments for expanding natural gas supply. The study identified the most cost effective facility option for augmentation of the national gas grid is installing compressor stations at Ashuganj. Based on that study, ADB extended loan assistance for meeting the cost of various sub-components under “Natural Gas Access Improvement Project” and it is intended that part of the proceeds of the loan will be applied for procurement of goods and services in accordance with ADB’s guideline.

Pursuant to above, to facilitate the above objective, the work had been awarded to Hyundai Engineering Co. Ltd. (HEC) on complete engineering, design, manufacture, furnish necessary documents, packing & forwarding, supply, unloading at site, storage at site, erection, installation, construction, testing, pre-commissioning, commissioning, guarantee test and operation & maintenance on Design-Build & Turnkey basis at Ashuganj Compressor Station at Ashuganj Gas Manifold Station (AGMS), Ashuganj, Brahmanbaria, and all necessary ancillary facilities including tie-in works/cold tapping with mainline in accordance with but not limited to the conceptual Drawings and Technical Specifications provided thereto in the bidding documents. The location and configuration of the aforesaid Compressor Station is outlined below:

Ashuganj: The Station consists of 3 X 15 MW (3 X 20000 HP) Siemens SGT 400 Gas Turbine driven Centrifugal Compressor Packages with gas filtration & cooling system. The other station support systems and utilities include flare system, instrument & plant air system, potable and utility water system, fuel gas system, power generation system including substation, fire & gas detection system and fire water system, gas metering system, condensate storage & handling system including API separator etc. Control & Office Building, Substation Building, Gas Generator Building, Air Compressor Building, Gas Compressor Shelter, Fire Water Pump Shelter and Guard Houses are also incorporated in the plant layout.

Total Station Flow Capacity: 750X2 = 1500 MMSCFD, Two units in operation, one unit on standby mode.

Design Suction Pressure: 680 psig, Design Discharge Pressure: 1000 psig.

It is quite some time that, HEC has completed construction, testing, pre-commissioning and commissioning of the Compressor Station and the station is now at its operation phase. But as per terms of the Special Condition of Contract (SCC) between GTCL and HEC, the latter is required to implement of
Environmental Management Plan (EMP) in line with the relevant points given under different phases of construction and operation of the Compressor Station as per contract.

Accordingly, HEC has engaged Miah Environmental Monitoring Center (MEMC) for carrying out monitoring of implementation of EMP of the project vide work order dated 16.12.15. Thus HEC has referred to the EMP of the Project relating to the Post construction tasks with the work order. According to the scope of work, MEMC was responsible for performing the Environmental Perimeter Tests (EPT) and providing Test Analysis and Reporting for Environmental Management Plan in quarterly and yearly basis. MEMC is thus submitting its yearly report after completion of every work and by gathering all the relevant information for EMP from HEC. It has been given to understand that HEC has to submit the same to GTCL for obtaining of final approval from DOE.

In pursuant to same, Miah Environmental Monitoring Center (MEMC) deployed its Specialist Team and mobilized with equipment & tools to Project area on January 1 & 2, 2016 and conducted the stack emission, ambient air and noise tests at Site. Samples of surface and ground water and soil were also collected for testing at respective designated laboratories in Dhaka.

Stack emission, ambient air quality parameters were determined in the Site with help of the fine particulate sampler and the high volume sampler. Noise level was measured by noise level meter. Stack Emission, Ambient Air, Noise, Water, & Soil quality parameters were analyzed in the Atomic Energy Center (AEC), Department of Public Health Engineering (DPHE) Central Laboratory and Soil Resources Development Institute (SRDI) Laboratory respectively.

Procedural details including test results with comments thereof have been provided in the report and the findings and observations from the analysis of test results are placed below in brief:

1. There is no fixed standard for stack emission quality by DOE of compressor station.

2. The ambient air quality (SPM, SO\(_2\), NO\(_x\), CO, Total Hydrocarbon Content) were satisfactory and within the allowable limit specified by DOE. There is no standard as yet for content of Total Hydrocarbon to refer to.

3. The measurement of noise level around the area was found within the allowable limit in daytime and also at night time according to the guidelines of Industrial Zone by DOE.

4. The analysis result of the soil test shows that Calcium and magnesium contents are very high and Zinc contents is high too. Since there is no fixed standard for soil quality so far as environmental impact is concerned, the test results so obtained would serve as a record and reference for future.

5. Ground water quality was analyzed in the DPHE Laboratory. From the analysis it is found that the ground water test results are within the allowable limit specified by DOE except for the content of iron & manganese.

The objections to iron are primarily organoleptic, but there has been recent medical concern about high levels in drinking water. So, for removal of the iron from water by installation of iron removal unit shall be studied.

Even though the concentration of manganese is higher than that of DOE standard, yet it stands below WHO guideline value of 0.5 mg/l. In other words, the present value of manganese being 0.44 mg/l, it’s well within safe range of WHO Guideline.

6. Surface water quality was analyzed in the DPHE Laboratory. From the analysis it is found that the surface water quality is satisfactory and within the allowable limit specified by DOE. There is no standard for salinity, Turbidity & Coliform (Fecal) to refer to.

In addition to the foregoing tasks, MEMC has reviewed the Health and Safety of workers and surrounding people as per work order for the EPTs and relating to the EMP of HEC.
Yearly Environmental Monitoring Report

of
Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

This report consists of Environmental Perimeter Tests (EPTs) which include sampling and analysis of the test results of different parameters as outlined in the EMP Ashuganj Compressor Station of GTCL located adjacent to its Ashuganj Gas Manifold Station Complex Ashuganj, Brahmanbaria.

A) Stack Emission Monitoring
B) Ambient Air Monitoring
C) Noise Monitoring
D) Soil Monitoring
E) Ground Water Monitoring
F) River Water Monitoring
G) Monitoring Habitat Quality for Vegetation and Wildlife Communities
H) Health and Safety of workers and surrounding people

A) Stack Emission Monitoring

A sample from Stack Emission monitoring point of Ashuganj CS was collected on 1st January 2016 to analyze SPM, SO\textsubscript{2}, NO\textsubscript{2} & Carbon Monoxide. Stack height is 75 feet. The analyses of the parameters have been done in Atomic Energy Commission Laboratory, Dhaka and results dated 10th January 2016 has been placed in the report.

PICTURES OF STACK EMISSION SAMPLING AND GPS LOCATION MONITORING

Table- 1: Stack Emission Monitoring Point and Location

<table>
<thead>
<tr>
<th>Identity No.</th>
<th>Location</th>
<th>GPS Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point-1</td>
<td>Ashugonj CS</td>
<td>24° 01.818 N &amp; 090° 59.548 E</td>
</tr>
</tbody>
</table>
### Analysis Results:

**Table - 2: Stack Emission Monitoring Report**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Parameter for Analysis</th>
<th>Unit</th>
<th>Test Result of Point 01</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SPM</td>
<td>milligram per cubic meter</td>
<td>0.435</td>
</tr>
<tr>
<td>2</td>
<td>NO\textsubscript{X}</td>
<td>milligram per cubic meter</td>
<td>1.23</td>
</tr>
<tr>
<td>3</td>
<td>SO\textsubscript{2}</td>
<td>milligram per cubic meter</td>
<td>0.50</td>
</tr>
<tr>
<td>4</td>
<td>Carbon Monoxide</td>
<td>milligram per cubic meter</td>
<td>Nil</td>
</tr>
</tbody>
</table>


**Comments**

There is no DoE/Bangladesh standard of stack emission for compressor station.

**B) Ambient Air Monitoring**

A sample from Ambient Air monitoring point of Ashuganj CS was collected on 1\textsuperscript{st} January 2016 to analyze SPM, SO\textsubscript{2}, NO\textsubscript{X}, Carbon Monoxide & Total Hydrocarbon Content. The analyses of the parameters have been done in Atomic Energy Commission Laboratory, Dhaka and results dated 10\textsuperscript{th} January 2016 has been placed in the report.

**Pictures of Ambient Air Sampling and GPS Location Monitoring**

**Table-3: Standard for Ambient Air**

The Ambient Air standards in Bangladesh as per Department of Environment suggest standards for different categories of areas (see the following table).

Density in microgram per cusec meter (cubic meter)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Categories of area</th>
<th>Suspended Particulate Matters (SPM)</th>
<th>Sulphur dioxide</th>
<th>Carbon Monoxide</th>
<th>Oxides of Nitrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Industrial and Mixed</td>
<td>500</td>
<td>120</td>
<td>5000</td>
<td>100</td>
</tr>
<tr>
<td>B</td>
<td>Commercial and Mixed</td>
<td>400</td>
<td>100</td>
<td>5000</td>
<td>100</td>
</tr>
</tbody>
</table>
According to the location of the most part would fall under ‘A’ category, which is ‘Industrial and Mixed area”. No data should exceed the Bangladesh regulatory limit.

Notes:

1. At national level, sensitive area includes monuments, health cancer, hospital, archeological site, educational institute, and government designated areas (if any).

2. Industrial units located in areas not designated as industrial areas shall not discharge pollutants which may contribute to exceeding the standard for air surrounding the area specified at sl. Nos. c and d above.

3. Suspended Particulate Matter means air borne particles of a diameter of 10 micron or less.

The sampling points are listed in the table below.

**Table- 4: Ambient Air Monitoring Point and Location**

<table>
<thead>
<tr>
<th>Identity No.</th>
<th>Location</th>
<th>GPS Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point-1</td>
<td>Ashuganj CS</td>
<td>24° 01.796 N &amp; 090° 59.607 E</td>
</tr>
</tbody>
</table>

**ANALYSIS RESULTS:**

**TABLE - 5: AMBIENT AIR MONITORING REPORT**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Parameter for Analysis</th>
<th>Bangladesh Standard (Industrial and Mixed Area)</th>
<th>Test Result of Point 01</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SPM</td>
<td>500 microgram per cubic meter</td>
<td>326</td>
</tr>
<tr>
<td>2</td>
<td>SO₂</td>
<td>120 microgram per cubic meter</td>
<td>0.039</td>
</tr>
<tr>
<td>3</td>
<td>NOₓ</td>
<td>100 microgram per cubic meter</td>
<td>87</td>
</tr>
<tr>
<td>4</td>
<td>Carbon Monoxide</td>
<td>5000 microgram per cubic meter</td>
<td>&lt;100</td>
</tr>
<tr>
<td>5</td>
<td>Hydrocarbons</td>
<td>Naphthalene microgram per cubic meter</td>
<td>1.527</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Phenanthrene microgram per cubic meter</td>
<td>0.909</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anthracene microgram per cubic meter</td>
<td>0.441</td>
</tr>
</tbody>
</table>

Note: Ambient Air Quality Tested from Atomic Energy Commission (Test report as Annex-II). Point-(Ashuganj CS).

**Result Summary**

The analysis results fully comply with the DoE standards. All the parameters are much lower than the allowable limit. There is no standard of Total Hydrocarbon Content.
C) Noise Monitoring

Four representative points of Noise monitored Ashuganj CS were collected on 1st January 2016 to analyze Noise level. The analyses of the parameters have been done in Atomic Energy Commission Laboratory, Dhaka and results dated 10th January 2016 has been placed in the report.

**PICTURES OF NOISE AND GPS LOCATION MONITORING**

![Picture of North East Corner of Ashuganj CS Noise Sampling](image1)

![Picture of Ashuganj CS GPS Location Monitoring](image2)

![Picture of South East Corner of Ashuganj CS Noise Sampling](image3)

![Picture of Ashuganj CS GPS Location Monitoring](image4)

![Picture of South West Corner of Ashuganj CS Noise Sampling](image5)

![Picture of Ashuganj CS GPS Location Monitoring](image6)

![Picture of North West Corner of Ashuganj CS Noise Sampling](image7)

![Picture of Ashuganj CS GPS Location Monitoring](image8)
The Ambient Noise standards in Bangladesh as per Department of Environment suggest standards for different categories of areas (see the following table).

**Table- 6: Standard for Ambient Noise**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Category of areas</th>
<th>Standards determined at dBA unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Silent zone</td>
<td>45 35</td>
</tr>
<tr>
<td>B</td>
<td>Residential area</td>
<td>50 40</td>
</tr>
<tr>
<td>C</td>
<td>Mixed area (mainly residential area, and also simultaneously used for commercial and industrial purpose)</td>
<td>60 50</td>
</tr>
<tr>
<td>D</td>
<td>Commercial area</td>
<td>70 60</td>
</tr>
<tr>
<td>E</td>
<td>Industrial area</td>
<td>75 70</td>
</tr>
</tbody>
</table>

According to the area the most part would fall under ‘E’ category, which is ‘Mixed area”. No data exceed the Bangladesh regulatory limit.

- **Notes:**
  1. The time from 6 a.m. to 9 p.m. counted as day time.
  2. The time from 9 p.m. to 6 a.m. counted as night time.
  3. Area up to a radius of 100 meters around hospitals or educational institutions or special institutions/ establishment identified/ to be identified by the Government is designated as Silent Zones where use of horns of vehicles or other audio signals, and loudspeakers are prohibited.

The sampling points are listed in the table below.

**Table-7: Noise Monitoring Point and Location**

<table>
<thead>
<tr>
<th>Identity No.</th>
<th>Location</th>
<th>GPS Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point-1</td>
<td>North East Corner of Ashuganj CS</td>
<td>24° 01.844N &amp; 090° 59.654E</td>
</tr>
<tr>
<td>Point-2</td>
<td>South East Corner of Ashuganj CS</td>
<td>24° 01.773N &amp; 090° 59.606 E</td>
</tr>
<tr>
<td>Point-3</td>
<td>South West Corner of Ashuganj CS</td>
<td>24° 01.813N &amp; 090° 59.532 E</td>
</tr>
<tr>
<td>Point-4</td>
<td>North West Corner of Ashuganj CS</td>
<td>24° 01.871N &amp; 090° 59.570 E</td>
</tr>
</tbody>
</table>

**ANALYSIS RESULTS:**

**Table – 8: Noise Monitoring Report**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Point</th>
<th>Bangladesh Standard</th>
<th>Test Time</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>North East Corner of Ashuganj CS</td>
<td>Day Time 75 dBA</td>
<td>6.00am</td>
<td>72.7±2.7dBA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Day Time 75 dBA</td>
<td>02.00pm</td>
<td>72.5±1.1dBA</td>
</tr>
</tbody>
</table>
### Design-Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj

**Result Summary**

The analysis results fully comply with the DoE standards. Therefore, it can be concluded that the noise is not creating any harm to the environment in terms of noise quality.

**D) 1) Soil Pollution Monitoring**

Samples from one soil point of Ashuganj CS was collected on 1st January 2016 to analyze pH, Organic Matters, Total Nitrogen, Potassium, Calcium, Magnesium & Zinc. The analyses of the parameters have been done in Soil Resource Development Institute Central Laboratory, Dhaka and result dated 20th January 2016 has been placed in the report.

### PICTURES OF SOIL SAMPLING AND GPS LOCATION MONITORING

![Picture of Ashuganj CS Soil Sampling](image)

![Picture of Ashuganj CS GPS Monitoring](image)

The sampling point is listed in the table below.

<table>
<thead>
<tr>
<th>Identity No.</th>
<th>Location</th>
<th>GPS Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point-1</td>
<td>Ashuganj CS</td>
<td>24° 01.790N &amp; 090° 59.609 E</td>
</tr>
</tbody>
</table>
**ANALYSIS RESULTS:**

**TABLE - 10: SOIL QUALITY ANALYSIS REPORT**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Parameter for Laboratory Analysis</th>
<th>Test Result of Point -1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>7.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Slightly Alkalinity</td>
</tr>
<tr>
<td>2</td>
<td>Organic Maters</td>
<td>0.61 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very Low</td>
</tr>
<tr>
<td>3</td>
<td>Total Nitrogen</td>
<td>0.031 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very Low</td>
</tr>
<tr>
<td>4</td>
<td>Potassium</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>5</td>
<td>Calcium</td>
<td>10.37 meq/100gm soil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very High</td>
</tr>
<tr>
<td>6</td>
<td>Magnesium</td>
<td>2.30 meq/100gm soil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very High</td>
</tr>
<tr>
<td>7</td>
<td>Phosphorus</td>
<td>8.73 µg/g (ppm)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>8</td>
<td>Zinc</td>
<td>1.85 µg/g (ppm)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
</tr>
</tbody>
</table>

Note: Soil Quality Test from SRDI Laboratory (Test report as Annex-IV). Sample ID # Ashuganj CS.

**Result Summary**

The analysis result of the soil test shows that Calcium and magnesium contents are very high and Zinc contents is high too. Since there is no fixed standard for soil quality so far as environmental impact is concerned, the test results so obtained would serve as a record and reference for future.

**II) Soil Pollution Inspection**

Inspection of solid and liquid storage tank and safe disposal system on 1st January 2016

**PICTURES OF SOIL POLLUTION INSPECTION AND GPS LOCATION MONITORING**

*Picture of Ashuganj CS Soil Sampling*  
*Picture of Ashuganj CS GPS Monitoring*
Design-Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

The sampling point is listed in the table below.

**Table- 11: Soil Quality Monitoring Point and Location**

<table>
<thead>
<tr>
<th>Identity No.</th>
<th>Location</th>
<th>GPS Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point-1</td>
<td>Ashuganj CS</td>
<td>24° 01.842N &amp; 090° 59.556 E</td>
</tr>
</tbody>
</table>

**TABLE - 12: SOIL & LIQUID WASTE POLLUTION INSPECTION REPORT**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Enhancement Measure</th>
<th>Yes</th>
<th>No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Is soil and liquid waste spread over the project site?</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Is oil storage area paved with the catch drain with line pit?</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Is any spillage on the ground scraped and stored in a container for safe disposal?</td>
<td>√</td>
<td></td>
<td>Closed Container</td>
</tr>
<tr>
<td>4</td>
<td>IS the spillage buried in a pit lined with geo-composite and HDPE liner?</td>
<td>√</td>
<td></td>
<td>No spillage allowed. API separator available at site for handling OWS.</td>
</tr>
</tbody>
</table>

Note: Soil & liquid waste pollution inspection sheet as Annex-V.

**Comments:**

Compressor station has sophisticated and most effective API Oil/Water Separating system. Pit system is not required. All used oil is properly collected in containers and kept in closed containers to avoid spill. As any open oil spillage is not followed the requirement of a separate buried pit. The generated wastes like domestic, metal, wood, hazardous, etc. is collected and properly segregated. The waste generated in station is disposed of to a vendor by GTCL. Only domestic waste which is collected in negligible quantity is burnt safely at a far location away from process area in an open earth pit or safely disposed to a nearby landfill areas designated by GTCL/Local authorities. It can be concluded that the soil and liquid waste is not creating any pollution to the environment.

**E) Ground Water Monitoring**

Sample from one ground water point Ashuganj CS was collected on 7th March 2016 to analyze Arsenic, Iron, Chloride & Manganese. The analyses of the parameters have been done in DPHE Central Laboratory, Dhaka and results dated 16th March 2016 has been placed in the report.

**PICTURES OF GROUND WATER SAMPLING AND GPS LOCATION MONITORING**

Picture of Ashuganj CS Points Water Sampling  
Picture of Ashuganj CS GPS Location Monitoring
The sampling points are listed in the table below.

**Table- 13: Ground Water Quality Monitoring Point and Location**

<table>
<thead>
<tr>
<th>Identity No.</th>
<th>Location</th>
<th>GPS Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point-1</td>
<td>Ashuganj CS</td>
<td>24° 01.805N &amp; 090° 059.592 E</td>
</tr>
</tbody>
</table>

**ANALYSIS RESULTS:**

**TABLE - 14: GROUND WATER QUALITY ANALYSIS REPORT**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Parameter for Laboratory Analysis</th>
<th>Bangladesh Standard (Drinking Water)</th>
<th>Test Result of Point -1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Arsenic</td>
<td>0.05 mg/L</td>
<td>0.005</td>
</tr>
<tr>
<td>2</td>
<td>Chloride</td>
<td>150-600 mg/L</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>Iron</td>
<td>0.3-1.0 mg/L</td>
<td>3.4</td>
</tr>
<tr>
<td>4</td>
<td>Manganese</td>
<td>0.1 mg/L</td>
<td>0.44</td>
</tr>
</tbody>
</table>

Note: Water Quality Test from DPHE Central Laboratory (Test report as Annex-VI). Sample ID #1(Ground water of Ashuganj CS).

**Result Summary**

Ground water quality was analyzed in the DPHE Laboratory. The analysis result of the ground water listed in the Table-14 shows that all the parameter test results are within the drinking water standard limit except those of iron and manganese.

The objections to iron are primarily organoleptic, but there has been recent medical concern about high levels in drinking water. So, for removal of iron from water by installation of iron removal unit shall be studied.

Even though the concentration of manganese is higher than that of DOE standard, yet it stands below WHO guideline value of 0.5 mg/l. In other words, the present value of manganese being 0.44 mg/l, it’s well within safe range of WHO Guideline.

**F) Surface Water Monitoring**

Sample from one Surface water point Near Ashuganj CS was collected on 2nd January 2016 to analyze pH, Salinity, Turbidity, TDS, TSS, DO, COD, BOD, Oil & Grease & Coliform (Fecal). The analyses of the parameters have been done in DPHE Central Laboratory, Dhaka and results dated 12th January 2016 has been placed in the report.

**PICTURES OF SURFACE WATER SAMPLING AND GPS LOCATION MONITORING**

![Picture of Surface Water Sampling at Near Ashuganj CS](image1.png)

![Picture of Surface Water GPS Location Monitoring](image2.png)
The sampling points are listed in the table below.

**Table- 15: Surface Water Quality Monitoring Point and Location**

<table>
<thead>
<tr>
<th>Identity No.</th>
<th>Location</th>
<th>GPS Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point-1</td>
<td>Surface water point Near Ashuganj CS</td>
<td>24° 01.977N &amp; 090° 59.248 E</td>
</tr>
</tbody>
</table>

**Analysis Results:**

**Table - 16: Surface Water Quality Analysis Report**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Parameter for Laboratory Analysis</th>
<th>Bangladesh Standard (Drinking Water)</th>
<th>Test Result of Point -1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>6-9</td>
<td>7.7</td>
</tr>
<tr>
<td>2</td>
<td>Salinity</td>
<td>0/%</td>
<td>0.05</td>
</tr>
<tr>
<td>3</td>
<td>Turbidity</td>
<td>JTU</td>
<td>22</td>
</tr>
<tr>
<td>4</td>
<td>TDS</td>
<td>2100 mg/L</td>
<td>48</td>
</tr>
<tr>
<td>5</td>
<td>TSS</td>
<td>150 mg/L</td>
<td>13</td>
</tr>
<tr>
<td>6</td>
<td>DO</td>
<td>4.5-8 mg/L</td>
<td>6.10</td>
</tr>
<tr>
<td>7</td>
<td>COD</td>
<td>200 mg/L</td>
<td>20</td>
</tr>
<tr>
<td>8</td>
<td>BOD</td>
<td>50 mg/L</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>Oil &amp; Grease</td>
<td>10 mg/L</td>
<td>0.20</td>
</tr>
<tr>
<td>10</td>
<td>Coliform (Fecal)</td>
<td>n/100ml</td>
<td>31</td>
</tr>
</tbody>
</table>

Note: Water Quality Test from DPHE Central Laboratory (Test report as Annex-VII). Sample ID # 1(Surface water point Near Ashuganj CS).

**Result Summary**

The analysis result of the surface water listed in the Table-16 shows that all the parameters are within the standard limit. There is no standard salinity, Turbidity & Coliform (Fecal).

**G) Monitoring Habitat Quality for Vegetation and Wildlife Communities**

All the parameters (regarding air, water, noise and soil testing) are within the limit of the DoE standard except ground waters iron and manganese. So it can be concluded that the compressor station plant itself not harming and/or reducing the habitat quality for vegetation and wildlife communities to the nearby homesteads.

**H) Health and Safety of workers and surrounding people**

It has been revealed during discussion with HEC officials at site that many times workers did not adhere to personal protective equipment (PPE) requirements because they felt it was a nuisance to wear or slows them down during a task. But, in course of time and due to continued vigilance from HEC and GTCL officials and their consultants, the situation changed. The safety awareness campaign with the slogan- “Always Safety First” turned everyone at work site within the Compressor Station compound at Ashuganj, Brahmanbaria. To wear personal protective
equipment (PPE) is a practice now and used always. It is their realization that any even unprecedented hazard may cause injury and failing to use the prescribed PPE puts the worker in a potential danger. Thus it is in use not only when some type of hazard has been identified and cannot be eliminated or controlled through other means but also at all times at the work places. In support of these statements HEC safety department has handed out some Pictures in evidence of Health and Safety compliance by their working crew at different work places:
It was also divulged by the Safety official of the HEC that Health & Safety and Fire Fighting Trainings have been and are a regular Practice that conducted by Hyundai Engineering's HSE Team at Project Site. In support of these statements HEC safety department has handed out some more Pictures in evidence of Health and Safety Fire Fighting Trainings that have been conducted by HEC to their working crew at different work places:
Health & Safety and Fire Fighting Training sessions by Hyundai Engineering’s HSE Team at Project Site.

In support of their plea of ensuring good hygiene and sanitation to their working crew and professionals at the work places, HSE department also handed out some more Pictures of Septic Tanks & Soak Pits installed at different work places:

Proper Sanitation Facilities Installed and Well Maintained by HEC inside the Project Site

Fire is probably the biggest threat to life that most people face at work. It can lead to immense damage, serious injuries, and death. It is critically important to minimize the risk of fires in the workplace. Therefore it was required that fire fighting Equipments and Fire Hydrants were installed inside the Project Plant Area to cover every single point. Some pictures of such installations are shown in the following pictures:

Different Fire Fighting Equipments & Fire Hydrant installed to cover different parts of the Project Plant Area.
As a part of Health, Safety and Environmental compliances, the safety department divulged that HEC conducts awareness campaign and often use microphone system to attract attention of the working crew and the inhabitants of the neighbourhood. The pictures in that perspective as provided by them are placed below:
Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

Comments

It appeared from ocular inspection and discussion with the HSE team of HEC that all of their personnel of compressor station use PPE, they are aware about health & safety and firefighting. Compressor station maintains proper sanitation and builds awareness to surrounding people.

Conclusion:

This plant is currently in its operation phase since commencement of its commercial. The proceedings of the monitoring as far as EPTs are concerned and so adopted by MEMC have been as per the methodologies outlined earlier in conducting tests for standard test results. The priorities preferred by the clients in selecting the recognized laboratories have been hold in high esteem too. The Environmental Management including EHS at plant level being the responsibility of the Plant’s management, the purpose of monitoring by the MEMC has been to ensure that it is being done by the HECs Plant management properly. In doing so, MEMC’s team of officials visited the site for their yearly monitoring and talked with its management and field personnel during 01st & 2nd January, 2016.

This visit was undertaken in accordance with the work order of MEMC and was pre-scheduled in consultation with the Project Personnel. Apart from the ocular inspection of the operational functioning of the plant, the team also collected the samples of the EPs for the tests in the field and in the laboratories during their said visit. Evaluation narratives of the results of the EPT with comments and recommendations have been placed in the report.

Further, certain issues relating to Health and Safety of workers and surrounding people have also been incorporated in the report with reference to cover the EMP compliances by the HEC. In doing so, the pictures and statements provided by the HEC officials in respect of, Health, Safety and Fire Fighting Trainings, Different Types of Fire Fighting Equipment & Fire alarm systems installed inside the Plant Area and the HSE compliances awareness campaign conducted by HEC for crew and the neighborhood.

In concluding, MEMC wishes to express its deep gratitude and thanks to the management of Hyundai Engineering Company Limited and all those who have extended their support and cooperation both at the sites & the laboratories in completing this task.
Annex-I: Air Emission Monitoring Result from Atomic Energy Centre
TEST RESULTS OF STACK EMISSION

SAMPLEING SITE DESCRIPTION

1. Sampling location : Air Emission from Stack, Ashuganj Gas Transmission Pipeline Compressor Station

2. Date of sampling : 1 January, 2016

ANALYSIS

The suspended particulate matter (SPM) concentration was measured by collecting sample on Teflon filter using Airmetrics portable sampler and subsequent gravimetric analysis using microbalance. The NO₂ and SO₂ samples were collected on impinger using GENT sampler. CO concentration was measured using CO monitor.

RESULTS

<table>
<thead>
<tr>
<th>Sample Description</th>
<th>SPM</th>
<th>NO₂</th>
<th>SO₂</th>
<th>CO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission conc.</td>
<td>0.435</td>
<td>1.23</td>
<td>0.50</td>
<td>Nil</td>
</tr>
<tr>
<td>Duration of sampling</td>
<td>30 minute</td>
<td>30 minute</td>
<td>30 minute</td>
<td>30 minute</td>
</tr>
</tbody>
</table>

(Dr. Bilkis Ara Begum)  
Head, Chemistry Division
Annex-II: Ambient Air Monitoring Result from Atomic Energy Centre
TEST RESULTS OF AMBIENT AIR QUALITY MONITORING

SAMPLEING SITE DESCRIPTION

1. Sampling location: Inside Ashuganj Gas Transmission Pipeline Compressor Station

2. Date of sampling: 1 January, 2016

ANALYSIS

The suspended particulate matter (SPM) concentration was measured by collecting sample on Nitro Cellulose filter using Airmetric portable sampler and subsequent gravimetric analysis using microbalance. The total hydrocarbon concentration was measured using GC-MS (Model CP-3800, Saturn-2200). The SO$_2$ and NO$_2$ samples were collected on impinger (For SO$_2$ the absorbing reagent is mercuric chloride and sodium chloride and for NO$_2$, the absorbing reagent is sodium hydroxide and sodium arsenite) using GENT sampler and CO concentrations were determined using CO monitor.

RESULTS

<table>
<thead>
<tr>
<th>Sampling Date</th>
<th>SPM</th>
<th>Hydrocarbons</th>
<th></th>
<th>SO$_x$</th>
<th>NO$_x$</th>
<th>CO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Naphthalene</td>
<td>Phenanthrene</td>
<td>Anthracene</td>
<td>µg/m$^3$</td>
<td></td>
</tr>
<tr>
<td>01/01/16</td>
<td>326</td>
<td>1.527</td>
<td>0.909</td>
<td>0.441</td>
<td>0.039</td>
<td>87</td>
</tr>
<tr>
<td>ECR 1997</td>
<td>500</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>120</td>
<td>100</td>
</tr>
</tbody>
</table>

OBSERVATION

- The ambient SPM, SO$_x$, NO$_x$ and CO concentrations are compliant with ECR 1997.

(Dr. Bilkis Ara Begum)
Head, Chemistry Division
Annex-III: Noise Monitoring Result Sheet from Atomic Energy Centre
NOISE LEVEL AT PLANT SITES

SAMPLEING SITE DESCRIPTION

1. Sampling location: Ashuganj Gas Transmission Pipeline Compressor Station
2. Date of sampling: 1 January, 2016

NOISE LEVEL MONITORING

The noise level is monitored using Sound Level Meter (Model No SL 4012) which is calibrated using Tenna 72-945 (NEDA-1604 IFC-6F22). The noise level at plant sites are presented in Table 1. The noise levels of plants sites are lower than the ECR 1997.

Table 1: Sound monitoring at four corner of Compressor Station

<table>
<thead>
<tr>
<th>Direction</th>
<th>6am</th>
<th>2pm</th>
<th>10pm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>72.7±2.7</td>
<td>72.5±1.1</td>
<td>68.1±1.4</td>
</tr>
<tr>
<td>Southeast</td>
<td>71.6±1.0</td>
<td>71.9±0.9</td>
<td>68.9±0.8</td>
</tr>
<tr>
<td>Southwest</td>
<td>67.0±0.4</td>
<td>67.8±1.0</td>
<td>67.7±0.7</td>
</tr>
<tr>
<td>Northwest</td>
<td>71.1±1.3</td>
<td>71.3±1.2</td>
<td>68.5±1.2</td>
</tr>
<tr>
<td><strong>ECR 1997</strong></td>
<td><strong>75</strong></td>
<td><strong>75</strong></td>
<td><strong>70</strong></td>
</tr>
<tr>
<td><strong>(Industrial area)</strong></td>
<td><strong>Day time</strong></td>
<td><strong>Day time</strong></td>
<td><strong>Night time</strong></td>
</tr>
<tr>
<td></td>
<td>(6am – 9pm)</td>
<td>(6am – 9pm)</td>
<td>(9pm-6am)</td>
</tr>
</tbody>
</table>

OBSERVATION

- Noise level monitoring data is compliant the National Noise Level Standards (ECR 1997) of Industrial site.

[Signature]

(Dr. Bilkis Ara Begum)
Head, Chemistry Division
Annex-IV: Soil Monitoring Result Sheet from SRDI Laboratory
Government of the People's Republic of Bangladesh
Soil Resource Development Institute
Central Laboratory
Krishi Khamar Sarak, Dhaka.

No: Lab/44(2)/03

Date: 20.01.16

To:
Proprietor
Minh Environmental Monitoring Center
Hyundai Engineering Co. Ltd
Design-Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline station at Ashuganj.
House-4, Block-I.
Extension Pallabi
Mirpur, Dhaka.

Subject: Analytical results of 01 soil sample.

The analytical results of soil sample supplied by you are given below:

<table>
<thead>
<tr>
<th>Lab No.</th>
<th>Soil sample No.</th>
<th>pH</th>
<th>Organic Matter</th>
<th>Total Nitrogen</th>
<th>Potassium</th>
<th>Calcium</th>
<th>Magnesium</th>
<th>Phosphorus</th>
<th>Zine</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>1</td>
<td>7.7</td>
<td>0.61</td>
<td>0.031</td>
<td>0.10</td>
<td>10.37</td>
<td>2.30</td>
<td>8.73</td>
<td>1.85</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Slightly Alkaline</td>
<td>Very Low</td>
<td>Very Low</td>
<td>Low</td>
<td>Very High</td>
<td>Very High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Md Nazmul Hasan)
Principal Scientific Officer
Phone: 9110507
Email: hasanmnazmul@gmail.com

Copy: 1. Office Copy.
Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

Annex-V: Soil & Liquid waste Inspection Form
Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

# Soil & Liquid Waste Pollution Inspection Form

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Enhancement Measure</th>
<th>Yes</th>
<th>No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Is soil and liquid waste spread over the project site?</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Is oil storage area paved with the catch drain with line pit?</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Is any spillage on the ground scraped and stored in a container for safe disposal?</td>
<td>✓</td>
<td></td>
<td>Closed Container</td>
</tr>
<tr>
<td>4</td>
<td>Is the spillage buried in a pit lined with geo-composite and HDPE liner?</td>
<td></td>
<td>✓</td>
<td>No spillage allowed, API supervisor available at site for handling.</td>
</tr>
</tbody>
</table>

Monitored by:

(Syd. Syaam Siddique)
Monitoring Officer
Miah Environmental Monitoring Center
Annex VI: Ground Water Quality Analysis Result Sheet from DPHE Laboratory
**Physical /Chemical/ Bacteriological Analysis of Water Sample**

<table>
<thead>
<tr>
<th>Sample ID: CEN(2016)03/148</th>
<th>Sample Receiving date: 04/02/2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ref. Memo No: MEMC/2016/Mil &amp; Dated: 07/03/2016</td>
<td>Sample Source: Ground Water</td>
</tr>
<tr>
<td>Sent by Proprietor, Meh Environmental Monitoring Center, Hyundai Engineering Co., Ltd.</td>
<td>Dest: Brahmanbaria, Upa/Ashuganj</td>
</tr>
<tr>
<td>Care Taker: Ashugang Gas Transmission Pipeline</td>
<td>Union: Ashugang, VIl.</td>
</tr>
<tr>
<td>Sample Collection date: 07/03/2016</td>
<td>Date of Testing: 04/03/2016 - 16/03/2016</td>
</tr>
</tbody>
</table>

**LABORATORY TEST RESULTS:**

<table>
<thead>
<tr>
<th>SL#</th>
<th>Water quality parameters</th>
<th>Bangladesh Standard</th>
<th>Concentration present</th>
<th>Unit</th>
<th>Analysis Method</th>
<th>LOQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Arsenic (As)</td>
<td>0.05</td>
<td>0.005</td>
<td>mg/L</td>
<td>AAS</td>
<td>0.001</td>
</tr>
<tr>
<td>2</td>
<td>Chlorides</td>
<td>150-600</td>
<td>18</td>
<td>mg/L</td>
<td>Titrimetric</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Iron (Fe)</td>
<td>0.3-3</td>
<td>3.4</td>
<td>mg/L</td>
<td>AAS</td>
<td>0.05</td>
</tr>
<tr>
<td>4</td>
<td>Manganese (Mn)</td>
<td>0.1</td>
<td>0.44</td>
<td>mg/L</td>
<td>AAS</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Comments: Sample was collected & Supplied by client.
N.B: AAS - Atomic Absorption Spectrophotometer, LOQ - Limit of Quantitation.

Test Performed by:
1. Name: Mahbubul Sabrina Motin
   Designation: Sample Analyzer

2. Name: Md. Saiful Islam Khan
   Designation: Sample Analyzer

Countersigned/Approved by:
1. Name: Md. Biplab Hossain
   Designation: Senior Chemist

2. Name: 
   Designation: 

Signature: 

Date: 16-03-16
Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas
Transmission Pipeline Compressor Station at Ashuganj.

Annex-VII: Surface Water Quality Analysis Result Sheet from DPHE Laboratory
**LABORATORY TEST RESULTS:**

<table>
<thead>
<tr>
<th>SL #</th>
<th>Water quality parameters</th>
<th>Bangladesh Standard</th>
<th>Concentration present</th>
<th>Analysis Procedure</th>
<th>LOQ</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Physical &amp; Aggregate Properties</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>pH</td>
<td>6.5 - 8.5</td>
<td>7.7</td>
<td>pH Meter</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Colour</td>
<td>15 Hazen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Temperature</td>
<td>20-30°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Salinity</td>
<td>– %   ©</td>
<td>0.05 %   ©</td>
<td></td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>Odour</td>
<td>Odourless</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>Turbidity</td>
<td>10 NTU</td>
<td>22 NTU</td>
<td>Turbidity meter</td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>Electric Conductivity (EC)</td>
<td>– µs/cm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>08</td>
<td>Total Alkalinity (Methyl)</td>
<td>– mg/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09</td>
<td>Phenolphthalein Alkalinity</td>
<td>– mg/L</td>
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<tr>
<td>10</td>
<td>Total Hardness (as CaCO₃)</td>
<td>200 - 500 mg/L</td>
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<td>11</td>
<td>Oxidation-Reduction Potential (ORP)</td>
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<td>12</td>
<td>Total Dissolved Solid (TDS)</td>
<td>1000.0 mg/L</td>
<td>48 mg/L</td>
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<td>13</td>
<td>Total Suspended Solid (TSS)</td>
<td>10.0 mg/L</td>
<td>13 mg/L</td>
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<td><strong>B. Inorganic Non-metallic Constituents</strong></td>
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<td>14</td>
<td>Phosphate (PO₄) as H₂PO₄</td>
<td>6.0 mg/L</td>
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<td>15</td>
<td>Chlorine (Residual)</td>
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<td>16</td>
<td>Chloride (Cl)</td>
<td>150 - 900 mg/L</td>
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<td>17</td>
<td>Iodine (I)</td>
<td>– mg/L</td>
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<td>Fluoride (F⁻)</td>
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<td>19</td>
<td>Ammonia (NH₃) as Nitrogen</td>
<td>0.50 mg/L</td>
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<td>20</td>
<td>Nitrate (NO₃)</td>
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<td>Nitrite (NO₂) as Nitrogen</td>
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<td>24</td>
<td>Dissolved Oxygen (DO)</td>
<td>6.0 mg/L</td>
<td>6.10 mg/L</td>
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<td>25</td>
<td>Ammonium (NH₄)</td>
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<td>27</td>
<td>Chemical Oxygen Demand (COD)</td>
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<td>30 mg/L</td>
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<td>Biochemical Oxygen Demand (BOD)</td>
<td>0.2 mg/L</td>
<td>5 mg/L</td>
<td>5 Days incubation</td>
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<td>29</td>
<td>Arsenic (As)</td>
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<td>Aluminium (Al)</td>
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<td>Iron (Fe)</td>
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<td>Lead (Pb)</td>
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<td>Magnesium (Mg)</td>
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<td>Selenium (Se)</td>
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<td>44</td>
<td>Sodium (Na)</td>
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<td>45</td>
<td>Zinc (Zn)</td>
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<td>46</td>
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<td>47</td>
<td>Oil &amp; Grease</td>
<td>0.01 mg/L</td>
<td>0.20 mg/L</td>
<td>Oil Content Meter</td>
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<td>48</td>
<td>Silica as SiO₂</td>
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<td>49</td>
<td>Faecal Coliform (FC)</td>
<td>0 n/100ml</td>
<td>31 CFU/100 mL</td>
<td>MFP</td>
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</table>


BDS value has been given on the basis of drinking water.

Comments: sample was collected and supplied by client.

Test performed by:
Name: Mahabuba Sabina Motin
Designation: Sample Analyzer
Signature:

Counter signed by:
Name: Md. Abdus Sattar Miah
Designation: Chief Chemist
Signature:
Annex-VIII: Picture of Ashuganj Compressor Station
Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

Picture of Ashuganj Compressor Station
Annex-IX: Picture of Geographical layout of Ashuganj
Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

Picture of Geographical layout of Ashuganj
Annex-X: Picture of Geographical layout of Ashuganj Compressor Station
Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.
Annex-XI: Overall Plot plan of Ashuganj Compressor Station
Overall Plot plan of Ashuganj Compressor Station
Annex-XII:  Plot plan of Ashuganj Compressor Station
Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

Plot plan of Ashuganj Compressor Station
Annex-XIII: Process flow diagram of Ashuganj Compressor Station
Design—Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.
Process flow diagram of Ashuganj Compressor Station
Process flow diagram of Ashuganj Compressor Station
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Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

Process flow diagram of Ashuganj Compressor Station
Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

Process flow diagram of Ashuganj Compressor Station
Annex-XIV: List of equipments of Ashuganj Compressor Station
Table: List of equipments of Ashuganj Compressor Station
### List of equipments of Ashuganj Compressor Station

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<thead>
<tr>
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<td>C-101A/B/C</td>
<td>COMPRESSOR</td>
<td>3</td>
<td>Centrifugal</td>
<td>750</td>
<td>Suct. [psig] 690</td>
<td>Disch. [psig] 1000</td>
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<td>100-104</td>
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*Note 1: To be confirmed later.*
List of equipments of Ashuganj Compressor Station

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<td>E-101A/BC</td>
<td>AIR COOLER</td>
<td>3</td>
<td>317</td>
<td>1135 200</td>
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<td>C.S.</td>
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<td>Note 1</td>
<td>Note 1</td>
<td>Note 1</td>
<td>Note 1</td>
<td>100-107</td>
<td>A BY PASS CASE</td>
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### List of equipments of Ashuganj Compressor Station

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<tr>
<td>D-101</td>
<td>INLET SCRUBBER</td>
<td>1</td>
<td>VERTICAL</td>
<td>7.2</td>
<td>19.7</td>
<td>1135</td>
<td>185</td>
<td>Shell: CS Internal 3/8 SS</td>
<td>0.118</td>
<td>100-102</td>
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<tr>
<td>D-102A/B</td>
<td>FILTER SEPARATOR</td>
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<td>VERTICAL</td>
<td>7.2</td>
<td>19.7</td>
<td>1135</td>
<td>185</td>
<td>Shell: CS Internal 3/8 SS</td>
<td>0.118</td>
<td>100-103</td>
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**List of equipments of Ashuganj Compressor Station**

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<th>REV.</th>
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<td>0</td>
<td>Feb. 21, 2012</td>
<td>ISSUED FOR INFORMATION</td>
<td>Y.S.PARK</td>
<td>M.S.JEON</td>
<td>W.J.CHOL</td>
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### List of equipments of Ashuganj Compressor Station

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<td>C-131A/8</td>
<td>AIR COMPRESSOR</td>
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<td>Screw</td>
<td>17800</td>
<td>ATM</td>
<td>95</td>
<td>Motor + Gas Engine</td>
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</table>
List of equipments of Ashuganj Compressor Station
### List of equipments of Ashuganj Compressor Station

<table>
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<tr>
<th>Equipment No.</th>
<th>Description</th>
<th>Quantity</th>
<th>Type</th>
<th>Internal Diameter (f)</th>
<th>Length / Height TT (ft)</th>
<th>Design Condition</th>
<th>Material</th>
<th>G.A. (Inch)</th>
<th>P.W.D (Inch)</th>
<th>Rev.</th>
<th>Remarks</th>
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<td>FLARE K.O DRUM</td>
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<td>5</td>
<td>11</td>
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**List of equipments of Ashuganj Compressor Station**

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Note 1: To be confirmed later.
### List of equipments of Ashuganj Compressor Station

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*Note 1: To be confirmed later.*
**List of equipments of Ashuganj Compressor Station**

<table>
<thead>
<tr>
<th>Equipment No.</th>
<th>Description</th>
<th>Quantity</th>
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### List of equipments of Ashuganj Compressor Station

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<td>X-121</td>
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<td>X-161A/B</td>
<td>GAS GENERATOR</td>
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<td>2 x 100% GAS ENGINE GENERATOR, DUTY: 1196 KW</td>
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<td>X-162</td>
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<td>X-181</td>
<td>AIR SEPARATOR</td>
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<td>X-182</td>
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Annex-XV: Health, Safety and Environmental plan
Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.
This page is a record of all revisions of this document. All previous issues are hereby superseded and are to be destroyed.

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<td>Ramesh</td>
<td>D.H. Hahn</td>
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<td>B.K. Kim</td>
<td>Ramesh</td>
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Document Class: Class-II Refer Note-4

NOTES:

(1) The revised portion of the document is shown by a vertical line in the right-hand margin against the revised text.

(2) The revised portion of the document is shown by a triangle symbol for graphics and drawings, the revision number being denoted within the symbol. Revision symbols are positioned adjacent to the revision.

(3) PRED = Prepared by, CHK'D = Checked by, APPR'D = Approved by

(4) Documents are classified into Class-I: For Employer Approval, Class-II: For Employer Review, Class-III: For Employer Information.
### REVISION LOG

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<td>Addition of applicable Standards, laws for ready reference</td>
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<td>Addition of functional organization chart</td>
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<td>1st paragraph, Section 10, Insert “Emergency Evacuation and” after “including”</td>
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INTRODUCTION
The Contractor places a great deal of emphasis on maintaining the highest standards of Health, Safety and Environment (HSE) protection. Compliance with legislation is seen as a minimum objective. The HSE Plan has been developed to provide the necessary guidelines to enable Contractor to effectively manage HSE requirements and conduct its undertakings in such a manner as to minimize any potential HSE effect.

SCOPE
This procedure applies to Gas Compressor Station Project (hereinafter referred to as Project) of Gas Transmission Company Limited (hereinafter referred to as Employer). This HSE Plan is designed to describe various methods and techniques to be followed by the Contractor and his Subcontractor during execution of Compressor Station Project. In order to comply with the latest HSE requirements, the plan will be continuously reviewed and updated as appropriate throughout the Project.

RESPONSIBILITY
3.1 Site Manager
The Site Manager represents Contractor at the Site and directs all the activities carried out on the Project in accordance with the Contract requirements.

The Site Manager’s responsibilities for the site include but not limited to:
1) Assuring that approved HSE procedures are adopted for defining methods and systems to be applied.
2) Assuring that all activities at work sites are carried out in compliance with the contract requirements and HSE Plan and Procedure.
3) Assuring that all local laws, regulations and relevant requirements in matters of HSE are respected.
4) Maintaining HSE relations with Subcontractors, local authorities, Employer and other organizations for HSE related issues.
5) Fully supporting the HSE Manager in the implementation of the HSE plan and procedure.

3.2 Site HSE Manager
The HSE Manager reports directly to Site Manager and will manage following activities:
1) Maintaining and monitoring the implementation of HSE guidelines and procedures
2) Providing HSE awareness training, where required
3) Ensure the development and implementation of site activities described in the HSE Plan and investigate and report all accidents and incidents, if any, on the Project
4) Assisting the Site Manager in all HSE related matters

HYUNDAI ENGINEERING CO., LTD.
Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

5) Manages the HSE Organization at Site
6) Ensure that all activities regarding work safety and hygiene are carried out in accordance with the HSE plan
7) Assisting the Project Management Team in the analysis and approval of each Subcontractors’ HSE Plan, associated Method Statements and Safe Working Procedures
8) Overviewing Subcontractors’ activities in compliance with the laws, regulations, and other relevant requirements
9) Liasing with Office of Safety and Environmental Management, Contractor Head Office

3.3 Site HSE Officers/Engineers

The HSE Officers report to the HSE Manager and will manage the following activities. The HSE Officers will assist the HSE Manager by ensuring that the provisions of the HSE Plan and other HSE related requirements are correctly complied with by Contractor personnel and Subcontractors in each working area. They ensure direct supervision and coordination of the Subcontractors’ activities through day to day contacts with them to deal with any HSE related matters.

The HSE Officers’ general responsibilities include, but not limited to:

1) Verifying that all the workforce under Contractor’s, direct or indirect responsibility receive appropriate HSE information, induction and training, including supervision and control on the HSE training program by Subcontractors.
2) Advising the HSE Manager of any necessary required actions to improve working and living conditions in the field under their individual responsibility.
3) Organizing, managing and recording of HSE meetings with Subcontractors as per the HSE meetings program.
4) Ensuring adequate levels of working and living conditions by means of regular inspections on housekeeping, hygiene, potable water system, kitchens and canteens, sewer system and waste disposal etc.
5) Leading accident, incident investigations and attending any accident investigation in areas under their responsibility and reporting on them to the HSE Manager.
6) Organizing and managing the first aid kits in areas under their control.
7) Overviewing execution of the Waste Management.

3.4 Supervisors

Supervisors generally assist the Construction Manager / Section Manager in the execution of their duties. The supervisors’ general responsibilities include, but are not limited to:

1) Being familiar with the requirements and recommendations for Safe Working Practices and Method Statements etc. applicable to their work place and ensure that they are enforced.
2) Incorporating HSE instructions into the routine day to day orders and make sure they are understood and obeyed.
3) Preventing site persons from taking unnecessary risks.
4) Ensuring that all operatives/labor are suitably trained for the work in which they will be engaged.
5) Ensuring that all employees, sub-contractors personnel adopt correct HSE precautions.
6) Checking that all plant and equipment, including power and hand tools are maintained in a good condition and remove from use any defective items.
7) Maintaining organized tidy and safe working areas.
8) Maintaining all welfare facilities in a clean and safe condition.
9) Ensuring that all operatives/labor are provided with and use approved personal protective equipment.
10) Ensuring that instructions are given in the use of any potentially hazardous materials.
11) Ensuring that other persons including Employer’s representatives, other contractors and members of the public are protected from the work activities of Contractor and its sub-contractors.
12) Discouraging horseplay and take actions against those who consistently fail to take care of their own Health and Safety and of other persons working with them or in the vicinity.
13) Stopping any activity on site if there is an immediate risk of injury to any site personnel, or the possibility of a dangerous occurrence happening.
14) Setting a personal example.
15) Participate in any accident/Incident investigation.

3.5 Subcontractors and Vendors

Every Subcontractor / Vendor working on the Project shall:
1) Comply with all Safety and Environmental protection laws and other requirements.
2) Comply with this HSE Plan, HSE requirements and Procedures. These are to be observed as minimum requirements.
3) Submit HSE Plan to Contractor for approval.
4) Include in the Subcontractor Site Organization, the HSE supervisor as the key personnel (directly reporting to the Site Manager). He shall assist the Site Manager in assuring that all activities in the Subcontractors / Vendors scope of works are carried out in accordance with the laws and regulations of HSE requirements.
5) Ensure that their own organization at Site include an adequate number (with respect to the total Subcontractors workforce) of HSE Officers, entitled to assist the HSE
Supervisor and survey and enforce suitable application of HSE procedures during the execution of the works.

6) Ensure that all of their own personnel are aware of HSE requirements arising from laws, regulations and the Contract and observe them by planning appropriate HSE training of their personnel and any of their Subcontractors on the Project.

7) Identify and analyze all job hazards for their workforce, apply all necessary preventative and protective measures and issue personal protective equipment to them as necessary for the work to be performed.

8) Ensure regular recorded site HSE inspections are conducted for maintenance of installations, plant equipment, work tools and Personal Protective Equipment, with the objective of identifying any potential hazard.

9) Cooperate with Contractor in investigating incidents, accidents to identify and enforce corrective actions to prevent recurrence.

10) Attend HSE meetings and comply with the coordination procedures stated to prevent or minimize risks that could possibly arise from interference between different activities being carried out in the same areas.

11) Timely inform Contractor of any incident / accident happening with the required information for the Site HSE Statistics, as per the incident / accident reporting procedure.

12) The Subcontractors' HSE Supervisor will ensure liaison between the Subcontractor and Contractor Project HSE organization.

4. DEFINITIONS

“HSE Management” - Part of the overall management system that facilitates the management of the HSE risks associated with the activities of Contractor, Subcontractors and Vendors.

“Safety” - Freedom from unacceptable risk of harm

“Environment” - Surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelation


“Corporate HSE Policy Statement” - Attachment 3

“Environmental Management Plan” - Refer to SCC Annexure 1. (Attachment 4)
5. HSE POLICY STATEMENTS AND OBJECTIVES

5.1 Corporate HSE Policy Statement
Corporate Environmental Policy Statement is enclosed as Attachment -1.

5.2 Project HSE Policy Statement
Contractor will issue and bring to the attention of all personnel a written Project HSE Policy Statement, signed by the Project manager. This will supplement the Corporate HSE Policy Statement. The Project HSE Policy Statement will be developed after award of the Contract.

5.3 Drug and Alcohol Policy Statement
The transportation, use, possession, promotion, or sale of Prohibited Substances such as alcohol, drugs, and other intoxicating substances in all work-sites which are under the direct control of Contractor are strictly forbidden.

Any person(s) found in possession, or under the influence of any alcohol, drug or other intoxicating substances whilst on duty, other than approved bona fide medical reasons, shall be subject to Disciplinary Procedures.

5.4 HSE Objectives
The highest standard of Health, Safety and Environment Protection are recognized by Contractor as criteria for good performance in the same way as Quality, Cost Control and Productivity. HSE standards will be measured constantly throughout the duration of the contract. The ISO 14001: 2004 (Environmental Management System) is enclosed as Attachment-2.

The HSE objectives are:

1) To comply with all applicable Health, Safety and Environment Regulations, relevant to the local Regulations and Employer standards as required by the Contract, supplemented by the Contractor’s operational experience.

2) Identify all potential hazards associated with the execution of the Project, and to develop prevention, control and mitigation measures to eliminate or minimize harm to people, damage to plant or equipment, or adverse impact on the environment.

3) Encourage the adoption of a positive, proactive, committed HSE culture throughout all phases of the Project.

4) The aim of Contractor is to complete the Project achieving the HSE target of ZERO fire and ZERO fatal accidents.

5) Contractor cooperative HSE Management system is supplemented by Contractor cooperative HSE Management System documents. These documents will take precedence should there be any conflict or clarification required.
6. PROJECT HSE ORGANIZATION

The HSE Management System ensures that the Project Health, Safety and Environmental Objectives are met through implementation of technical activities and procedures, a Project HSE Team will be appointed to perform all the technical activities included in this HSE Plan.

The Contractor Head Office, Office of Safety and Environmental Management based in Seoul–Korea, supports the Project HSE Team with specialist advice, consultation, inspection, auditing and directions for the execution of the tasks.

The Project HSE Team interfaces with Contractor Project Management, also with Subcontractors and Vendors, to establish that all activities comply with the Project HSE Objectives.

Following is Project Safety & Health Organization Chart
7. HSE MANAGEMENT OF SUBCONTRACTORS

To assist Contractor in its quest to consistently achieve high levels of accident prevention and decrease levels of pollution emitted from its operations, Subcontractors to be used by Contractor on this Project will only be selected if they can prove that they are able to execute their work in a safe and healthy condition.

Contractor will check the arrangements that Subcontractors have in place for managing the Health and Safety of their employees and protection of other persons not involved in their activities.

Subcontractors will submit method statements for high risk and unusual activities.

Contractor imposes the same level of standards to works by Subcontractors who are expected to perform to the satisfaction of Contractor in respect of HSE matters. They will be subject to the same monitoring and assurance systems as works carried out directly by Contractor.

Subcontractors and Vendors will be held responsible for all persons employed by them. There will be on acceptance during the tender stage that they must observe all ordinances, including the safety and well being of all their personnel on site wherever they are involved.

Each Subcontractor will be issued with a copy of the HSE Plan together with HSE procedures applicable to their activities. Major and specialist Subcontractors will be required to produce an HSE Plan for their section of the works. These will include detailed method statements for high risk and unusual activities.

HSE procedures will be discussed at HSE meetings. Project Management will constantly liaise with Subcontractors to establish the HSE requirements of their work and make arrangements for them to work in a safe manner. Subcontractors who do not perform to the satisfaction of Contractor will be subject to penalties and risk removal from site.

8. HEALTH, SAFETY AND ENVIRONMENT COMMITTEE

A Project HSE Management Committee will be established to monitor the implementation of the HSE Plan in line with Statutory and Contractual HSE requirements.

The Employer Representative shall be the chairman of the Committee Meeting and Site HSE Manager shall work as a Member Secretary of the Committee.

Attendees at these meetings will include the Site HSE Manager and other persons from the Project Management Team nominated by the Site Manager, Site HSE officers, Subcontractors, Site Managers and Safety Representatives.

The function and terms of reference of the HSE Committee are:
1) To monitor the adequacy of the HSE Plan and ensure its implementation.
2) To study accident statistics and trends to identify unsafe practices and conditions.
3) To review emergency and rescue procedures.
4) To promote HSE requirements on Site.
5) To review results of HSE inspections.
6) To determine that required follow up actions are implemented.

Minutes of the HSE meeting will be circulated to all members.
The HSE Manager, if necessary through the Site Manager, arrange an extraordinary meeting to discuss any urgent HSE matters.

9. HSE INFORMATION AND TRAINING

Contractor recognizes that the provision of adequate HSE information for all levels of personnel makes a vital contribution towards an effective accident prevention program and will ensure that a suitably structured schedule of HSE information and training is adopted by all parties throughout the Project.

9.1 HSE Information.

1) Contractor will adopt a variety of information techniques, such as poster campaigns featuring the work activities during the following month. The distribution of HSE information sheets, newsletter and bulletins will be made in order to generally promote HSE throughout the Project.

2) Contractor will display relevant warning signs, emergency and rescue procedures, notices and placards at strategic points in offices, workshops, welfare facilities, accommodation camps, canteens, and construction areas.

3) Such information sheets, bulletins, warning signs, notices and placards will be translated into the required languages for all personnel to understand.

4) Contractor will also develop as necessary means of disseminating HSE information including accident statistics, accident case studies, etc. to employees through effective means.

9.2 HSE Training

1) Contractor will ensure that suitable ongoing programs for HSE training including accident prevention and other specific training courses are implemented to the Contractor Project Management Team, other supervisory personnel, including Sub-contractors and the workforce.

2) All site personnel will undergo initial HSE induction training before they commence work on the Project. An identification card and Safety Helmet sticker will be issued as proof of such induction training.

3) Additional training may be necessary as Site conditions change or new HSE Procedures are introduced.

4) Contractor will also organize Toolbox training meetings daily during which, foreman and their work group will discuss matters relating to HSE, including where necessary circumstances and causes of incidents and accidents.

5) Comprehensive and up to date records of all HSE training will be kept.
6) The Site Manager will be provided with detailed reports of HSE training carried out on a monthly basis.

7) Contractor will require Subcontractors to implement HSE training programs.

10. COMMUNICATION AND REPORTING
Contractor acknowledges the importance of establishing effective communication procedures on HSE matters throughout the organizational structure of the Project. Weekly coordination meetings will be held between the HSE Manager and Managers from all departments. In the interest of day to day operational HSE matters Contractor will ensure that effective radio communication systems are established and maintained, allowing instant contact between the relevant onsite Managers, Supervisors, HSE personnel, first aid, emergency personnel of Contractor and its Subcontractors. All the foregoing nominated key personnel will carry their assigned radio with them at all times. All HSE information directed at the workforce will be in the local language or any other language in use by a significant number of the workforce. Contractor will report all accident and incident to Employer immediately and submit an initial accident report within 24 hours.

The HSE Manager will provide a report to the Project Manager. The following items will form the base of this report.

1) HSE promotion and training undertaken.
2) HSE Committee and details from other HSE meetings.
3) HSE instructions and corrective actions.
4) Site HSE inspections.
5) HSE performance of Subcontractors.
6) HSE audit.
7) Details of accidents and dangerous occurrences.
8) Safety and accident statistics.
9) Identification of high-risk activities for the forthcoming month.

10.1 Meetings

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<tr>
<td>Meeting</td>
<td>Contractor's representatives</td>
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<td>HSE Manager</td>
<td>Responsibilities for follow-up determined</td>
</tr>
<tr>
<td>Event</td>
<td>Participants</td>
<td>Description</td>
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</tr>
<tr>
<td>HSE Planning Meeting</td>
<td>Employer representatives</td>
<td>HSE Plan for Employer’s review</td>
</tr>
<tr>
<td></td>
<td>Contractor’s representatives</td>
<td>A list of action items, time for completion and responsibilities for completion and acceptance</td>
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<tr>
<td></td>
<td>HSE Manager</td>
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</tr>
<tr>
<td>Site start-up Meeting(s)</td>
<td>All field personnel</td>
<td>Inform personnel of Employer’s and Contractor’s HSE requirements and procedures</td>
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<td>Subcontractor personnel</td>
<td>Inform personnel of specific HSE hazards, mitigating measures and procedures to be followed</td>
</tr>
<tr>
<td></td>
<td>Employer’s field representatives</td>
<td>Inform personnel of their HSE responsibilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Review emergency response and contingency plans</td>
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</table>
10.2 Injury and Dangerous Occurrences Reporting and Recording

1) Contractor's procedures for reporting and recording injuries and dangerous occurrences are designed to satisfy both its statutory and contractual obligations and will apply to all Subcontractors engaged on the Project.

2) All accidents must be reported to the Project HSE Department immediately of its occurrence verbally and later in writing. In the case of death, serious accident, dangerous occurrence or injury to a third party, the HSE Manager must be informed immediately.

3) All accidents and dangerous occurrences will be thoroughly investigated by the HSE Management Team with the objectives to:
   - Investigate to establish the root and contingency causes which determined the accident or occurrence;
   - Take corrective action and monitor their implementation, in order to prevent recurrence of similar situations;
   - Inform all appropriate personnel of the results of the investigation.

4) All near miss case will also be reported and investigated.

11. EMERGENCY RESPONSE PROCEDURE

Contractor will implement suitable procedures to cater for emergency situations, including emergency evacuation and rescue operations. The foreseeable emergencies would include, but not limited to: fire, explosion, collapse of ground conditions, collapse of structure or plant, etc.

In case of any emergency, the HSE Manager will be immediately informed by radio or telephone. The name and phone number of the HSE Manager shall be clearly posted on the Site notice boards.

The HSE Manager, when informed of an emergency, will proceed to the scene and supervise the workforce to take appropriate action to avoid further damage. The HSE Manager should prepare the scene for arrival of the emergency services, who can then commence rescue operations as soon as possible.

The appropriate action taken may be limited to ensuring that all personnel are cleared from the area of danger and kept at a safe distance. It is not expected that the HSE Manager or any other person put themselves or other persons at risk to contain the emergency situation.

It is envisaged that the major rescue and emergency force will be the local emergency services. The Contractor emergency team will act as support to the services by providing information, any plant or equipment and render any assistance as requested by them.
In the case of any emergency in the work area, the work will be suspended. The HSE Manager or Officer will check that equipment has been made safe and ensure that unauthorized persons move out of the area.

Before returning to work after an emergency, the Site Manager will direct all managers and line supervisors to check damage and loss facilities, and also take measures to rectify any unsafe conditions.

11.1 Unusual Weather / Conditions

1) In order to protect and minimize loss from unusual weather or conditions (flood, heavy rainstorm, earthquake etc.), Contractor recognizes the importance to take into account the local data for extreme weather.

2) Contractor will establish an adequate alarm or paging system.

3) When strong gusts of wind are expected, the necessary measures to prevent the collapse of temporary facilities or structures and cranes shall be provided.

4) When flood warning and heavy rain storms are expected Contractor will alert all personnel and its Subcontractors. The site will carry out the necessary actions and precautionary measures.

5) If a rainstorm is expected, the site will continue its normal operation. Outdoor work may be suspended in exposed places at the discretion of the Site Manager in conjunction with the HSE Project Team.

6) Supervisors will arrange for the personnel concerned to take shelter temporarily and resume duties only when weather conditions permit.

7) The Site Manager and the HSE Manager will at their discretion, close the site in case of a very heavy rainstorm and a forecast for more inclement weather.

8) Employees and Subcontractors may be released but an emergency crew will remain on site to undertake all reasonable measures to minimize damage.

9) After any unusual weather conditions, an emergency crew will carry out, with members of the HSE Team and Project Management a thorough inspection of the site and prepare a report for the Site Manager for circulation to all section supervisors. The report will detail damage to any permanent or temporary structures, plant, scaffolding, ladders or access that may adversely affect safety.

10) The various supervisors will ensure that arrangements are made for the affected areas to be made safe before re-opening those areas of the site.

11.2 First Aid

Contractor and its sub-contractors will provide adequate First Aid Kits within its working areas.

Additional local first aid kits will be provided to various work locations in order to render immediate first aid treatment as necessary.
All First Aid Kits will have suitable signs displayed to indicate their existence. These facilities will normally be under the charge of a trained first aider.

First aid facilities will be properly maintained and inspected on a frequent basis by members of the Project HSE Management Team.

Contractor will maintain liaison with the local Emergency Services to ensure that emergency services arrive at the incident in the shortest possible time.

Notices in the necessary languages will be posted at each workplace providing the telephone number of emergency services and the Project Management HSE Department.

12. ENVIRONMENTAL CONTROL

Contractor and its Subcontractors will take all necessary measures to prevent any discharge of substances which might cause pollution or be deleterious to life or environment, in violation of local laws, rules or regulations. The Project will be subject to Contractor’s Environmental Management System and Employer’s Environmental Management Plan (Refer to attachment 4).

All waste will be categorized into one of the following classes:

1) Hazardous Waste
   Wastes which are corrosive, explosive, toxic, oxidizing etc. and constitute a high degree of hazard to the public or the environment

2) Non-Hazardous Waste
   Wastes which are biologically or chemically active in the environment

3) Inert Waste
   Wastes which are not biologically or chemically active in the environment

The Project Waste Management Plan will include a strategy for managing waste based on the principles of Reduction, Reuse, Recycle, and Recover.

Material should be stored in an orderly and safe manner. Storage or disposal will be clearly defined and located on the plan. Frequency of waste disposal will be based on job site conditions. Disposal by burning of any waste materials at the job site will be prohibited. Garbage containers will be kept clean and emptied when full.

Waste storage facilities will be regularly inspected by members of the Project HSE Management Team; they will also:

1) Inspect housekeeping standards in working areas during day-to-day operations.

2) Identify waste classification and keep records in the waste register.

3) Estimate the amounts of wastes.

4) Ensure that all Subcontractors are aware of the waste management procedures.

5) Control that all Subcontractors in charge of waste management and disposal are provided with required licenses and approval.
6) Ensure that all environmental incidents (accidental spillage or discharges) are properly managed, reported and recorded.

12.1 Housekeeping
The act of keeping the working environment cleared of all unnecessary waste, thereby providing a first line of defense against accidents and injuries. Housekeeping is the responsibility of all site personnel, and line management commitment will be demonstrated by the continued efforts of supervising staff towards this activity.

13. HSE INSPECTION AND AUDIT

13.1 HSE Inspection
1) All Project Management and Supervisory personnel will carry out continual Health, Safety and Environmental surveillance’s as they go about their day to day business and take immediate steps to rectify any defects or unsafe practices they observe.
2) HSE Inspections designed to identify defects, unsafe conditions/practices and breaches of statutory or Site HSE Plan requirements will be conducted on a regular basis by the HSE Manager and HSE Officers.
3) The Project HSE Inspections will be carried out weekly and include representatives from Employer, Contractor supervision and subcontractors.
4) The HSE Inspections will be carried out a comprehensive checklist. A copy of the inspection results will be distributed to the Site Manager, Construction Manager. Areas of particular concern will be brought to the attention of the appropriate persons immediately.
5) All HSE checklists/inspection reports will incorporate a follow-up procedure to ensure that any recorded HSE contraventions have been promptly attended to in a satisfactory manner.
6) Should there be an imminent risk to any persons, the work will be stopped and an HSE instruction issued. The HSE instruction will take immediate effect and work cannot restart unless compliance with the HSE instruction has been carried out and accepted by members of the HSE Project Management Team.

13.2 HSE Audit
1) Contractor Head Office Safety and Environment Department based in Seoul, Korea will plan and organize HSE audits to monitor correct implementation of the Project HSE Plan and compliance with statutory regulations and contractual HSE requirements.
2) Every six months, HSE Management Team will conduct a full Site Safety Audit. The findings will be discussed at the next safety meeting and remedial action taken where appropriate. A copy of the HSE audit will be attached to the 6-monthly HSE report and a copy of safety audit report will be reported to the Project Manager.
14. **PUBLIC SAFETY AND SITE SECURITY (PERSONNEL ACCESS TO SITE)**

An access control system such as a security pass system will be operated at the Contractor’s main entrance to the site, including the office compound of Compressor Stations located at a remote location.

All guard posts shall be equipped with a telephone / radio communication system, a panic button and an audible alarm.

The access control system shall cover all Contractor’s staff as well as all subcontract staff/workers and those of sub-subcontractors etc. including operators of rental construction equipment, plant, etc.

Each security pass shall bear the photograph of the holder in accordance with contractual security regulation.

Persons not wearing the correct PPE shall not be allowed to work at Construction site.

15. **INCENTIVES AND PENALTIES**

Contractor will implement a penalty system as well as safety award scheme to effectively manage HSE of the Project.

15.1 **Safety award scheme**

1) The scheme shall be divided into two (2) parts, namely individual awards and group awards.

2) All individuals, from workers to supervisors and from direct staff to subcontractors, on the Project shall be included in the scheme.

3) The group award will be arranged through the competition among subcontractors or the relevant section of the construction department.

15.2 **Penalty system**

1) The penalty will be charged to the Subcontractors as well as Contractor for any case which breach to this rules (with evidence) according to the specified “Penalty for Site Safety”. The Subcontractors cannot have any objection. The amounts of the “Penalty for Site Safety” are the minimum penalty and it can be increased, if necessary, which will be voted and passed in the Organization. The funds collected from penalties will be solely used for safety and hygiene education, training, facilities and PPE.

2) If the Subcontractors breach Contractor Safety Regulation and related regulations with immediate hazard, Contractor will instruct to suspend and resume after the improvement completed. The Subcontractors should bear all loses due to suspension.

3) Contractor will terminate the subcontract due to the delay, no ability to execute the works of the subcontract by serious accident of safety and hygiene by the Subcontractors. The Subcontractors should bear the responsibilities on penalty, medical treatment, occupational disaster compensation, damage compensation and
Design-Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

16. DISCIPLINARY PROCEDURES

16.1 First Offense — Verbal Warning
1) A verbal warning will be given to the employee in the presence of his supervisor. This warning will include an explanation of the corrective action expected to avoid a recurrence and the consequence for a second violation.
2) The information about his safety violation will be entered in the Safety Violation Log Book.

16.2 Second Offense — Written Warning
1) A written warning will be given to the employee and a copy will be kept in safety file. This warning will include an explanation of the corrective action expected to avoid a recurrence and the consequence for a third violation.
2) The information about this safety violation must be entered in the Safety Violation Log Book.

16.3 Third Offense — Disciplinary action
1) Disciplinary action will be taken. The action can include suspension, termination or any other measures warranted by the circumstances of the incident.
2) The information about this violation will be entered in the Safety Violation Log Book.

A safety disciplinary committee composed of the Project Manager, Construction Manager, HSE Manager, Subcontractor's Project Manager, Construction Manager and their Safety representatives shall convene on special cases where stringent disciplinary measures (i.e. termination) is required.

17. CONTROL OF HAZARDOUS MATERIAL

17.1 HSE Manager
HSE Manager will collect MSDS (Material Safety Data Sheet) if available and provide advice to Section Supervisor/Subcontractor as required.

17.2 General Information
Chemicals, dust, and fumes can harm the body in three ways:
1) By inhalation.
2) By swallowing.
3) By the skin contact.

The effects of such may be immediate but can also appear several years later. This procedure and guidance are aimed at the protection of personnel and the environment from the effects of hazardous substances.

Hazardous substances include but not limited to:

- Solvents
- Catalysts
- Chemicals
- Cement
- Glues
- Lead-Cadmium
- Plaster
- Weed killer
- Bitumen
- Epoxy resins
- Filters
- Brick dust
- Silica dust
- Isocyanates
- Toxic substances in the ground, e.g. PCBs (Chemicals found in the use of electrical equipment)

All sources of ignition will be prohibited while flammable liquids are stored, handled, and processed. Suitable "NO SMOKING OR OPEN FLAME" signs will be posted in all such areas.

Flammable or combustible liquids will not be stored at exits stairways, or safe passage of people.

Electrical lighting with no sparks will be used for artificial illumination in areas where flammable liquids, vapors, fumes, dust, or gasses are present.

All buildings, rooms, and compartments where flammable liquids are stored, processed, or used will be properly ventilated.

Drums, barrels and other flammable liquid containers will be tightly capped. Safety Cans or other portable service containers of flammable liquids having a flash point at or below 730°F shall be painted red with a yellow band around the can and/or the name of the
contents conspicuously painted or stenciled on the container in yellow to identify the danger in handling.

Buildings for the storage of flammable liquids or gases will be of fire-resistant construction with protected wall openings and located at least 15 m from adjoining structures.

Smoking or open flames with 15 m of where flammables are being used or transferred or where equipment is being fueled are prohibited.

Workers will be required to guard carefully against any part of their clothing contaminated with flammable or combustible fluids.

Oil, grease, or fuel stored underground will be kept in tightly sealed containers in fire-resistant areas, at safe distances from explosives, electrical installations, and shaft stations.

17.3 Hazardous Warning Symbols

The following diagrams depict hazardous warning symbols that should appear on packaging and containers to warn of the hazards associated with their contents.

Symbols are in black on an orange yellow background.
## Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj

### PROJECT PROCEDURE

#### HEALTH, SAFETY AND ENVIRONMENTAL PLAN

<table>
<thead>
<tr>
<th>Safety Precautions and Medical Action</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wear suitable protective clothing, gloves, and eye, face protection.</td>
<td>Toxic/Very Toxic</td>
</tr>
<tr>
<td>2. After contact with skin, wash immediately with plenty of water.</td>
<td></td>
</tr>
<tr>
<td>3. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.</td>
<td></td>
</tr>
<tr>
<td>4. In case of accident or if you feel unwell, seek medical advice immediately.</td>
<td></td>
</tr>
<tr>
<td>5. Wear suitable gloves and eye, face protection.</td>
<td>Corrosive</td>
</tr>
<tr>
<td>6. Take off immediately all contaminated clothing.</td>
<td></td>
</tr>
<tr>
<td>7. In case of contact with skin, wash immediately with plenty of water.</td>
<td></td>
</tr>
<tr>
<td>8. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.</td>
<td></td>
</tr>
<tr>
<td>9. Do not breathe vapors or spray dust.</td>
<td>Harmful</td>
</tr>
<tr>
<td>10. Avoid contact with skin.</td>
<td></td>
</tr>
<tr>
<td>11. Wash thoroughly before you eat, drink or smoke.</td>
<td></td>
</tr>
<tr>
<td>12. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.</td>
<td></td>
</tr>
<tr>
<td>13. Do not breathe vapors or spray dust.</td>
<td>Irritant</td>
</tr>
<tr>
<td>14. Avoid contact with skin.</td>
<td></td>
</tr>
<tr>
<td>15. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.</td>
<td></td>
</tr>
<tr>
<td>16. In case of contact with skin, rinse immediately with plenty of water.</td>
<td></td>
</tr>
<tr>
<td>17. Protect from source of ignition.</td>
<td>Highly flammable</td>
</tr>
<tr>
<td>18. Have fire extinguishing at hand.</td>
<td></td>
</tr>
</tbody>
</table>

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18. PERSONAL PROTECTIVE EQUIPMENT (PPE)

1) All employees will be provided with the necessary PPE for their particular work activity. They will also be provided with the necessary instruction and training in its correct use. PPE and the necessary training courses shall be supplied to the employee.

2) All employees will be held responsible for the proper care and use of any PPE supplied to them. Subcontractor will replace, free of charge to the employee, any PPE which becomes deficient in any way through normal work usage or wear and tear to ensure that at all times the worker has adequate protection. Normal wear and tear shall include the period of effective use specified by the manufacturer and requirements of basic hygiene standard.

3) Supervisors of any work site will be responsible for ensuring that all personnel on site are trained in the use of, provided with, and wearing all PPE required for the particular activity and environment of the work. Personnel not equipped with PPE for whatever reasons will be prohibited to start or continue working.

4) All employees will wear the appropriate PPE supplied to them at all times while working at their assigned tasks. Supervisors will apply disciplinary action to any employee who fails comply.

5) Safety Helmet
   - Every employee will be provided with a hard-hat (Safety Helmet) at the time of his employment and will be required to wear it at all times during working hours while on the job site. Metal hard hats and “Bump or laceration caps” will be prohibited.
   - This requirement will also apply to office personnel and visitors who visit Construction areas.

6) Eye Protection
   - Where there is a danger of injury or irritation on the worker’s eyes, the Subcontractor shall ensure that the worker wears properly fitting eye protecting equipment that is appropriate to the work being done and the hazards involved, and is approved under national or international standards.
   - A worker will not be allowed to perform electric arc welding when another worker may be exposed to the radiation of the arc unless he is wearing suitable eye protection or protected by a screen.
   - Light eye protection will be worn at all times. This has become an industry standard.

7) Foot Protection
   - All employees will be ensured to wear approved work boots or shoes in good repair. Soft shoes, sandals, etc. will not be permitted.

8) Hand Protection
   - Employees will be recommended to wear protective gloves when performing work...
which has danger of wounding their hands.

9) Respiratory Protection
   • When working in abnormally dusty atmospheres, where effective ventilation cannot be achieved, appropriate respiratory protective devices (i.e., dust mask) shall be provided to the workers.
   • Whenever unusual physical or atmospheric conditions and/or unsafe accumulation of contaminants exist, the use of ventilators, fans and air movers will be used as necessary. When the amount of Oxygen is not enough to sustain life or it is expected to decrease below 19.5% or increase more than 22.5% air will be used from the supplied oxygen bottle.
   • When effective engineering controls (i.e., ventilators, fans or air movers) are not feasible, respirators will be provided which are applicable and suitable for the purpose intended when working around hazardous or toxic fumes.
   • The use of fresh air-supplied masks will be required whenever hazardous to life fumes, mists, vapors, gases are present or tank entry is required or where exit is restricted. Supervisor or safety officer will be consulted before working in any fume condition.
   • Where breathing apparatus is required a trained standby man will be required.

10) Hearing Protection
    • Protective hearing equipment is to be provided and used in designated areas or for high noise hazard jobs. Areas which have abnormal noise levels shall be so posted with the safety sign indicating that ear protection is required.

11) Protective Clothing
    • All personnel will be eligible to receive free issue, such personal protective clothing/equipment as deemed appropriate to the hazards associated with performing their assigned duties.

Contractor will implement permit to work procedures during execution of tie-in works. This procedure will include confined space working, radiography, lighting operation and excavation during the constructions phase and electrical isolation, flushing/blowing procedures during pre-commissioning and commissioning activities carried out where work permit system is applicable. All work outside the main plot area will be controlled by Employer permit to work procedures.

18. HSE Document control

HSE related documents will be controlled in accordance with Contractor Corporate procedure 'Standard Control Procedure'. Each document maintained in the Project files is assigned and inscribed with a unique identification code. The codes and a description of the document are then entered in a register. HSE records will be kept secure at all times.
20. ATTACHMENTS

1) ISO Certificate 14001:2004 (Environmental Management System)
2) OHSAS Certificate 18001:2009 (Occupational Health & Safety Management System)
3) Corporate HSE Policy Statement
4) Environmental Management Plan
Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

ATTACHMENT 1. ISO Certificate 14001:2004
Certificate of Registration

ENVIRONMENTAL MANAGEMENT SYSTEM - ISO 14001:2004

This is to certify that
Hyundai Engineering Co., Ltd.
Hyundai 41 Tower
#917-9, Mok-dong
Yangcheon-gu
Seoul
158-723
Republic of Korea

Hold Certificate No. FM5 54428
and operates an Environmental Management System which complies with the requirements of ISO 14001:2004 for the following scope:

Please see scope page.

For and on behalf of BSI.

Managing Director Korea, J.A. Ginn

Originally registered: 12/12/2009
Latest issue: 12/12/2009
Expiry Date: 12/12/2012

Page 1 of 2
Registered Scope:

R&D, project management, construction management and supervisory service for engineering procurement and construction. Assessment of environmental impact/traffic impact and safety diagnosis. Planning and design of urban development and landscapes. Study, design and construction of civil fields (soil mechanics and foundation engineering, structures, roads, airports, harbors, coastal, water resources development, geology, geotechnical engineering, water supply & sewerage and railways) and building & housing. Design & construction of plants (refinery, oil & gas production, gas treatment, petrochemical, fertilizer, desalination and offshore pipelines. Design & construction of power plants, industrial plants and fire fighting systems. Design & construction of environmental facilities (incinerating facilities, sewage & waste water treatment plants), Planning of energy consumption.

This certificate is renewable to the company's original registration certificate No. EAC-02653 dated 28 Feb 2007 and issued by the Registrar.
### ATTACHMENT 2. OHSAS Certificate 18001:2009
Design-Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

Certificate of Registration

OCCUPATIONAL HEALTH & SAFETY MANAGEMENT SYSTEM

This is to certify that:

Hyundai Engineering Co., Ltd.
Hyundai 41 Tower
R017-9, Mok-dong
Yongsan-gu
Seoul
110-723
South Korea

Holder Certificate No. OHS 044623

This is an Occupational Health and Safety Management System which complies with the requirements of BS OHSAS 18001:2007 for the following scope:

R&D, project management, construction management and supervisory services for engineering procurement and construction. Assessment of environment/disenase/traffic impact and safety diagnosis. Planning & design of urban/regional development and landscape. Study, design and construction of civil, railway, mechanical & structural engineering, structures, road, bridges, airports, harbors & coastal, water resources development, geology & geotechnical engineering, water supply & sewerage and railway and building & housing, design & construction of plants/petriofy, oil & gas production, gas treatment petrochemical, fertilizer, desalination and offshore, and pipelines. Design & construction of power plants, industrial plants and fire fighting systems. Design & construction of environmental facilities (incinerating facilities, sewage & waste water treatment plants). Planning of energy consumption.

For and on behalf of BSI:

Managing Director Korea, J.K. Chung

Original registration: 10/01/2008
Latest Issue: 10/04/2009
Expiry Date: 08/01/2012

HYUNDAI ENGINEERING CO., LTD.
ATTACHMENT 3. Corporate HSE Policy Statement
Health, Safety and Environmental Policy

Our vision at HEC is to make our company respect Human Life, conserve the Environment for the next generation and create future value as one of the top premier engineering and construction companies. To realize this vision, HEC has adopted the followings to be recognized and put into practice as the top priority.

1. We comply with HSE legislation and other relevant requirements.
2. We are committed to building our management base on Sustainable Zero-Accident through establishing the Global HSE Standards, developing self-regulating competence and enhancing Risk Management.
3. We are recognized to minimize risks and environmental effects on project, activities and service and to prevent environmental pollution in advance.
4. We share HSE Policy and HSE Performance with our employees and the concerning parties.

All employees and contractors are accountable for complying with our HSE Policy and establishing management system for improvement of their HSE Performance, and the HSE Policy will be regularly reviewed in order to applying to continual improvement and technical innovation.

01 SEP 2011
Hyundai Engineering President
Kim. Woo-Chul
ATTACHMENT 4. Environmental Management Plan
Environmental Management Plan

Environmental Management Plan (EMP) including mitigation measures, enhancement measurements, environmental monitoring arrangements and institutional arrangements for the two compressor stations are presented in the following matrices. (This plan is same as the contract requirements mentioned in SCC Annexure 1.)

1. Ashuganj Compressor Station

<table>
<thead>
<tr>
<th>Impact</th>
<th>Mitigation / Enhancement Measures</th>
<th>Monitoring arrangements</th>
<th>Responsible Party</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Pre-construction Phase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor employment</td>
<td>Employment of local laborers should be prioritized</td>
<td>Daily labor log checking</td>
<td>GTCL &amp; Contractor</td>
</tr>
<tr>
<td>Encroachment of public/private properties</td>
<td>Compensation of crop loss and damage to properties during mobilization</td>
<td>Physical enumeration of loss by type and owner</td>
<td>Contractor</td>
</tr>
</tbody>
</table>
| Underground cables and pipelines in the Ashuganj C/S sites | * Designing of compressor station should be compatible with the existing infrastructures.  
* The Contractor shall locate the pipelines and underground cables prior to commence construction works with due precautionary measures for the safety and integrity of the existing systems (i.e. underground pipelines, cables etc.) | | Contractor |

| B. Construction Phase |
| Air pollution | Water spraying during construction works to control the dust. | Conduct air quality to check with the specification | Contractor: A surveillance team formed by implementing agency for monitoring |
| Noise pollution | * Compressor station shall be sufficiently covered using sound and noise absorbing materials to absorb sound, noise and vibration.  
* Compressor station shall | Conduct noise quality test to check with the specification. | Contractor: A surveillance team formed by implementing agency for monitoring |
<table>
<thead>
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</thead>
</table>
| be sufficiently covered using sound and noise absorbing materials to absorb sound, noise and vibration.  
  * Boundary wall may be constructed with sufficient height for abatement of noise pollution. |                                                                                                  |                                                                                         |                                                                                 |
| Soil pollution                                                          | * Solid and liquid waste shall not be spread over the project site.  
  * Oil Storage area should be paved with the catch drain with line pit.  
  * Any spillage on the ground should be scraped and stored in a container for safe disposal.  
  * Finally the spillage should be buried in a pit lined with geo-composite and HDPE liner. | Surveillance team to periodically visit the project site for ensuring soil pollution.     | Contractor. A surveillance team formed by implementing agency                    |
<p>| Temporary loss of resident wildlife habitat due to construction activities | Avoid too much noise.                                                                             | Check the noise level at site and at nearby homesteads                                    | Contractor. A surveillance team formed by implementing agency                    |
| Encroachment/Obstruction to existing public and private land and properties | Compensate shall be paid to the owners of land and structures for the loss of their crops or properties. | Checking compensation payment register                                                    | Contractor                                                                      |
| Labor employment                                                        | Employment of local laborers should be prioritized.                                               | Daily labor logbook checking                                                             | GTCL8 Contractor                                                                 |
| Encroachment/Obstruction to existing public passage to highway           | Provide alternative access road to the highway for the nearby inhabitants.                        | Alternative road construction plans and implementation thereof                          | Contractor                                                                      |
| Underground cables and pipelines in the Ashuganj C/S sites              | * The Contractor shall locate the pipelines and underground cables prior to commence construction works with due pre- |                                                                                         | Contractor                                                                      |</p>
<table>
<thead>
<tr>
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<th>Mitigation / Enhancement Measures</th>
<th>Monitoring arrangements</th>
<th>Responsible Party</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission of radioactive material (X-rays and gamma waves) during NDT (Non Destructive Testing) operations of welding joints</td>
<td>Radioactive source/materials used in NDT operation should be performed in a controlled and restricted area with proper notification and safety precautions. The workers must wear proper shielding (Pb/Steel) for protecting X-ray/Y-ray. Shielding includes Pb apron, Pb gloves etc. Experienced technicians shall be employed in a controlled setting/environment to minimize the emission of X-rays/Y-rays. Rules and Regulation of Atomic Energy Commission of Bangladesh shall be followed</td>
<td>Contractor</td>
<td></td>
</tr>
<tr>
<td>Health and Safety of workers and surrounding people</td>
<td>Necessary personal protective equipment (PPE) must be used by personnel working inside the station as measure of safety. Fire fighting equipment including fire hydrant should be kept in the project site. The workers should be trained in health, safety and</td>
<td>Regular health check-up of workers. Monitoring of awareness raising activities such as publishing posters, bill boards/signboards, safety signage etc.</td>
<td>Contractor</td>
</tr>
</tbody>
</table>

HYUNDAI ENGINEERING CO., LTD.
<table>
<thead>
<tr>
<th>Impact</th>
<th>Mitigation/Enhancement Measures</th>
<th>Monitoring arrangements</th>
<th>Responsible Party</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air pollution</td>
<td>Emission from compressor station (NOx, CO &amp; PM) should comply with the DoE standard</td>
<td>Conduct air quality test to check with the specification</td>
<td>Contractor</td>
</tr>
<tr>
<td>Noise pollution</td>
<td>Noise level of the compressor station including metering runs should be maintained as per DoE standard</td>
<td></td>
<td>Contractor</td>
</tr>
<tr>
<td>Surface water quality may deteriorate due to sewage/liquid waste disposal to Meghna river near Ashuganj site only</td>
<td>• Sewage from plant and residential area should be kept in septic tank. No sewage should be dumped in the river or flood plain lands. • Liquid waste and engine oils should be kept in tanks/drums to avoid contamination with water and soil. The liquid wastes may be incinerated.</td>
<td>Conduct chemical water quality test for DO, BOD etc</td>
<td>GTCL &amp; Contractor</td>
</tr>
<tr>
<td>Soil pollution</td>
<td>• Solid and liquid waste shall not be spread over the project site • Oil Storage area should be paved with the catch</td>
<td>Surveillance team to periodically visit the project site for enquiring soil pollution</td>
<td>Contractor. A surveillance team formed by implementing agency</td>
</tr>
</tbody>
</table>

HYUNDAI ENGINEERING CO., LTD.$$
### Design-Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj

<table>
<thead>
<tr>
<th>Impact</th>
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<th>Monitoring arrangements</th>
<th>Responsible Party</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain with line pit. Any spillage on the ground should be scraped and stored in a container for safe disposal. Finally the spillage should be buried in a pit lined with geo-composite and HDPE liner.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce habit quality for vegetation and wildlife communities for the nearby homesteads</td>
<td>Reduce noise pollution by installing barriers both physically as well as biologically through developing green belt of local trees around the installation.</td>
<td>Monitor noise pollution and wildlife population periodically.</td>
<td>Contract. A surveillance team formed by implementing agency</td>
</tr>
<tr>
<td>Health and Safety of workers and surrounding people</td>
<td>• Necessary personal protective equipment (PPE) must be used by personnel working inside the station as measure of safety. • Fire fighting equipment including fire hydrant should be kept in the project site. • The workers should be trained in health, safety and environment (HSE). • Proper manpower scheduling is required to ensure health &amp; safety of workers. • Building awareness for surrounding people about the project activities, probable impacts and mitigation measures. • Proper sanitation facilities must be maintained inside the plant area and as well as inside the workers colony.</td>
<td>Regular health check-up of workers. Monitoring of awareness raising activities such as publishing poster, bill board/signboards, safety signage etc.</td>
<td>GTCL &amp; Contractor</td>
</tr>
</tbody>
</table>
Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

### 2. Elenga Compressor Station

<table>
<thead>
<tr>
<th>Impact</th>
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<th>Responsible Party</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Pre-construction Phase</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor employment</td>
<td>Employment of local laborers should be prioritized.</td>
<td>Daily labor log checking</td>
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</tr>
<tr>
<td>Encroachment of public/private properties</td>
<td>Compensation of crop loss and damage to properties during mobilization</td>
<td>Physical enumeration of loss by type and owner</td>
<td>Contractor</td>
</tr>
</tbody>
</table>
| Underground cables and pipelines in the Ashuganj C/S sites | - Designing of compressor station should be compatible with the existing infrastructures.  
- The Contractor shall locate the pipelines and underground cables prior to commence construction works with due precautionary measures for the safety and integrity of the existing systems (i.e., underground pipelines, cables etc.) |                                  | Contractor                        |
| Existing pipeline on Bangadandhu Bridge (Jamuna Bridge) | - During designing the Elenga compressor station, assessment (hydraulic modeling, vibration analysis etc.) shall be performed for the impact on existing pipeline (30” dia) on Bangadandhu Bridge (Jamuna Bridge) for increased pressure after installation of compressor station to ensure the safety and integrity of the whole system.  
- HAZOP study should be carried out to ensure safety in operational phase. |                                  | Contractor                        |
| **B. Construction Phase**                   |                                                                                                 |                                  |                                   |
| Air pollution                               | - Water spraying during                                                                        | Conduct air quality              | Contractor. A                     |

HYUNDAI ENGINEERING CO., LTD.
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</table>
| Noise pollution                             | • Compressor station shall be sufficiently covered using sound and noise absorbing materials to absorb sound, noise and vibration.  
• Compressor station shall be sufficiently covered using sound and noise absorbing materials to absorb sound, noise and vibration.  
• Boundary wall may be constructed with sufficient height for abatement of noise pollution. | Conduct noise quality test to check with the specification. | Contractor. A surveillance team formed by implementing agency for monitoring. |
| Soil pollution                              | • Solid and liquid waste shall not be spread over the project site.  
• Oil Storage area should be paved with the catch drain with line pit.  
• Any spillage on the ground should be scraped and stored in a container for safe disposal.  
• Finally the spillage should be buried in a pit lined with geo-composite and HDPE liner. | Surveillance team to periodically visit the project site for enquiring soil pollution. | Contractor. A surveillance team formed by implementing agency. |
<p>| Drainage of surrounding areas              | Pipe culvert under approach road and surface drain pipes are to be constructed at surrounding points. |                         | Contractor.                                                                     |
| Temporary loss of resident wildlife habitat due to construction activities | Avoid too much noise. Check the noise level at site and at nearby homesteads. |                         | Contractor. A surveillance team formed by implementing agency. |
| Encroachment/Obstruction                   | Compensation shall be paid Checking                                     |                         | Contractor.                                                                     |</p>
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<td>to existing public and private land and properties</td>
<td>to the owners of land and structures for the loss of their crops or properties: compensation payment register</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underground cables and pipelines in the Ashuganj C/S sites</td>
<td>• The Contractor shall locate the pipelines and underground cables prior to commence construction works with due precautionary measures for the safety and integrity of the existing systems (i.e. underground pipelines, cables, etc.) • Rearrangement of the underground cables and pipelines shall be done, if required, keeping the integrity of the existing system during construction.</td>
<td></td>
<td>Contractor</td>
</tr>
<tr>
<td>Emission of radioactive material (X-rays and gamma waves(y)) during NDT - Non Destructive Testing operations of welding joints</td>
<td>• Radioactive source/materials used in NDT operation should be performed in a controlled and restricted area with proper notification and safety precautions. • The workers must wear the proper shielding (Pb/Steel) for protecting X-ray rays. Shielding includes Pb apron, Pb gloves etc. Experienced technicians shall be employed in a controlled setting/environment to minimize the emission of X-rays/γ-rays. • Rules and Regulation of Atomic Energy Commission of Bangladesh shall be followed.</td>
<td></td>
<td>Contractor</td>
</tr>
<tr>
<td>Crop damage</td>
<td>Excavated earth material should not be dumped over</td>
<td></td>
<td>Contractor</td>
</tr>
</tbody>
</table>

*HYUNDAI ENGINEERING CO., LTD.*
## Design–Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj

### HEALTH, SAFETY AND ENVIRONMENTAL PLAN

**DOC. NO.:** GTCL-CSP-HSE-000-FF-001  
**Rev.:** 0  
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<td>Labor Employment</td>
<td>Employment of local laborers should be prioritized.</td>
<td>Daily labor logbook checking</td>
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</tr>
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<td>Encroachment/Obstruction to existing public passage to highway</td>
<td>Provide alternative access road to the highway for the nearby inhabitants.</td>
<td>Alternative road construction plans and implementation thereof</td>
<td>Contractor</td>
</tr>
</tbody>
</table>
| Underground cables and pipelines in the Ashuganj C/S sites | • The Contractor shall locate the pipelines and underground cables prior to commence construction works with due precautionary measures for the safety and integrity of the existing systems (i.e. underground pipelines, cables, etc.)  
• Rearrangement of the underground cables and pipelines shall be done, if required, keeping the integrity of the existing system during construction | | Contractor |
| Emission of radioactive material (X-rays and gamma rays) during NDT «Non Destructive Testing» operations of welding joints | • Radioactive source/materials used in NDT operation should be performed in a controlled and restricted area with proper notification and safety precautions.  
• The workers must wear the proper shielding (Pb/Steel) for protecting X-ray/y-ray. Shielding includes Pb apron, Pb gloves etc. Experienced technicians shall be employed in a controlled setting/environment to minimize the emission of X- | | Contractor |
### Design-Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj

#### Health, Safety and Environmental Plan

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</table>
| Health and Safety of workers and surrounding people | - Necessary personal protective equipment (PPE) must be used by personnel working inside the station as a measure of safety.  
- Fire fighting equipment including fire hydrant should be kept in the project site.  
- The workers should be trained in health, safety and environment (HSE).  
- Proper manpower scheduling is required to ensure health & safety of workers.  
- Building awareness for surrounding people about the project activities, probable impacts and mitigation measures.  
- Proper sanitation facilities must be maintained inside the plant area and as well as inside the workers' colony. | Regular health check-up of workers.  
Monitoring of awareness raising activities such as publishing posters, billboards/signboards, safety signage etc. | Contractor |

#### C. Post Construction Phase

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<tbody>
<tr>
<td>Air pollution</td>
<td>Emission from compressor station (NOx, CO &amp; PM) should comply with the DoE standard.</td>
<td>Conduct air quality test to check with the specification</td>
<td>Contractor</td>
</tr>
<tr>
<td>Noise pollution</td>
<td>Noise level of the compressor station including metering runs should be maintained as per DoE standard</td>
<td>Conduct noise level test</td>
<td>Contractor</td>
</tr>
<tr>
<td>Surface water quality may deteriorate due to</td>
<td>- Sewage from plant and residential area should be</td>
<td>Conduct chemical water quality test</td>
<td>GTCL &amp; Contractor</td>
</tr>
</tbody>
</table>
Design-Build and Turnkey Supply, Construction, Testing, Commissioning and Operation & Maintenance of Natural Gas Transmission Pipeline Compressor Station at Ashuganj.

### Project Procedure

**Health, Safety and Environmental Plan**

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<td>Sewage/liquid waste-disposal</td>
<td>Kept in septic tank. No sewage should be dumped in the river or flood plain lands.</td>
<td>For DO, BOD etc</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Liquid waste and engine oils should be kept in tanks / drums to avoid contamination with water and soil. The liquid wastes may be incinerated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil pollution</td>
<td>* Solid and liquid waste shall not be spread over the project site.</td>
<td>Surveillance team to periodically visit the project site for enquiring soil pollution</td>
<td>Contractor: A surveillance team formed by implementing agency</td>
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<td></td>
<td>* Oil Storage area should be paved with the catch drain with line pit.</td>
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<td>* Finally the spillage should be buried in a pit lined with geo-composite and HDPE liner.</td>
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<td>Reduce habitat quality for vegetation and wildlife communities for the nearby homesteads</td>
<td>Reduce noise pollution by installing barriers both physically as well as biologically through developing green belt of local trees around the installation.</td>
<td>Monitor noise pollution and wildlife population periodically.</td>
<td>Contractor: A surveillance team formed by implementing agency</td>
</tr>
<tr>
<td>Health and Safety of workers and surrounding people</td>
<td>* Necessary personal protective equipment (PPE) must be used by personnel working inside the station as measure of safety.</td>
<td>Regular health check-up of workers. Monitoring of awareness raising activities such as publishing poster, bill board/signboards, safety signage etc.</td>
<td>GTCL &amp; Contractor</td>
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<td>* Fire fighting equipment including fire hydrant should be kept in the project site.</td>
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<td>* The workers should be trained in health, safety and environment (HSE).</td>
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<tr>
<td></td>
<td>* Proper manpower</td>
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</table>
### Impact

- Scheduling is required to ensure health & safety of workers.
- Building awareness for surrounding people about the project activities, probable impacts and mitigation measures.
- Proper sanitation facilities must be maintained inside the plant area and as well as inside the workers colony.

### Mitigation / Enhancement Measures

### Monitoring arrangements

### Responsible Party