Confidential

REPORT ON

RAPID ENVIRONMENTAL IMPACT ASSESSMENT & RISK ANALYSIS STUDY INCLUDING DISASTER MANAGEMENT PLAN

for

THE PROPOSED NATURAL GAS
DISTRIBUTION NETWORK

OF
GUJARAT ADANI ENERGY LTD.

IN
AHMEDABAD CITY,

AHMEDABAD CITY, DIST. AHMEDABAD GUJARAT

prepared by

TELOS RESK MANAGEMENT & INSURANCE BROKING SERVICES (P) LTD.

DECEMBER, 2003

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LIST OF ACRONYMS

	TO THE ACKONYMS
MQ	: Ambient Air Quality
AEL	: Adani Exports Limited
APHA	: Ahmedabad Municipal Corporation
AUDA	: American Public Health Association
Avg.	: Ahmedabad Urban Development Authority
BDL	: Average
	: Below Detectable Limit
CCOE	: Biological Oxygen Demand
Cd	: Chief Controller of Explosives
CFO	: Cadmium
	: Chief Fire Officer
CGS	: City Gate Station
CH₄	: Methane
CI	: Chlorides
CNG	: Compressed Natural Gas
CNS	: Central Nervous System
co	: Carbon Monoxide
CO ₂	: Carbon dioxide
СРСВ	: Chemical Oxygen Demand
Cr	: Central Pollution Control Board
Cu	: Chromium
D.G.	: Copper
	: Diesel Generator
dB (A)	: Decibel
DCP	: Dry Chemical Powder
DMP	: Disaster Management Plan
DO	: Dissolved Oxygen
- DRS	: District Regulating Station
ECR	: East
EIA	: Emergency Control Room
EMP	: Environment Impact Assessment
ENE	: Environmental Management Plan
EOC	- Cast North East
EPA	: Emergency Operations Center
ERO	- Environment Protection Agency
ERP	- Emergency Response Omanication
F&EI	: Lineagency Response Plan
Fe	Fire & Explosion Index
GAEL	: Iron
GAIL	: Gujarat Adani Energy Ltd.
GAPL	- Gas Authority of India Ltd
GI	Spirit roat if Port Ltd.
GIDC	- Tornsed from
GoG	The Action of Comment Comment
	: Government of Gujarat
Section and security and section and section and the section of th	

GPCB	: Gujarat Pollution Control Board
GPH	: General Process Hazards
GSEB	: Gujarat State Electricity Board
GSP(: Gujarat State Petroleum Corporation
GSPL	: Gujarat State Petronet Ltd.
GW	: Ground Water
HC	: Hydrocarbons
HSD	: High Speed Dissel
HVS	: High Volume Sampler
IIM - A	: Indian Institute of Management - Ahmedabad
IMD	: Indian Meteorological Department
IOCL	: Indian Oil Corporation Ltd.
IS	: Indian Standards
ISO	
ΠES	The standard of garrisation for Standardisation
К	THE SECTION OF THE
LDO	: Potassium
LFL	: Light Diesel Oil
LNG	: Lower Flammability Limit
	: Liquefied Natural Gas
LDC.	: Low Pressure
LPG .	: Liquefied Petroleum Gas
LSHS	: Low Sulfur Heavy Stock
Max.	: Maximum
MCLS'	: Maximum Credible Loss Scenarios
MCR	: Master Control Room
MD	: Managing Director
MDPE	: Medium Density Polyethylene
MF	: Material Factor
Min.	: Minimum
MOC	: Material of Construction
MOEF	
MOU	or Environment & Forests
MPN	- The standard of Orderstanding
MRS	- Todake Nulliker
MS ERW BK/BL	Industrial Metering & Regulating Station
MSDS	. Mild Steel Electric Resistance Welded Bewel End
MSL	: Material Safety Data Sheets
N N	: Mean Sea Level
N.S.	: North
Na	: Not Specified
	: Sodium
NAAQS	: National Ambient Air Quality Standards
NE	: North East
NFPA	: National Fire Protection Association
VG	: Natural Gas
NH	: National Highway
VID · OIV	: National Institute of Design
40C	: No Objection Certificate

NO _x	: Nitrogen Oxides
NTU	: Nephelometric Turbidity Unit
w	: North West
OG	: Out Growths
OISD	: Oil Industry Safety Directorate
Pb	: Lead
PE	: Poly Ethylene
PHA	: Preliminary Hazard Analysis
ppm	: parts per million
PM	: Particulate Matter
PRS	
PRV	Pressure Regulating Station Pressure Reducing Valve
PUC	: Pollution Under Control
R&B	Roads & Building
RA	: Risk Analysis
REIA	
ROU	ASSESSMENT STURY
RPM	- grit of ose
RTO.	: Respirable Particulate Matter
S	: Road Transport Office
SAR	South
SCADA	: Sodium Absorption Ratio
SCBA	: Supervisory Control & Data Acquisition System
SCMD	Self Contained Breathing Apparatus
SE	Standard Cubic Metre / day
SH	: South East
	: State Highway
SO₂	: Sulfur Dioxide
SO ₄	: Sulfates
SPH	: Special Process Hazards
SPM	: Suspended Particulate Matter
SR	: Service Regulator
SW	: South West
TDS	: Total Dissolved Solids
<u> Telos</u>	: Telos Risk Management & Insurance Broking Services (P) Ltd.
SS	: Total Suspended Solids
I/C	: Under Construction
JFL	: Upper Flammability Limit
JHF .	: Unit Hazard Factor
SEPA	: United States Environmental Protection Agency
VCE	: Unconfined Vapour Cloud Explosion
/	: West
n ·	: Zinc

EXECUTIVESUMMARY

Introduction

ADANI Group, a leader in Trading & Infrastructure Development is one of the fastest growing corporate houses in India with diversified interest & businesses and a consolidated tumover of over Rs.4,500 crores.

The Adani Group has under its banner various companies such as Adani Exports Limited (AEL), the flagship company of the Adani Group and the largest export house in the country today. The other group companies are Gujarat Adani Port Limited (GAPL) for development of port facilities in the country, Adani Wilmar Limited, operating the edible oil refinery for manufacture of refined oil and vanaspati, B2C India Limited for retail marketing business in the country and iCall India Limited, a leading edge IT enabled service (ITES) company specializing in outsourced customer care solutions.

In line with the Adani Group's vision to be globally competitive and to establish leadership in trading and infrastructure, the group has developed comprehensive in-house capabilities and created a pool of knowledge to develop world class infrastructure projects in the country over a short period of time. So also, the Adani Group has acquired rich experience in procuring, trading, supplying and providing logistics support for energy products to its customers. Its trading portfolio boasts of several energy-related products such as Coal, Coke, Furnace Cil, Biturnen and Superfine Kerosene Oil.

In the energy sector, Natural Gas (NG) is fast becoming the most preferred fuel for customers' world wide considering the numerous advantages NG has over the other conventional fuels. Gas distribution through pipelines is the most economical way of providing clean energy at the customer premises.

Recognising the huge potential of such gas distribution business, the ADANI Group has formed a subsidiary called Gujarat Adani Energy Limited (GAEL) to explore, evaluate and implement various opportunities in the gas distribution sector. This finds basis in the encouragement received in the State for gas based industrial development due to the announcement of Government of Gujarat's (GoG) Interim Policy on gas distribution network (vide Resolution No. GPC-10-2002-623-E dated July 18, 2002) to ensure development of gas distribution networks in the State.

This finds basis in the encouragement received in the State for gas based industrial development due to the announcement of Government of Gujarat's (GoG) Interim Policy on gas distribution network (vide Resolution No. GPC-10-2002-623-E dated July 18, 2002) to ensure development of gas distribution networks in the State. As per the provisions of the Interim Policy, the GoG has awarded "No Objection Certificate" (NOC) (vide letter DOP/NOC/2/2003 dated April 21, 2003) to GAEL for setting up of the NG distribution network in the cities of Ahmedabad and Vadodara in the State of Gujarat. The project aims to of Gujarat.

As per the existing applicable legislation, preparation of Environmental Impact Assessment (EIA) study is not required for pipeline projects by the regulatory authorities. However, proposed project requires to obtain consent to establish from the Gujarat Pollution Control Board (GPCB) prior to commencing construction of the NG distribution network. GAEL though has no obligations to carry out an Environmental Impact Assessment (EIA) study; it has carried out an EIA study for their NG distribution project in Ahmedabad as a good management practice in line with their internal corporate requirement.

GAEL has retained Telos Risk Management & Insurance Broking Services (P) Ltd. (Telos) to carry out the Rapid EIA study (REIA) study for the above-mentioned proposed projects. For the purpose of carrying out the baseline data collection and impact assessment for the REIA study, area covered by the NG distribution pipeline project has been considered as the study area.

This report presents the findings of the REIA study for the Ahmedabad NG distribution project.

Background and need of the project

Energy is the key to development and success of human society today. Of the various energy generation sources, thermal energy sources finds wide application considering the ease of availability, ease of operability and affordable technology in any part of the country.

Depleting reserves and high pollution potential in terms of Particulate Matter (PM) and Sulfur Dioxide (SO₂) of the conventional fuels, coupled with the ever increasing stringent environmental regulatory framework in the country has forced the fuel consumers to look for available cleaner fuel alternatives.

In this scenario, NG, one of the cleanest fuels, has emerged as the most preferred fuel considering the numerous advantages it has over other conventional fossil fuels. The advantages lie in the fact that:

- NG is a most energy efficient fuel: NG offers several economic benefits to users, as equipments based on gas offer higher efficiencies and lead to significant savings.
- NG is a clean fuel: Combustion of NG results in virtually no atmospheric emission of Suspended Particulate Matter (SPM) and SO₂ as compared to other fossil fuels such as coal, fuel oils, etc.
- There is potential for use of NG in various sectors such as industry, commercial establishments, domestic use as well as transportation
- Safe, easy to use and continuous availability ("On Tap")

- Pricing comparable to other conventional fuels (based on heat content)
- . Based on the survey instituted by GAEL in the city of Ahmedabad, approximate fuel consumption for which consumers have indicated interest for substitution by NG is 10,70,000 Standard Cubic Metres/day (SCMD), the break-up of which is provided in **Table 1**. This NG requirement shall be catered in a phased manner over a period of 6 7 years. This is considering the use of fuel in various sectors such as industrial, commercial establishments, transportation as well as domestic use.

Table 1: Estimated fuel demand in the city of Ahmedabad likely to be substituted by NG

Type of fuel	Quantity (
Naphtha	Quantity (units)	NG Equivalent Quantity (SCMD)
Fuel Oil	· 128,570 (kg/day)	150,000
	161,050 (Vday)	170,000
LDO	75,789 (Vday)	
LPG	1,62,855 (kg/day)	80,000
Coal / Lignite		190,000
Petrol	360,000 (kg/day)	200,000
Diesel Oil	250,000 (l/day)	250,000
	22,750 (Vday)	30,000
TOTAL		
		10,70,000

The break-up of equivalent NG demand for use in various consumer sectors is approximately 10,70,000 SCMD and is presented in **Table 2**. The basis for this demand is substitution of existing conventional fuels by NG by various users as well as additional demand of the existing NG users in the Ahmedabad region.

Table 2: Estimated demand of NG for various Demand Centres in and around the city of Ahmedabad

Sector type	Types of units in the	Load Center	Expected Demand
Industrial	Chemicals, fertilisers, glass, plastics,		(SCMD)
	dyes, engineering, etc. in the Large, Medium and Small scale	Odhav area	30,000
		Vatva ·	130,000
		Naroda	150,000
		Narol	200,000
The state of the s		City Area	90,000

Sector type	Types of units in the sector	Load Center	Expected Demand	
Compercial	Restaurants, hotels, hospitals, etc.		(SCMD)	
Domestic	Households		40,000	
Transportation	Mainly petrol driven vehicles - 4		150,000	
TOTAL	Mainly petrol driven vehicles not complia	int with EURO II norms	280,000	
A CAST TO SEE THE PART THE SEE			10,70,000	

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As can be seen from **Table 2**, the maximum demand i.e. 600,000 SCMD is for the industrial consumers due to the fact that air emissions norms are becoming stringent and meeting such stringent norms results in higher pollution control and monitoring costs. However, the demand for the transportation sector shall be vehicles. This is considering the high cost of retrofitting for diesel driven vehicles for conversion to CNG as fuel.

Hence, to meet the demand of NG, a cleaner fuel and thus the NG distribution network is the need of the hour. Development of such NG distribution network in the Gujarat State is now possible considering the enabling environment created by the interim policy of GoG coupled with the measures undertaken by the Central Government to import NG as Liquefied NG (LNG) or through pipelines.

GAEL is evaluating various options for sourcing gas for this project. It has signed a Memorandum of Linderstanding (MOU) with Indian Oil Corporation Limited (IOCL) for the supply of gas and discussion is at very advanced stage with Gujarat State Petroleum Corporation (GSPC) for gas supply for its project. NG is proposed to be supplied at Ahmedabad through the Gujarat State Petronet Ltd. (GSPL) NG pipeline which is under construction between Vadodara & Ahmedabad. The GSPL pipeline will receive the NG supply from the LNG receiving terminals of Petronet LNG Ltd. at Dahej and gas fields of Caim Energy, Niko Resources for its onward distribution.

Benefits of the proposed Project

Reduction in Air Pollution potential

The major benefit of setting up the proposed NG distribution network is its potential to substitute the conventional fuels, especially the industrial and transportation fuels thereby improving the urban air quality.

For the Ahmedabad network, various large industrial units such as Arvind Mills, Ashima Mills, Calico Textile Mills, Omkar Mills, Soma Textiles, MH Mills, Asarwa Mills, Jindal Texofab, Chiripal Group, etc. have evinced interest in use of NG as fuel. Other medium and small industries from chemicals, dyes, engineering and plastics sectors have also indicated interest in use of NG as fuel.

Apart from the above, a large number of commercial establishments and domestic consumers shall also be switching over to NG as fuel. Demand for NG is also for the transportation sector, though mainly for petrol driven vehicles considering the high cost of retrofitting for diesel driven vehicles.

It is estimated that when a substantial portion of currently used conventional fuels are substituted with NG for energy needs in Ahmedabad area, total pollution load in this area from these activities will be significantly reduced. The expected avoided emissions due to the fuel substitution by NG are presented in **Table 3**.

Table 3: Expected avoided emiscions due to fuel substitution by NG (for industrial, commercial and domestic users)

(kg/day)		indus	1				
	NG	LPG	Type of	Furnace	Coal	Expected Avoided	% decrease
SPM	32.1	18.56	54.49	481.54	120044.5	emission	increase
NOx	2675	607.54	599.41		32911.2	-33433.7	-99
S() ₂	10.7			863.23	2952	-2347.2	-47
		0.56	4073.24	12136.73	3267	-19466.8	ļ
CO	1070	96.2	599406.4	425172	425.0		-99
CO₂	2054400	482658.3	4073.24		435.6	+305,35	+40
•	٠.		4073.24	12136,73	Emission factor not	+547163.4	+36
CH4	42.8	6.75	Emission	Cminai	specified		
			factor not specified	Emission factor not specified	Emission factor not specified	+36.04	+534

As can be seen from Table 3, there will be a significant decrease in SPM and SO₂ emissions to the extent of approximately 99% and moderate decrease in NO_X emissions to the extent of 47%. However, there will be a significant increase in Methane (CH₄) emissions as well as moderate increase in Carbon Monoxide (CO) and Carbon Dioxide (CO₂) emissions due to fuel substitution by NG.

As for the transportation sector, a decrease of approximately 16.67% to 93% of CO and 19.37% to 28.3% of Hydrocarbon (HC) emissions for diesel buses and cars respectively are expected due to fuel substitution by

Improved Energy Efficiency

NG offers several economic benefits to users, as equipments based on gas offer higher efficiencies and lead to significant savings. The overall efficiency of NG from source to end-user is reported to be about

Proposed NG distribution project and relevant details

The NG distribution network shall comprise tap-off points from the main GSPL pipeline, City Gas Stations (CGS), Pressure Regulating Stations (PRS), Industrial Metering & Regulating Stations (MRS), District Regulating Stations (DRS), Service Regulators (SR) as well as CNG stations.

The coverage of the NG distribution network is mainly the city area of Ahmedabad as well as the Gujarat Industrial Development Corporation (GIDC) industrial areas of Odhav, Vatva, Narol and Naroda. NG demand is by the large, medium and small-scale industries located near the Ahmedabad city as well as in the industrial areas, commercial establishments, domestic users as well as transportation sector in the area.

Based on the demand requirements, the NG distribution network*project is proposed to be developed both in East and West Ahmedabad in Phase 1 & 2 respectively as follows:

Tap-off points shall be taken from the GSPL pipelines at:

- Bibipura (near Ramol) terminal to cater to the NG demand of Vatva, Narol, Odhav, Naroda & East
- Koba (near Koba circle) terminals to cater the demand of West Ahmedabad city.

Of the two CGSs, one will be located at Bibipura (near Ramol) near GSPL terminal and the other opposite

Minus sign indicates % decrease in emissions and Plus sign indicates % increase in emissions

CNG stations will be also developed as part of the project. Approximately 30 CNG on-line stations have been planned over a period of 6 – 7 years distributed in the entire city based on the CNG demand. Of these, 5 are planned in Phase 1 & 2 of the project. These could either be located in the premises of existing petrol pumps or snall be as independent units.

In addition to the above the following industrial areas will also be covered by the proposed network:

- Odhav Gujarat Industrial Development Corporation Ltd. (GIDC) industrial area located about 19 km south-east of Ahmedabad city.
- Vatva GIDC industrial area located about 7 km south-east of Ahmedabad city.
- Narol GIDC industrial area located about 6 km south of Ahmedabad city.
- Naroda GIDC industrial area located about 10 km north-east of Ahmedabad city.

Proposed project area description and relevant details

As mentioned above, the proposed NG distribution network will be developed to cover mainly the city of Ahmedabad and the surrounding GIDC industrial areas of Odhav, Vatva, Narol and Naroda in the Ahmedabad taluka. The co-ordinates of the area to be covered under the proposed NG distribution network

Latitude: between 22° 55' N to 23° 05' N and Longitude: between 72° 30' E to 72° 45' E

Thus, an approximate area of 325 km² is proposed to be covered under the NG distribution network in and around Ahmedabad city.

The city of Ahmedabad is one of the oldest and principal cities and the leading industrial centre in Gujarat. It was founded by a Muslim ruler Sultan Ahmed Shah (hence Ahmedabad) in the year 1411. The city is situated on the banks of Sabarmati river which traverses almost through the mid of the city. In fact, it can be said that the NG distribution project would be equally divided on either side of river Sabarmati.

Ahmedabad is one of the major cities on the national rail and road network joining Mumbai with Delhi through Western Railway Main line and National Highway (NH) No. 8. All major super fast and express trains halt at Ahmedabad Railway Station. Ahmedabad has an airport, which is well connected with the

Various industrial areas such as Odhav, Vatva, Narol, Naroda, etc. have been developed by GIDC, the industrial development authority in Gujarat.

A large part of the population resides in households, which are either bungalows or multi-storey flats. With the rising population, the trend has been shifting towards the flat system. Some of the population also resides in low-income group houses as well as hutments. Recently developed residential areas are the Satellite Nagar, Memnagar, Chandkheda, Bopal, Vastrapur, Motera, etc.

Ahmedabad city has good infrastructure in terms of road network, transportation, water supply, sewage network, medical and educational facilities, fire-fighting facilities, and other community facilities, etc.

The road network is well developed in the new parts of the city being well spaced as well as having adequate Right of Use (ROU) for future development. However, the old city being already congested has very narrow roads. Public transport vehicles within the city include buses, auto rickshaws and taxis. There are few private bus services too. Of course, there are many people who use their own vehicles - cars, scooters, motorcycles and bicycles. Private taxis are also available.

Water supply is mainly from Kadana dam located on Sabamati river, approximately 165 km from the city of Ahmedabad. Water supply to industrial locations is from Sabarmati River.

The major river in the study area is Sabarmati river with Vaheva nadi and Khari nadi being the smaller ones. There are other water bodies such as Vatva Branch canal, Kharicut canal and Narmada Main canal in the study area. Chandola and Kankariya lakes are the other water bodies in the study area.

The area is fairly level with no major undulations or abrupt changes in the terrain. The maximum and minimum elevation encountered in the area is 78 - 40 m respectively. Surface soil in the area is

The area falls under seismic Zone-III as per the IS classification 1893-1984, where the intensity of earthquake as per Modified Mercalli scale is VII or below. Heavy tremors were felt and damage occurred in Ahmedabad city during the Bhuj earthquake of January 2001.

Components of the proposed NG distribution project

The following facilities are proposed as part of the NG distribution network:

- Main tap-off point from the GSPL main NG pipeline
- City Gate Station (CGS) including infrastructure facilities such as buildings, control room, odorant injection, pressure reduction, water supply, drainage, etc.
- NG distribution network comprising primary network (i.e. Main Trunk line and Steel Spur lines) and secondary network (i.e. MDPE network) including PRS, DRS, SRs and MRSs.
- CNG stations for the transportation sector

Salient features of the NG distribution network are as follows:

- Graded pressure regime throughout the network
- Addition of odorant to facilitate early leak detection
- On-line metering

- Primary network operation pressure between 19 barg to 4 5 barg with steel as Material of Construction
- Secondary network operation pressure between 4 5 barg and 110 to be developed mainly in MDPE (PE 100 Grade) pipes which shall be orange coloured and tested as per ISO 4437 and/ ISO 9080. "Loops" are developed at strategic points on the network to give some redundancy of gas supply and thus increase the overall reliability.
- The entire gas distribution network to be managed through a Master Control Room (MCR) equipped with Supervisory Control & Data Acquisition System (SCADA) and other associated communications systems. Also an Emergency Control Room (ECR) to handle emergencies of serious nature in the city.
- For various pipelines, all required guidelines as specified by the OISD shall be followed. All the pipelines shall be underground at a minimum depth of 1 m. At the railway/ river/ highway crossings, the pipelines shall be with a "casing" and a minimum depth of 2 m shall be maintained. At every suitable distance and at all demand points, isolation valves shall be provided.
- Where the pipeline shall cross third party utilities, a minimum distance of 0.5 m shall be maintained. Cathodic protection shall be provided for the steel network by proper bonding of the existing utility
- The steel pipeline network shall be hydro-tested before commissioning of the system. No hydro-testing is required for the PE network.

Routing of the proposed NG pipeline network

For routing of the NG distribution network, apart from the main consideration of maximum reach to potential demand centres with minimum length, the pipeline route has been firmed up bearing in mind various

- Use of existing defined pipeline comdors by respective authorities
- Easy and favourable terrain conditions free of large water bodies, low lying marshy lands, obstacles like ravines, depressions and unstable grounds, meandering rivers, etc.
- Ground profile for pipeline hydraulics and avoidance of steep rising and failing ground, hills and valleys
- Shortest pipeline length with minimum number of bends to the extent possible so as to disturb least
- Availability of infrastructure and access to the pipeline route during construction and maintenance

A preliminary list of species suitable for green belt development based on the above considerations is as

Sr. No.	Local Name		
	Babool	English Hame	
2.	Neem	Acacia nilotica	
	Tamrind	Azardiracta indica	
		Tamorindus indica	
·	Eucalyptus	Eucalyptus sps.	
	Rose	Rosa domascena	
	Tulsi	Ocimum sanctum	
	Peacock Flower		
	Sweet Acacia	Delonix oragia	
	· · · · · · · · · · · · · · · · · · ·	Acacia femesiona	

Risk Analysis

The NG network is designed to supply the gas to industrial and domestic consumer for which the pressure

In case of a leak, the gas being lighter than air will rise upwards if it takes place in the open, which is comparatively safe if ignition takes place. But a NG leak in a confined space would be disastrous. It is seen that dispersion to LFL level concentration is 8.5 m at a wind speed of 3 m/s and atmospheric stability D which is normally expected in the region. In the vehicle refuelling area the LFL distance is 63 m as the pressures are as high as 250 bar. Any unignited NG leak in the open would require about 10 m clearance all around to be freed of combustibles. Any NG gas fire should be handled by cutting off-the gas supply.

All NG pipelines whether underground or aboveground require to be tagged to alert any third party carrying out excavation work in the vicinity of your NG pipeline.

It is important that a system has to be in place for detecting drop in gas pressure due to leaks in the pipeline.

All recommendations suggested for laying the NG pipelines should be followed along with the requirement

On-Site Disaster Management Plan

An On-Site Emergency Plan has been formulated for the existing as well as proposed operations to ensure its effective implementation for quick deployment of the emergency response organisation. The Plan

- Accident Initiation and Raising the Alarm
- Accident Evaluation and Classification of On-Site Emergency Declaration
- Off-site and External Agency Notification (when required)
- Implementation of On-site Response Actions
- Implementation of Protective Actions and Evacuation
- Co-ordination of Response Actions with External agencies
- Effective Management of the Emergency Resources

Conclusion

As is evident from the above discussion, the proposed NG distribution project is a beneficial project for the city of Ahmedabad. The project will help in contributing significantly towards improving the air quality environment of the area due to substantial substitution of conventionally used fuels by NG, a clean fuel. The improvement will be mainly in terms of reduction of SPM, SO_2 and NO_X emissions. The fuel usage efficiency

in industrial processes is likely to increase due to the fact that NG has higher energy efficiency than the conventional fuels.

The environmental impacts, mainly during the construction stage shall be addressed comprehensively in order to ensure that these are either eliminated or reduced to the minimum. The construction schedule shall be implemented. Appropriate waste management procedures shall be in place during the operational phase to ensure that environmental impacts are adequately addressed.

Improvement in air quality will result in better and healthier environment for the people in the area and thus having indirect benefits in terms of reduced medical expenses contributing to betterment of the economy of the area. Benefits in terms of improved revenue by way of sales tax earned from the sale of NG in the city as well as octroi on the project plant & machinery for the state and local bodies will also be there due to the

Hence the proposed project will have an overall beneficial effect on the environment as well as socio-



INTRODUCTION

1.1 Background

ADANI Group, a leader in Trading & Infrastructure Development is one of the fastest growing corporate houses in India with diversified interest & businesses and a consolidated tumover of over Rs.4,500 crores. Recognizing the growing need for competitive infrastructure in the country, the Adarii Group's vision is to be globally competitive and to establish leadership in trading and infrastructure. In line with its vision, the group has developed comprehensive in-house capabilities and created a pool of knowledge to develop world class infrastructure projects in the country over a short period of time. With every project, the Adarii Group has acquired core skills and resources to implement and operate high value projects. The Adarii Group today is truly a rich blend of entrepreneurship, skill and experience

The Adani Group has under its banner various companies such as Adani Exports Limited (AEL), the flagship company of the Adani Group and the largest export house in the country today. AEL is the first trading house to be awarded the prestigious "Golden Super Star Trading House" status by Government of India. The other group companies are Gujarat Adani Port Limited (GAPL) for development of port facilities in the country, Adani Wilmar Limited, operating the edible oil refinery for manufacture of refined oil and vanaspati, B2C India Limited for retail marketing business in the country and iCall India Limited, a leading edge IT enabled services (ITES) company specializing in outsourced customer care solutions.

Realizing the potential of increased energy requirement in the country, the Adani Group has acquired rich-experience in procuring, trading, supplying and providing logistic support for energy products to its customers. Its' trading portfolio boasts of several energy related products such as Coal, Coke, Furnace Oil, Bitumen and Superfine Kerosene Oil.

Considering the numerous advantages NG has over other fuels, it is fast becoming the most preferred fuel for the customers' world wide. Gas distribution through pipelines is the most economical way of providing clean energy at the customer premises. Recognizing the huge potential of such gas distribution business, the Adani Group has formed a subsidiary called Gujarat Adani Energy Limited (GAEL) to explore, evaluate and implement various opportunities in the gas distribution sector.

This finds basis in the encouragement received in the State for gas based industrial development due to the announcement of Government of Gujarat's (GoG) Interim Policy on gas distribution network (vide Resolution No. GPC-10-2002-623-E dated July 18, 2002) to ensure development of gas distribution networks in the State. As per the provisions of the Interim Policy, the GoG has awarded "No Objection Certificate" (NOC) (vide letter DOP/NOC/2/2003 dated April 21, 2003) to GAEL for setting up of the NG distribution network in the cities of Ahmedabad and Vadodara in the State of Gujarat. The project aims to of Gujarat.

As per the existing applicable legislation, preparation of Environmental Impact Assessment (EIA) study is not required for pipeline projects by the regulatory authorities. However, proposed project requires to obtain the NG distribution network, GAEL though has no obligations to carry out an Environmental Impact Assessment (EIA) study; it has carried out an EIA study for their NG distribution project in Ahmedabad as a good management practice in line with their internal corporate requirement.

GAEL has retained Telos Risk Management & Insurance Broking Services (P) Ltd. (Telos) for carrying out the Rapid Environmental Impact Assessment (REIA) study including Risk Analysis (RA) and On-site Disaster Management Planning (DMP) of the proposed NG distribution network in the city of Ahmedabad in GAEL.

1.2 Proposed project and its objectives

The proposed project comprises setting up of NG distribution networks in the city of Ahmedabad in Gujarat' State. NG shall be used for industrial, commercial ε nd domestic purposes as well as in the transportation sector. This is mainly with the objective of supplying a cleaner and environment friendly fuel as a substitute for conventionally used fuels such as coal, furnace oil, wood, petrol, diesel, etc. to maximum number of users.

In executing the above project, GAEL shall not only adhere to the accepted codes of practice but strive to create new benchmarks in environment and safety standards.

1.3 Background and need of the project

Energy is the key to development and success of human society today. Energy fuels our industries, provides us our modern lifestyle, lights and conditions our homes, helps cook our food and powers our vehicles.

Energy can be generated from various sources such as thermal i.e. combustion of fuels, hydroelectric i.e. use of water and other non-conventional sources such as wind, solar, geothermal, etc.

Energy generation using thermal energy sources finds wide application considering the ease of availability, ease of operability and affordable technology in any part of the country. Conventionally used fuels in the industrial as well as transportation sector have been coal, wood, lignite, fuel oils (furnace oil, High Speed Diesel (HSD), Light Diesel Oil (LDO), Low Sulfur Heavy Stock (LSHS)), etc. due to their easy availability. LPG finds wide use as a fuel mainly in the domestic as well as commercial sector.

Based on the survey instituted by GAEL in the city of Ahmedabad, approximate fuel consumption for which consumers have indicated interest for substitution by NG is 10,70,000 Standard Cubic Metres/day (SCMD), the break-up of which is provided in **Table 1-1**. This NG requirement shall be catered in a phased manner over a period of 6 - 7 years. This is considering the use of fuel in various sectors such as industrial, commercial establishments, transportation as well as domestic use.

Table 1-1: Estimated fuel demand in the city of Ahmedabad likely to be substituted by NG

Type of fuel	Quantity (units)	NG Equivalent Quantity (SCMD)
Naphtha	128,570 (kg/day)	150,000
Fuel Oil	161,050 (May)	170,000
LDO	75,789 (Vday)	80,000
LPG	162,855 (kg/day)	190,000
Coal/ Lignite	360,000 (kg/day)	200,000
Petrol	250,000 (Vday)	250,000
Diesel Oil	22,750 (Vday)	30,000
Total		1,070,000

However, inspite of the wide use of fuels for various applications, these conventional fuels have a high air pollution potential mainly due to the high atmospheric emissions of Particulate Matter (SPM) and Sulfur Dioxide (SO₂) due to fuel combustion. The fact also remains that the reserves of such fossil fuels are fast dwindling due to their overuse and excessive demand. Though the fuel demand is on the rise due to the increasing development, the above mentioned reasons coupled with the ever increasing stringent regulatory framework in the country has forced the fuel consumers to look for available cleaner fuel alternatives.

In this scenario, NG, one of the cleanest fuels, has emerged as the most preferred fuel considering the numerous advantages it has over other conventional fuels. The advantages lie in the fact that:

NG is a clean fuel - Combustion of NG results in virtually no atmospheric emission of SPM and SO₂ as compared to other fossil fuels such as coal, fuel oils, etc. Estimated air emissions from combustion of

NG and other conventional fuels are provided in **Table 1-2**. These emissions are estimated based on US EPA AP-42 emission factors for fuel combustion. An average emission factors for a particular fuel type considering different firing methods as well as capacities of combustion equipment is considered for arriving at an approximate emission factor. Vehicular emissions considering NG as fuel vis-à-vis other fuels such as petrol/ diesel are provided in **Table 1-3**.

- NG is a most energy efficient fuel According to a study by the U.S. Department of Energy, overall efficiency of NG from source to end-user is about 91%. In other words, more than 9 out of 10 units of equipment have low maintenance requirements as well as down time.
- NG finds use in various sectors such as industry, commercial establishments, domestic use as well as transportation In the industrial sector, NG is used for energy generation i.e. both power and thermal energy. The combination of high efficiency and low emissions at each point along the energy cycle lead to comparative economic and environmental superiority of NG as fuel. NG is also used as feedstock for fertilizer and petrochemical industries. In the commercial establishments, NG finds wide usage for cooking fuel as well as heating requirements. In the domestic sector, NG finds application as a is being the most preferred fuel option due to reduction in pollution potential as well as economic benefits it provides due to lower running cost as compared to conventional vehicle fuels.
- The hassle free transportation as well as logistics of receiving NG make it the most preferred fuel for use in industrial sector.
- Similarly, in the domestic sector as well as commercial establishments, NG is the one of the most preferred fuel option because of ease of use, continuous availability ("On Tap") as well as safety.
- Pricing of NG is comparable to other conventional fuels considering the heat content of various generally used conventional fuels as provided in Table 1-4.

Table 1-2: Fuel combustion emissions from burning of NG and other conventional fuels

Type of fuel	Air Pollutant							
	PM (kg/m³)	NO _x (kg/m³)	SO ₂ (kg/m³)	CO (kg/m³)	CO ₂ (kg/m³)	CH ₄ (kg/m³)		
Natural Gas (NG)	0.00003	0.0025	0.00001	0.001	1.92	- 		
LPG (based on butane)	0.066	2.16	0.002	0.342	1716	0.00004		
Fuel Oil - Distillate Oil (considering 1% as S content, includes Naphtha and LDO)	0.24	2.64	17.94	0.6	2640	N.S. ¹		
Fuel Oil - Residual oil (considering 4% as S content and 1% as ash content) —	2.99	5.36	75.06	0.6	2640	N.S.		
Coal, Lignite	91.42 kg/ton	8.2 kg/ton	9.075 kg/ton	1.21 kg/ton	N.S.	N.S.		

¹ N.S. means Not Specified

Table 1-3: Vehicular Emissions (2)

Type of Vehicle	Air Pollutant	Petrol	Diesel	СИС	% Reduction
.Passenger Ca	ers				
Maruti Omni	CO (g/km)	19.79	N.P,	0.55	
	HC (g/km)	1.14	N.P.		97
Maruti Gypsy	CO (g/km)	4.94	N.P.	1.02	11
	HC (g/km)	1.86	N.P.	0.59	88
Premier	CO (g/km)	18.38	N.P.	1.42	24
Padmini	HC (g/km)	2.83	N.P.	0.94	95
Premier 118 NE	CO (g/km)	15.6	N.P.	2.03	28
	HC (g/km)	2.57	N.P.	2.04	87
Ambassador	CO (g/km)	52.16	N.P.	1.92	25
	HC (g/km)	6.37	N.P.	0.78	98
Autorickshaws			IN.F.	4.33	32
Bajaj Three	CO (g/km)	3.26	N.P.	T.	
Wheelers	HC (g/km)	5.48		1.26	61.35
	00 / 1	47.44	N.P.	1.57	71.35
	110	0.25	N.P.	27.6	41.82
Diesel Buses	, vox (grany	0.25	N.P.	0.2	20
Ashok	CO (g/km)		1		
eyland		N.S.	1.68	1.4	16.67
ŀ	10	N.S.	4.5	3.77	19,37
	NO _x (g/km)	N.S.	13.73	8.0	41.77

Table 1-4: Comparison of fuel pricing based on calorific values

Type of fuel	Calorific value	Price (Rs.)		
			Price (Rs.)/calorific	
NG	9000 kcal/ m ³	9/ m ³	0.001/kcal	
LPG	10500 kcal/kg	19.3/kg		
Furnace Oil	9500 kcal/litre	12/itre	0.0018/kcal	
LDO	10000 kcal/litre		0.0013/kcal	
Coal		14/litre	0.0014/kcal	
	4500 kcal/kg	2.5/kg	0.0006/kcal	
Lignite	3500 kcal/kg	1.5/kg	0.0000/kg/l	
Wood	2500 kcal/kg	0.8/kg		
Naphtha	11000 kcal/litre		0.0003/kcal	
	The state of the s	18/ktre	0.0016/kcal	

² Based on information of ARAL/ VROX

Based on the survey, equivalent NG demand for use in various sectors is approximately 10,70,000 SCMD, break-up of which is presented in Table 1-5. The basis for this demand is substitution of existing conventional fuels by NG by varicus users as well as additional demand of the existing NG users in the Ahmedabad region. The existing NG users in the area are Indian Farmers & Fertilizers Co-operative Ltd. (IFFCO) and Ahmedabad Electricity Company (AEC) receiving the NG supply from Gas Authority of India Ltd. (GAIL). However, these industries are in huge scarcity of NG. Moreover, no piped gas network exists in the city of Ahmedabad for use by the other industrial units as well as for use in the commercial and domestic

Table 1-5: Estimated demand of NG for various Demand Centers in and around the city of Ahmedabad

Sector type	Types of units in the sector	Load Center	Expected Demand (SCMD)
Industrial	Chemicals, fertilizers, glass, plastics, dyes, engineering, etc. in the Large, Medium and Small scale	Odhav area	30,000
		Vatva	130,000
		Naroda	150,000
		Narol	200,000
Commercial	Rectaumata batat	City Area	90,000
Domestic	Restaurants, hotels, hospitals, etc. Households		40,000
Transportation			150,000
	Mainly petrol driven vehicles not complinorms	ant with EURO II	280,000
TOTAL	,		
		•	10,70,000

As can be seen from Table 1-5, maximum demand i.e. 600,000 SCMD is for the industrial consumers. This is due to the fact that air emissions norms are becoming stringent and meeting such stringent norms results in additional expenses in terms of pollution control equipment as well as monitoring costs for the industries. However, the demand for the transportation sector shall be mainly there only of the government makes the use of CNG compulsory in vehicles. This is considering the high cost of retrofitting for diesel driven vehicles for conversion to CNG as fuel.

Hence, to meet the demand of NG - a cleaner fuel, the need for NG distribution network is the need of the hour. Development of such NG distribution network in the Gujarat State is now possible considering the enabling environment created by the interim policy of GoG. Coupled with this are measures being undertaken by the Central Government to import NG as Liquefied NG (LNG) or through pipelines increasing the availability of gas in the country creating conducive environment for accelerated use of NG.

GAEL is evaluating various options for sourcing gas for this project. It has signed a Memorandum of Understanding (MOU) with Indian Oil Corporation Limited (IOCL) for the supply of gas and discussion is at very advanced stage with Gujarat State Petroleum Corporation (GSPC) for gas supply for its project. NG is proposed to be supplied at Ahmedabad through the Gujarat State Petronet Ltd. (GSPL) NG pipeline which is under construction between Vadodara & Ahmedabad. The GSPL pipeline will receive the NG supply from the LNG receiving terminals of Petronet LNG Ltd. at Dahej and gas fields of Caim Energy, Niko Resources and GSPC at Hazira. Through multiple "tap-off" points on this pipeline, GAEL shall take the delivery of gas

Thus, based on the above discussion, it can be said that the proposed NG distribution network for the city of

1.4 Benefits of the proposed Project

1.4.1 Reduction in Air Pollution potential

The major benefit of setting up the proposed NG distribution network lies in being an urban air quality improvement project. This is because choice of NG as a fuel for various uses namely industrial, commercial and domestic use as well as transportation is one of the cleanest fuels and presents the least polluting option.

For the Ahmedabad network, various large industrial units such as Arvind Mills, Ashima Mills, Calico Textile Mills (CTM), Omkar Mills, Soma Textiles, M.H. Mills, Asarwa Mills, Jindal Texofab, Chiripal Group, etc. have evinced interest in use of NG as fuel. Other medium and small industries from chemicals, dyes, engineering and plastics sectors have also indicated interest in use of NG as fuel.

Apart from the above, a large number of commercial establishments and domestic consumers shall also be switching over to NG as fuel. Demand for NG is also for the transportation sector, though mainly for petrol driven vehicles considering the high cost of retrofitting for diesel driven vehicles.

Thus, in the city of Ahmedabad, the likely substitution of various conventional fuels by NG due to the proposed project is presented in **Table 1-6**.

Table 1-6: Likely substitution of conventional fuels by NG in the city of Ahmedabad

Sector	Type of fuel								
	Furnace Oil	LDO	Coal &	Naphtha ;	LPG	Petrol	Diesel		
Industrial	161,050 Vday	75,789 Vday	360,000 kg/day	128,570 kg/day	0	0	0		
Commercial	0	0	0	0	34,285 kg/day	0	0		
Domestic	0	0	0	0	128,570 kg/day	0.	0		
Transportation	0	0	0	0	0	250,000 Vday	22,750 Vday		

Hence, when a substantial portion of currently used conventional fuels are substituted with NG for energy, needs in Ahmedabad area, total pollution load in this area from these activities will be substantially reduced. This is considering that NG burns cleanly and thus is an effective means of reducing pollution from various sources such as industries, commercial establishments, domestic uses as well as vehicular traffic. The expected avoided emissions due to the fuel substitution by NG are presented in **Table 1-7**.

Table 1-7: Expected avoided emissions due to fuel substitution by NG (for industrial, commercial and domestic users)

Air			Туре о	Expected	%		
Pollutant (kg/day)	NG	LPG	LDO	Furnace	Coal	Avoided emission	decrease /
SPM	32.1	18.56	54.49	481.54	32911.2	-33433.7	-99
NOx	2675	607.54	599.41	863.23	2952	-2347.2	-47
SO ₂	10.7	0.56	4073.24	12136.73	3267	-19466.8	-99
СО	1070	96.2	599406.4	425172	435.6	+305,35	+40
CO ₂	2054400	482658.3	4073.24	12136.73	Emission factor not specified	+547163.4	+36
CH4	42.8	6.75	Emission factor not specified	Emission factor not specified	Emission factor not specified	+36.04	+534

As can be seen from **Table 1-7**, there will be a significant decrease in SPM and SO₂ emissions to the extent of approximately 99% and moderate decrease in NO_X emissions to the extent of 47%. However, there will be a significant increase in Methane (CH₄) emissions as well as moderate increase in Carbon Monoxide (CO) and Carbon dioxide (CO₂) emissions due to fuel substitution by NG.

As for the transportation sector, a decrease of approximately 16.67% to 93% of CO and 19.37% to 28.3% of Hydro Carbon (HC) emissions for diesel buses and cars respectively are expected due to fuel substitution by NG.

1.4.2 Improved Energy Efficiency

NG offers several economic benefits to users, as equipments based on gas offer higher efficiencies and lead to significant savings. As mentioned above, overall efficiency of NG from source to end-user is reported to be about 91%.

1.5 Proposed NG distribution project and relevant details

The NG distribution network shall comprise tap-off points from the main GSPL pipeline, City Gas Stations (CGSs), Pressure Regulating Station (PRS), Industrial Metering & Regulating Stations (MRSs), District Regulating Stations (DRS), Service Regulators (SRs) as well as CNG stations.

The coverage of the NG distribution network is mainly the city area of Ahmedabad as well as the Gujarat Industrial Development Corporation (GIDC) industrial areas of Odhav, Vatva, Narol and Naroda. NG demand is by the large, medium and small-scale industries located near the Ahmedabad city as well as in the industrial areas, commercial establishments, domestic users as well as transportation sector in the area.

Based on the demand requirements, the NG distribution network project is proposed to be developed both in East and West Ahmedabad in Phase 1 & 2 respectively as follows:

Tap-off points shall be taken from the GSPL pipelines at Bibipura (near Ramol) terminal to cater to the NG demand of Vatva, Narol, Odhav, Naroda & East Ahmedabad city and from Koba (near Koba circle) terminals to cater the demand of West Ahmedabad city. Of the two CGSs, one will be located at Bibipura (near Ramol) near GSPL terminal for the East Ahmedabad network with a tap-off at Gatrad on GSPL Kanbha - Vadnagar pipeline and the other opposite to existing facility of GSPL near Koba circle for the West Ahmedabad network with a tap-off at Ambapur from GSPL Ahmedabad - Kalol pipeline.

³ Minus sign indicates % decrease in emissions and Plus sign indicates % increase in emissions

CNG stations will be also developed as part of the project. Approximately 30 CNG on-line stations have been planned over a period of 4 - 5 years distributed in the entire city based on the CNG demand. Of these 2 CNG stations will be developed in Phase 1 (East network) and 3 CNG stations will be developed in Phase 2 (West network) of the project. These could either be located in the premises of existing petrol pumps or shall be as independent units.

The Odhav Gujarat Industrial Development Corporation Ltd. (GIDC) industrial area is located about 19 km south-east of Ahmedabad city and is spread on both sides of Ahmedabad - Indore NH 59. This comprises about 525 nos. of small industrial units, majority belonging to the Engineering sector. A few of the large industrial units such as Sheetal Ispat, Sagar Rolling Mills, Devarsen Industries, Udaya Udyog, Sarhind, etc. are also located in the industrial area.

The Vatva GIDC industrial area is located about 7 km south-east of Ahmedabad city and is located on the east side of Mumbai-Ahmedabad Western Railway Main line. This comprises about 1750 nos, of industrial units, majority belonging to the Chemical & Engineering sector. A few of the large industrial units such as Rajesh Malleable, Mayur DyeChem, Ahmedabad Chemicals, Ishan Dye & Chemicals, Jindal Texofab, etc. are located in the industrial area.

The Narol GIDC industrial area is located about 6 km south of Ahmedabad city and is situated to the east of the NH 8. This comprises about 42 nos. of industrial units, majority belonging to the Textile sector. A few of the industrial units such as Deepak Textile, Dayaram Printing & Dyeing Mills, Shree Govind Texofab, etc. are located in the industrial area.

The Naroda GIDC industrial area is located about 10 km north-east of Ahmedabad city and is on the eastem side of NH 8. This industrial area comprises about 941 nos. of industrial units, majority belonging to the Chemicals & Engineering sector. A few of the large industrial units such as Lao-More Biscuits, National Ceramics, Arbuda Chemicals, Narmada Chemicals, etc. are located in the industrial area.

The map providing the layout of NG distribution network is given in Figure 1-1.

1.6 Proposed project area description and relevant details

As mentioned above, the proposed NG distribution network will be developed to cover mainly the city of Ahmedabad and the surrounding GIDC industrial areas of Odhav, Vatva, Narol and Naroda in the Ahmedabad taluka. The co-ordinates of the area to be covered under the proposed NG distribution network are approximately:

Latitude: between 22°55' N to 23°05' N Longitude: between 72°30' E to 72°45' E

Thus, an approximate area of $325 \, \mathrm{km}^2$ is proposed to be covered under the NG distribution network in and around Ahmedabad city.

The city of Ahmedabad is one of the oldest and principal cities and the leading industrial centre in Gujarat. It is also the main transport hub for the state of Gujarat. It was founded by a Muslim ruler Sultan Ahmed Shah (hence Ahmedabad) in the year 1411. The city is situated on the banks of Sabarmati river which traverses almost through the mid of the city. In fact, it can be said that the NG distribution project would be equally divided on either side of river Sabarmati. Ahmedabad is a dynamic industrial city and has a long standing history in the textile sector of India. Ahmedabad is also called 'Manchester of the East' because of its thriving textile and textile auxiliaries/ ancillaries industry in the city as early as the 1960s. The city can be distinctly divided into the old and the new city - old city being highly populated and congested whereas the new city having adequate space. Also, the city is incredibly polluted and unbearably dusty in summer.

Ahmedabad is an important location on the map of India being one of the major cities on the national rail and road network joining Mumbai with Delhi through Western Railway Main line and National Highway (NH) No. 8 connecting to Mumbai and to north India. The road network also includes the Express Highway (under construction) connecting Ahmedabad to Vadodara, State Highway (SH) No. 3 connecting Ahmedabad to Memdabad, SH 68 connecting to Dehgam and SH 43 connecting to Gandhinagar. All major super fast and express trains halt at Ahmedabad Railway Station. Ahmedabad has an airport, which is very well connected with the other major airports of India.

The city is well developed and truly cosmopolitan having people residing from various parts of the country. This is due to the fact that Ahmedabad is a highly industrialized city as well as boasts of several educational institutes such as the Law College, Indian Institute of Management, Ahmedabad (IIM-A), Mundra Institute of Communications, etc.

It is also home to several interesting monuments and museums such as Shaikh Amhed Khattu tomb, Dutch tomb, Dada Harir step well, Hathi Singh Mandir, Swami Narayan temple, Sabarmati Ashram, etc. The nine-night festival of Navaratri is celebrated with high fervor and splendor in Ahmedabad.

Ahmedabad city boasts of being one of the oldest industrial towns of the country having industries such as Arvind Mills, Ahmedabad Electricity Co. Ltd., etc.

Various industrial areas such as Odhav, Vatva, Narol, Naroda, etc. have been developed by GIDC, the industrial development authority in Gujarat.

In terms of commercial development, Ahmedabad city is on a fast track development and the trend has been towards development of multiplexes providing a one-stop-shop for entertainment, shopping as well as food. The latest additions to this, is the Wide Angle, Fun Republic, City Pulse, etc. There are a large number of hotels, restaurants, cinema houses, shopping malls, places of recreation and entertainment, etc. in the city.

On the domestic front, maximum population resides in households, which are either bungalows or multistorey flats. With the rising population, the trend has been shifting towards the flat system. Recently developed residential areas have been the Satellite Nagar, Memnagar, Chandkheda, Bopal, Vastrapur, Motera, etc.

Ahmedabad city has good infrastructure in terms of road network, transportation, water supply, sewage network, medical and educational facilities, fire-fighting facilities, and other community facilities, etc.

The road network is well developed in the new parts of the city being well spaced as well as having adequate Right of Use (ROU) for future development. However, the old city being already congested has very narrow roads. Public transport vehicles within the city include buses, auto rickshaws and taxis. There are few private bus services too. Of course, there are many people who use their own vehicles — cars, scooters, motorcycles and bicycles. Private taxis are also available.

Water supply is mainly from Kadana dam located on Sabarmati river, approximately 165 km from the city of Ahmedabad. Water supply to industrial locations is from Sabarmati River.

The major river in the study area is Sabarmati river with Vaheva nadi and Khari nadi being the smaller ones. There are other water bodies such as Vatva Branch canal, Kharicut canal and Narmada Main canal in the study area. Chandola and Kankariya lakes are the other water bodies in the study area. Also, a number of

The area is fairly level with no major undulations or abrupt changes in the terrain. The maximum and minimum elevation encountered in the area is 78 and 40 m respectively. Surface soil in the area is predominantly silty clay and sandy clay.

The area falls under seismic Zone-III as per the IS classification 1893-1984, where the intensity of earthquake as per Modified Mercalli scale is VII or below. Heavy tremors were felt and damage occurred in Ahmedabad city during the Bhuj earthquake of January 2001.

1.7 Scope of this report

Telos has carried out the Rapid Environmental Impact Assessment (REIA) study including Risk Analysis (RA) and On-site Disaster Management Planning (DMP) of the proposed NG distribution network in the city of Ahmedabad in Gujarat. This report documents the findings of the REIA study.

The REIA report contains seven chapters including the present chapter and executive summary. The brief contents of these chapters are given below as an overview of this report:

Executive summary contains brief findings of this REIA study for the top executives and decision makers.

This Chapter 1 details the introduction and justification of the project.

Chapter 2 documents the project details and also describes the expected emissions/ discharges from the proposed project.

Chapter 3 presents the environmental settings of the study area, i.e. the area covered by the NG distribution network. The likely impacts on various relevant environmental parameters of the study area have been identified and predicted.

Chapter 4 contains the EMP, which is a documentation of proposed measures for mitigating adverse environmental impacts of the proposed project.

Chapter 5 presents the summary of the predicted environmental impacts with brief mitigation measures for adverse impacts.

Chapter 6 presents the findings of the Risk Analysis study along with measures for improvement of risks. Chapter 7 presents guidelines on the Disaster Management Plan.



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2.1 Components of the proposed NG distribution project

The proposed project comprises establishing a NG distribution network in the city of Ahmedabad in Gujarat State for industrial, commercial and domestic consumption as well as for the transportation sector.

The following facilities are proposed as part of the NG distribution network:

- Main tap-off point from the GSPL main NG pipeline
- CGS including infrastructure facilities such as buildings, control room, odorant injection, pressure reduction, water supply, drainage, etc.
- NG distribution network comprising primary network i.e. Main Trunk line and Steel Spur lines and secondary network i.e. Medium Density Poly Ethylene (MDPE) network including PRS, DRS, SRs and MRSs
- CNG stations for the transportation sector

2.2 Description of various facilities planned as part of the proposed project

2.2.1 Tap-off points

GAEL proposes to take gas through multiple tap-off points on the GSPL's transmission line in order to reduce the construction of steel network within the city. Accordingly, GAEL shall take gas from the Bibipura (near Ramol) terminal of GSPL (tap-off at Gatrad from GSPL Ahmedabad-Kalol pipeline) to cater to the NG demand at Vatva, Narol, Odhav, Naroda and East Ahmedabad city and from Koba (near Koba circle) terminal (tap-off at Ambapur on the GSPL Kanbha-Vadnagar pipeline) to cater to the demand of West Ahmedabad city including Kali Industries area. The pressure at the tap-off point will be between 20 - 49 barg (approx). From these tap-off points, NG will be taken in underground steel pipelines to a point called CGS.

2.2.2 City Gate Station (CGS)

Typically, gas from tap-off point will be brought to the CGS for reducing pressure and adding odorant before distributing it in various parts of the city. Entire network operates on a graded pressure regime.

CGSs for the Ahmedabad network will be located near GSPL terminals. Based on the off-take of gas from multiple tap-offs and the demand volume there would be two CGSs for Ahmedabad city. An approximate area of $100 \text{ m} \times 100 \text{ m}$ shall be required for each of the CGSs.

At the CGS, NG will be filtered; pressure reduced to 19 barg in one/ two stages and odorized using mercaptans. The CGS will be designed for a maximum flow rate of 41667 m³/hr. From here, the gas will be distributed through the primary network (in steel pipelines) to various demand centers through a DRS to SR or MRS as well as to CNG stations.

2.2.3 District Regulating Station (DRS)

At the DRS, pressure will be reduced from 19 barg to 4 - 5 barg and the gas shall be distributed to industrial units through MRS and to industrial, commercial establishments as well as domestic users through Service Regulators (SRs). The DRS will be designed for 5000 m³/hr of gas flow. Eight DRSs have been planned to cater to the domestic and commercial demand pockets. Industrial units will be serviced either directly at Maninagar, Gomatipur, Asarva, and Naroda and four in West Ahmedabad at Sabarmati, Navawadaj, Memnagar, Vejalpura.

Where the pipeline shall cross third party utilities, a minimum distance of 0.5 m shall be maintained. Cathodic protection shall be provided for the steel network by proper bonding of the existing utility pipelines as well as the proposed NG pipeline. No cathodic protection is required for the PE pipeline network.

The steel pipeline network shall be hydro-tested before commissioning of the system. However, no hydro-testing is required for the PE network as it is pneumatically tested.

Table 2-1: Typical pressure regimes in the NG pipeline network in the city of Ahmedabad

Sr. No.	Network Component	Inlet From	Inlet Pressure	Outlet Pressure	Outlet to	
1.	CGS	Transmission Line	20 barg to 49 barg	19 borg	Steel Pipeline	
2.	Steel Pipeline	CGS	19 txng	19 to 4.5 barg	DRS CNG	
3.	DRS	Steel Pipe	19 to 4.5 barg	4 barg	MP PE Pipeline	
4.	MDPE Pipeline	DRS	4 barg	4 to 2.0 barg	Industrial MRS	
					Service Regulator	
5.	Industrial MRS	MDPE Pipeline 4 t	4 to 2 barg	1.5 barg	Industrial Internal	
		Steel Network	19 to 4.5 barg	1.5 barg	piping	
6.	SR	MDPE Pipeline	4 to 2 barg	110 mbarg	PE Loop, Commercial, Internal piping, Industrial Internal	
7.	LP PE Loop	. SR	110 mbarg	440	piping	
			rioniwary	110 mbarg to 50 mbarg	GI pipeline	
8.	GI Pipeline	LPPE	110 mbarg to 50 mbarg	110 mbarg to 50 mbarg	Domestic Meter Regulator	
9	Meter Regulator	GI Riser	110 mbarg to 50 mbarg	21 mbarg	Meter & Copper pipe	

2.3 Routing of the proposed NG pipeline network

For routing of the NG distribution network, apart from the main consideration of maximum reach to potential demand centres with minimum length, the pipeline route has been firmed up bearing in mind various considerations as follows:

- Use of existing defined pipeline corridors by respective authorities
- Easy and favorable terrain conditions free of large water bodies, low lying marshy lands, obstacles like ravines, depressions and unstable grounds, meandering rivers, etc.
- Ground profile for pipeline hydraulics and avoidance of steep rising and falling ground, hills and valleys having sloping Right of Way
- Shortest pipeline length with minimum number of bends to the extent possible so as to disturb least amount of area
- Availability of infrastructure and access to the pipeline route during construction and maintenance
- Environmental impact and avoidance to the extent possible, of environmentally sensitive lands, such as reserved forests, agricultural lands, vegetated areas, built-up areas, places of worship, burial grounds, etc.

- Minimum crossing of existing pipelines, transmission lines, parallel alignment, etc.
- Minimum roads, rail, river and canal crossings
- Avoidance of rugged and intricate grounds with hard strata, exposed rocks, boulders and quarries
- Existing and future developments in the region such as roads, rail lines, canal network, reservoirs, townships, industrial units, etc.
- Proximity to future gas demand centers
- Scope for future expansion of the gas pipeline network
- Safety of people and property
- Safe distance from the village

Safety of the pipeline from engineering and other considerations

Detailed description of the proposed NG pipeline network routing is provided in Table 2-2.

Details about various pipeline crossings at third party utilities, railway, roads and rivers is provided in Table 2-3.

Table 2-2: Details of pipeline route for the Ahmedabad NG distribution network

Section	Chainage details (in km.)	Location Details	Lengtin (In km.)	Terrain	Land Use	Environmenta issues
EAST AHMED	ABAD (CUMUI	ATIVE LENGTH = 33.		J		
	TRUNK PIPELI					
Bibipura tap-off to Vatva GIDC tap-off point	0.000 to 3.120	Proposed pipeline runs parallel to Bibipura - Ramol district road and Ramol-Vatva road. It crosses ring road (under construction) of Ahmedabad Urban Development Authority (AUDA), Express Highway and other four asphalt roads.	3.12	Flat terrain	Planned pipeline route is within ROU of existing road and it is barren land,	Requirement of ROU passing through privately owned agricultural land for Tap off point and connection to CGS. Land requirement of approximately 100 X 100 m for CGS. This land will be privately-owned
Vatva GIDC tap- off point to CTM Textile Mill tap- off	3.120 to 7.320	In this section portion of pipeline is parallel to peripheral road of Vatva GIDC and remaining part is parallel existing NH-8. Major crossings falling along the proposed route are NH-8 and one GIDC road.	4.2	Flat terrain	Planned pipeline route is within ROU of existing road and it is barren land.	agricultural land,
CTM Textile Mill ao-off to Ambica Mill Feen Rasta	7.320 to 9.87	This section is parallel to Khokhra-Memdabad Road within Ahmedabad city. Crosses 5 internal roads of city.	2.55	Flat terrain	Proposed route is within ROU of Ahmedabad Municipal Corporation (AMC) road.	Commercial and domestic establishments exist on both sides of the road.

Section	Chainage details (in km.)	Location Details	Length (In km.)	Terrain	Land Use	Environmenta issues
Ambica Mill Teen Rasta to Arvind Mill Char Rasta	9.87 to 14.67	Proposed pipeline runs parallel to Khandubhai Desai Road and passes through the heart of Ahmedabad city. Crosses Amravadi road, Diwan Balkubhai road, Rakhial road, Thakkar Baba road and other eight numbers existing roads.	4.8	Flat terrain	Within ROU of AMC road.	This passes through the heart of the city which is highly congested. Commercial & domestic establishments exist on both sides of road.
Avind Mill Char Rasta to Naroda GIDC	14.67 to 21.27	Pipeline parallel to Shyama Prasad Vasavada road and NH- 8. Crosses four internal roads of city.	6.6	Flat terrain	Within ROU of AMC road.	Commercial and domestic establishments exist on both sides of the road.
SPURLINES F	ROM TRUNK	INE			<u></u>	Tioad.
Narol Spurline	0.000 to 4.200	Narol spurfine originates from Chainage no. 5.820 km. of main trunkline. It runs parallel to NH-8 upto Narol Char Rasta. Crosses one internal city road.	42	Flat terrain	Within ROU of NH-8 road.	Commercial and domestic establishments exist on both sides of the road,
Maninagar Spurline	0.000 to 3.600	Maninagar spurfine starts from chainage no. 2.400 km, of Narol Spurfine, It runs parallel to Vatva road and Lala Laipatrai road. Crosses 5 nos. of internal city roads.	3.6	Flat terrain	Within ROU of AMC road	Domestic and small commercial establishments exist on both sides of the road.
Sourline for COM Textile Mill	0.000 to 0.600	It originates from chainage no. 7.320 km. of main trunkline, Runs parallel to an existing road-which goes to Ramol, Crosses NH-8.	0.6	Flat terrain	Within ROU of AMC road.	Major commercial establishments exist on both sides of the road.
Spurline for SOMA Textile	0.000 to 1.200	tt originates from chainage no. 12.270 km. of main trunkline. Runs parallel to an existing AMC road-which goes to Ramrajnagar. Crosses two internal roads of city	1.2	Flat terrain	Within ROU of AMC road.	Major commercial establishments exist on both sides of the road.
purline for I.H. Mills		It originates from chainage no. 14,070 km. of main trunkline. Runs parallel to an existing AMC road. Crosses one internal road of city	1.2	Flat terrain	Within ROU of AMC road,	Industrial textile establishments exist on both sides of road.
purline for sarva Mill		It originates from chainage no. 14.670 km. of main trunkline. Runs parallel to an	2.1	Flat terrain	Within ROU of AMC road.	Domestic establishments exist on both sides of the road.

Table 3.3-4: Methodology for Ambient Air Monitoring

Sr. No.	Parameter	Code of Practice	Sampler	Methodology
1.	SPM	IS: 5182 (Part IV)	High Volume Sampler (HVS)	Adopted
2.	Respirable Particulate			Gravimetric Method
	Matter (RPM)		HVS with Cyclone Separator	Gravimetric Method
3.	SO₂	IS: 5182 (Part II)	HVS	0.1 :
4.	NO _X	IS: 5182 (Part VI)	HVS	Colorimetric
5.	HC	IS: 5182 (Part XVII)		Colorimetric
 -6.	Cochon Mana il 100		Bladder and Aspirator	Flame Ionization Detector
	Carbon Monoxide (CO)	IS: 5182 (Part X)	Bladder and Aspirator	Flame Ionization Detector
7.	Lead (Pb)	APHA	HVS	Dithizone Method

Table 3.3-5: Summary of AAQ data for Mithakali Circle (near Navrangpura) (A-1) – Residential, Rural & Other (Commercial area)

Statistics	Ground Level Concentration (24-hour average unless otherwise specified)									
	SPM (µg/m³)	RPM (µg/m³)	SO ₂ (μg/m³)	NO _χ (μg/m³)	CO (µg/m³) (8	· · · · · · · · · · · · · · · · · · ·	Pb			
Maximum (24 hourty)	233.0	191.0	11,4	25.1	1791.0	1.8	(µ g/m³) BDL 3			
Minimum	196.0	142.0	6.4	20.8	1512.0	1.4				
Average	213.0	171.7	8.8	23.6	1657.9	1.5	BDL			
98th Percentile	232.1	190.6	11.3	25.1	1786.0	1.8	BDL			
Applicable Standard	200	100	80	80	2000	N.S. 4				

³ BDL is Below Detectable Limit

⁴ N.S. is Not Specified

Table 3.3-6: Summary of AAQ data for Drive in area (A-2) - Residential, Rural & Other (Commercial area)

Statistics	Ground Level Concentration (24-hour average unless otherwise specified)									
	SPM (µg/m³)	RPM (μg/m³)	SO ₂ (μg/m³)	NO _X (μg/m³)	CO (µg/m³) (8 hourty)	HC (Methane) (ppm)	γ			
Maximum (24 hourty)	150.0	110.0	12.4	20.3	891.0	1.2	BDL.			
Minimum	83.8	68.4	9.8	16.2	439.0	0.9	BDL			
Average	116.9	89.2	11.1	18.3	712.3	1,1	BDL			
98th Percentile	148.7	109.2	12.3	20.2	889.9	1.2	BDL			
Applicable Standard	200	100	80	80	2000	N.S.	1			

Table 3.3-7: Summary of AAQ data at Kali Industries Area (A-3) – Industrial Area

Statistics	Ground Level Concentration (24-hour average unless otherwise specified)									
	SPM (µg/m³)	RPM (µg/m³)	SO ₂ (μg/m³)	NO _X (μg/m³)	CO (µg/m³) (8 hourly)	HC (Methane)	,			
Maximum (24 hourly)	186.0	147.0	11.0	18.2	823.0	1.0	BDL			
Minimum	98.0	84.0	10.7	14.6	705.0	0.8	BDL			
Average	142.0	115.5	10.9	16.4	762.0	0.9	BDL			
98th Percentile	184.2	145.7	11.0	18.1	822.3	1.0	BDL			
Applicable Standard	500	150	120	120	500-)	N.S.	1.5			

Table 3.3-8: Summary o' AAQ data for Naroda GIDC (A-4) - Industrial Area

Statistics	Ground Leve! Concentration (24-hour average unless otherwise specified)									
	SPM (μg/m³)	(µg/m³)	SO ₂ (μg/m³)	MO _X (μg/m³)	CO (pg/m³) (8 feourty)		Pb			
Maximum (24 hourly)	362.0	323.0	25.1	41.3	1842.0	1.7	(hg/m³)			
Minimum	296.0	210.0	18.6	32.8	1573.0	1.2	BDL			
Average	327.3	250.3	22.0	37.1	1717.9	1.5	<u> </u>			
98th Percentile	360.5	318.8	25.0	41.1	1840.6		BDL BDL			
Applicable Standard	500	150	120	120	5000	N.S.	1.5			

Table 3.3-9: Summary of AAQ data for Odhav GIDC near Odhav village (A-5)
– Industrial Area

Statistics	Ground Level Concentration (24-hour average unless otherwise specified)									
	SPM (µg/m³)	RPM (µg/m³)	\$O ₂ (μg/m³)	NO _X (μg/m³)	CO (µg/m³) (8		Pb			
Maximum (24 hourly)	320.0	204.0	14.1	41.3	1245	1.2	(µg/m³)			
Minimum	243.0	145.0	12.8	21.3	890.0	0.9	BDL			
Average	283.0	180.7	13.5	27.3	1104.7	1.1	 			
98th Percentile	318.6	203.6	14.1	32.1	1244.2	1.2	BDL BDL			
Applicable Standard	500	150	120	120	5000	N.S.	1.5			

Table 3.3-10: Summary of AAQ data for Vatva GIDC (A-6) - Industrial Area

Statistics	Ground Level Concentration (24-hour average unless otherwise specified)									
	(µg/m³)	RPM (µg/m³)	SO ₂ (μg/m³)	NO _χ (μg/m³)	CO (μg/m³) (8	HC (Methane)	Pb			
Maximum (24 hourly)	228.0	178.0	13.7	30.4	1429.0	(ppm)	(µg/m³)			
Minimum	210.0	152.0	10.5	27.2	1225.0	1.1				
Average	219.0	165.0	12.1	28.8	1328.7	1.3	BDL BDL			
98th Percentile	227.6	177.5	13.6	30.3	1428.3		BDL			
Applicable Standard	500	150	120	120	5000	N.S.	1.5			

Table 3.3-11: Summary of AAQ data for Kallupur (near Gujarat Housing (A-7) - Residential, Rural & Other (Commercial area)

Ground Level Concentration (24-hour average)									
(µg/m³) ⁵	RPM (μg/m³) ⁶	SO ₂ (μg/m³) ⁷	NO _χ (μg/m³) ⁶		HC (Methane)				
198.0	112.0	7.5	14.3	716.0		BDL			
110.0	58.0	6.4	12.1	571.0					
154.0	85.0	6.9		Cana		BDL			
196.2	110.9	7.4	14.3	745.0	0.0	BDL			
200	100	80	80	2000		BDL			
	(µg/m³) ⁵ 198.0 110.0 154.0 196.2	Ground Level C SPM RPM (μg/m³) 6 198.0 112.0 110.0 58.0 154.0 85.0 196.2 110.9 120.0 120.	Ground Level Concentration SPM (μg/m³) 5 (μg/m³) 6 (μg/m³) 7 198.0 112.0 7.5 110.0 58.0 6.4 154.0 85.0 6.9 196.2 110.9 7.4	Ground Level Concentration (24-hour and property) SPM (μg/m³) 5 (μg/m³) 6 (μg/m³) 6 (μg/m³) 7 (μg/m³) 8 198.0 112.0 7.5 14.3 110.0 58.0 6.4 12.1 154.0 85.0 6.9 13.2 196.2 110.9 7.4 14.3	Ground Level Concentration (24-hour average unless) SPM (μg/m³) 5 (μg/m³) 6 (μg/m³) 7 (μg/m³) 7 (μg/m³) 8 (μg/m³) 8 (μg/m³) 7 (μg/m³) 8 (μg/m³)	Ground Level Concentration (24-hour average unless otherwise speciments) SPM (μg/m³) 5 (μg/m³) 6 (μg/m³) 7 (μg/m³) 7 (μg/m³) 8 (μg/m³)			

⁵ Detection limit for SPM - 10 μg/m³

⁶ Detection limit for RPM - 10 μg/m³

Detection limit for SO₂ - 5 µg/m³

Detection limit for NOx - 4 µg/m³

⁹ Detection limit for CO - 100 μg/m³

¹⁰ Detection limit for HC - 0.1 ppm

¹¹ Detection limit for Pb - 0.0005 µg/m³

Table 3.3-12: Summary of AAQ data for Narol GIDC (A-8) – Industrial Area

Statistics	Ground Level Concentration (24-hour average unless otherwise specified)									
	(µg/m³)	RPM (µg/m³)	SO ₂ (µg/m³)	MO _X (μg/m³)	CO (µg/m³) (8					
Maximum (24 hourly)	244.7	134.0	11.8	31.2	1482.0	1.3	BDL			
Minimum	181.0	114.0	11.2	26.4	1425.0	1.1				
Λverage	212.9	124.0	11.5	28.8	1455.8		BDL			
98th Percentile	243.4	133.6	11.8	31.1	1481.6	1.3	BDL BDL			
Applicable Standard	500	150	120	120	5000	N.S.	1.5			

The following observations can be made from the above Table 3.3-5 to Table 3.3-11:

- The average as well as the 98th percentile SPM and RPM values at Mithakali circle (near Navrangpura) (A-1) exceed the AAQ standards specified for residential, rural & other areas. Also, the SO₂, NO_X and CO values are high though within the specified standard. Even HC are detected in the AAQ samples though there is no specified standard for HC. This can be attributed to the high vehicular traffic in this area which is one of the extremely busy commercial areas of Ahmedabad.
- The AAQ for Drive-in area (A-2), a relatively new and upcoming commercial area of Ahmedabad city is well within the specified standards for residential, rural and other areas.
- The AAQ at Kali Industries Area (A-3) is well within the AAQ standards specified for industrial areas.
- The AAQ at Naroda GIDC (A-4) is well within the standards for SPM, SO₂, NO_x, CO & Pb. However, the matter of concern is the very high RPM almost double the specified standard, which is attributable to the industrial activity as well as vehicular traffic, the GIDC area being located close to the city area.
- Similar to the AAQ at Naroda GIDC, AAQ at Odhav GIDC (A-5) and Vatva GIDC (A-6) is well within the standards for SPM, SO₂, NO_x, CO & Pb except RPM values which are higher than the specified standard of 150 µg/m³. This is attributable to the industrial activity as well as vehicular traffic in the GIDC
- At Kallupur (near Gujarat Housing Board) (A-7), a highly congested commercial area, though the SPM values are within the specified standard, the RPM values exceed the limits specified for residential, rural & other areas. As Kallupur is the centre area of the city and a highly commercial area, these high values of RPM can be attributable to the vehicular traffic.
- At Narol GIDC (A-8), the AAQ is well within the standards specified for industrial areas.

Thus, it can be said that the SPM values at Mithakali area (commercial area) as well as RPM values in the study area exceed the specified limits for the industrial as well as residential areas, which can mainly be attributed to the industrial activities as well as vehicular traffic in the area.

The National Ambient Air Quality Standards (NAAQS) prescribed by CPCB are given in a consolidated form in Table 3.3-13 for easy reference and comparison.

Table 3.3-13: Mational Ambient Air Quality Standards (CPCB, New Delhi, India)

Pollutant	Time weighted Average		ration in ambient ess otherwise spe	Measurement method	
		Industrial area	Residential, Rural and Other areas	Sensitive area	
Suspended Particulate	Annual Average 12	360	140	70	High Volume Sampler (average flow rate not less
Matter (SPM)	24 hours ¹³	500	200	100	than 1.1 m ³ /min)
Respirable Particulate	Annual Average	120	60	50	RPM Sampler
Matter (RPM)	24 hours	150	100	75	
Sulphur Dioxide (SO₂)	Annual Average	80 .	60	15	Improved West and Gaeke method
	24 hours	120	80	30	Ultraviolet fluorescence
Oxides of Nitrogen (as NO ₂)	Annual Average	80	60	15	Jacob & Hochheiser modified (Na-Arsenite) method
·	24 hours	120	80	30	Gas phase chemiluminescence
Lead (Pb)	Annual Average	1	0.75	0.5	AAS Method after sampling using EPM 20006Y
	24 hours	1.5	1	0.75	equivalent filter paper
Carbon Monoxide (CO)	8 hours	5000	2000	1000	Non-dispersive Infrared technique
	1 hour	10000	4000	2000	-

3.3.2 Air Emissions from the NG distribution network and their proposed method of handling

3.3.2.1 During Construction Phase

Air emissions will be generated due to:

- Exhaust emissions from construction equipment and vehicles due to fuel combustion. It shall be
 ensured that the construction equipment and vehicles are maintained in proper condition at all times.
 Fuel of a proper quality shall be used to ensure that exhaust emissions are well within the specified
 CPCB standards for vehicles.
- Generation of dust due to clearing of vegetation, earth moving and stockpiled soil. Regular water sprinkling shall be carried out to ensure that dust emissions are minimized.

¹² Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform intervals.

¹³ 24 hourly/8 hourly values should be met 98% of the time in a year. However, 2% of the time it may exceed, but not on two consecutive days.

- Generation of dust due to construction activities such as excavation of soil using mechanized as well as manual equipment, soil grading, back-filling, etc. It shall be ensured that state-of-the-art equipment are used which shall result in reduced dust generation.
- Domestic activities at construction camps.

3.3.2.2 **During Operational Phase**

Air emissions will be generated due to:

- Operation of D.G. sets at the CGS/ CNG stations resulting in fuel combustion products such as SPM, SO₂, NO_x and CO. However, emissions from D.G. set shall not be continuous as the D.G. set shall be operated only during grid power failure or during an emergency. Moreover, the D.G. set shall be
- Use of vehicles as daughter stations resulting in vehicular emissions such as NO_x, CO and HC. However, such vehicles shall conform to the vehicular emissions specified by the CPCB.
- Release of NG vapors due to inadvertent release/ leakage of NG at the CNG stations as well as CGS. All safety systems shall be incorporated to ensure that such leaks are minimized, to the extent possible.
- In fact, during the operational phase, the proposed project is likely to reduce the air pollution potential in the city areas of Ahmedabad due to use of NG, which is a clean fuel as compared to the conventional fuels such as fuel oils, etc. The approximate quantities of fuels that will be replaced are presented in Table 1-6. The avoided emissions from substitution of fuels by NG are presented in Table 1-7. 3.3.3

Potential Environmental Impacts

The potential environmental impacts of the proposed project on air environment are documented below.

Construction phase

Construction phase impacts will be relatively short term considering that the proposed project will be . developed in two phases which are expected to last for a short period of about 6 months each respectively.

As mentioned above, fuel combustion products will be generated due to operation of construction equipment, construction vehicles as well as D.G. sets for power requirement during the construction stage. Other construction activities will also generate fugitive dust pollution and vehicular emission at the

However, by taking appropriate measures as described in the EMP (Chapter 3), such air emissions during construction will be minimized. Also, these emissions from construction activities will be mainly coarse dust particles, which are not expected to travel long distance before settling.

Thus, it can be said that there will be a minor negative but temporary impact on air quality during the construction phase of the proposed project. However, the impacts will be restricted to the length of the

3.3.3.2 Operational phase

As such, during the operational phase of the proposed project, no significant emissions are expected. Minor emissions in the form of release of NG vapors due to inadvertent release/ leakage of NG at the CNG stations or the CGSs will not have any change in ambient air quality in the area. In fact, use of vehicles as mother stations will help in reducing the air emissions due to the fact that these vehicles will be operating on

In fact, there will be reduction in emissions, specifically in terms of SPM and SO₂ due to fuel substitution by NG. These avoided emissions will, to a large extent help in reducing the air pollution in the area, specifically of SPM, SO₂ and NO_X emissions. However, due to use of NG, there will be an increase in the CO as well as HC (methane) emissions. This is well evident from the information in the Table 1-7 on avoided emissions.

Thus, it can be said that the proposed project will have major positive impact on air quality in the area.

ENVIRONMENTAL SETTING AND POTENTIAL EXURONMENTAL IMPACTS (CONTINUED

3.4 Noise level

This Chapter documents the baseline noise scenario in the study area and discusses the potential impacts of the proposed NG distribution project during construction and operational stages on the noise environment

3.4.1 **Baseline setting**

To establish the baseline noise scenario in the study area, results of noise level monitoring carried out during the study period at eight (8) locations has been considered. These locations are the same as the ambient air quality locations and are provided in Table 3.4-1. Hourly noise levels were recorded over a period of 24 hours once at each of these locations during the study period using a digital noise-level meter.

Table 3.4-1: Locations of noise monitoring stations

Location of noise monitoring stations	Area Classification 1	Approximate distance from project site (in km) ²		Height
Mithakali Circle (near Navrangpura)	Commercial	12.3	SW	
Drive in Area (near circle)	Residential/	15.0	wsw	1.5
Kali Industries Area				1.5
Naroda GIDC (above GIDC police chowki)	Industrial	9.9	W	1.5
Odhav Village (within	Industrial	7.2	S	1.5
Vatva GIDC (within GIDC area)	Industrial	15.3		1.5
Callupur (near Gujarat Tousing Board)	Commercial	10.2		1.5
Varol GIDC (within GIDC irea)	Industrial	15.2		1.5
	Mithakali Circle (near Navrangpura) Drive-in Area (near circle) Kali Industries Area Naroda GIDC (above GIDC police chowki) Odhav Village (within Odhav GIDC) Vatva GIDC (within GIDC area) Callupur (near Gujarat fousing Board) Larol GIDC (within GIDC	Location of noise monitoring stations Classification 1 Mithakali Circle (near Navrangpura) Drive-in Area (near circle) Kali Industries Area Industrial Naroda GIDC (above GIDC police chowki) Odhav Village (within Odhav GIDC) Atva GIDC (within GIDC Industrial Callupur (near Gujarat fousing Board) Larol GIDC (within GIDC Industrial Larol GIDC (within GIDC Industrial	Location of noise monitoring stations Classification 1 Commercial 12.3 Prive-in Area (near circle) Residential/ Commercial Commercial Commercial Industrial Commercial Commercia	monitoring stations Classification 1 Commercial 12.3 SW SW Commercial 15.0 WSW Call Industries Area Industrial 9.9 W Commercial 15.0 C

The above mentioned locations are shown in Figure 1-1 and the monitored noise level data along with applicable CPCB noise standards is given in Table 3.4-2.

As per CPCB classification for noise levels

² Reference point is considered as the meteorological station set up at Naroda GIDC

Table 3.4-2: Baseline noise levels in the study area

Location Code	Monitoring Locations	Sound level dB(A) (Leq)									
3000	Encanons .		r.	ay-time			N	ight-tim	<u> </u>		
		Max.	Min.	Avg.	Applicable standard	Max.	Min.	Avg.	Applicable standard		
N-1	Mithakali Circle (Navrangpura)	73.2	52.6	68.45	65	69	61.6	66.05	55		
N-2	Drive-in Area	75.4	54.2	67.83	65	62.7	52.6	58.44	CC		
N-3	Kali Industries Area	83	62	77.2	75	71.8	53.9	 	55		
N-4	Naroda GIDC	78.3	55.4	73.83	75	 		67.23	70		
N-5	Odhav GIDC (near Odhav village)	80.6	60.9	73.29	75	75.0 76.3	63.2 50.8	68.42 71.52	70 70		
N-6	Vatva GIDC	89.1	55.3	78.83	75 .	69.7	57.0	05.10			
N-7	Kallupur (Near Gujarat Housing Board)	76.8	53	71.73	65	63.4	57.0 42.5	65.16 57.01	55		
N-8	Narol GIDC	79.4	44.2	71.19	75	66.6	45.0	58.51	70		

The ambient noise standards prescribed by the CPCB are given in Table 3.4-3.

Table 3.4-3: CPCB Ambient Noise Standards

Area code	Category of area	Limits in dB(A) (Leq)			
	• •	Day time	Night-time		
(A)	Industrial area	75	70		
B)	Commercial area	65	55		
C) '	Residential area	55			
D)	Silence zone	50	45		
Ja4a		1 50	40		

Note on Table 3.4-3:

- Daytime is reckoned between 6 a.m. to 10 p.m.
- Night time is reckoned between 10 p.m. to 6 a.m.
- 3) Silence zone is defined as area upto 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the Competent Authority. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
- 4) Mixed categories of areas should be declared as one of the four above mentioned categories by the competent Authority and the corresponding standards shall apply.

From Table 3.4-2, the following observations can be made:

- The average day-time and night-time noise levels at Mithakali circle (near Navrangpura) (N-1) are higher than the standards specified for commercial areas. This is due to the high vehicular traffic in the busy commercial centre, the heart of Ahmedabad city.
- In the Drive-in area (N-2), average day time as well as night time average noise levels are slightly higher than the specified standards in commercial areas. This is also attributable to the vehicular noise in the area.
- The average day-time noise level in Kali Industries Area (N-3) is higher than the specified standard of

75 dB(A) though the night-time noise levels are within the specified standards. The higher day-time noise levels can be attributed to the heavy vehicular traffic in the area, which is not in the night-time.

- In the Naroda GIDC (N-4), an industrial area, the average day-time as well as night-time noise levels
 are close to the specified limits of 75 dB(A) and 70 dB(A) respectively.
- In the Odhav GIDC near Odhav village (N-5), the average day-time as well as night-time noise levels are higher than the specified limits of 75 dB(A) and 70 dB(A) respectively. This can be attributed to the heavy vehicular traffic being an industrial area as well as industrial activities in the area.
- In the Vatva GIDC (N-6), an industrial area, the average day-time levels are higher than the specified limit of 75 dB(A) though the night-time noise levels are well within the specified standards of 70 dB(A). This is also due to the high vehicular traffic during the day-time as well as industrial activities in the area.
- In the Kallupur area (near Gujarat Housing Board) (N-7), though one time day-time noise levels are high, the average day-time and night-time noise levels are well within the specified standards.
- In the Narol GIDC (N-8), an industrial area, the average day-time as well as night-time noise levels are well within the specified limits of 75 dB(A) and 70 dB(A) respectively.

3.4.2 Noise from the proposed project

3.4.2.1 Construction phase

During the construction phase, noise will be generated due to:

- Operation of construction equipment and vehicles. However, it shall be ensured that construction
 equipment and vehicles are maintained properly at all times to ensure reduced noise levels.
- Operation of D.G. sets. The D.G. sets shall be maintained at all times in proper condition to ensure reduced noise levels. Though the D.G. sets used during construction stage will not be provided with an acoustic enclosure, the workers shall be provided with noise protection equipment.

3.4.2.2 Operational phase

During the operational phase, noise will be generated due to:

- Operation of compressors at CNG stations. These compressors shall be housed in built-in acoustic enclosures for noise reduction.
- Operation of Pressure Reducing Valve (PRV) at the CGSs. The PRVs are selected such that the noise level is below 85 dB(A). However, noise levels at the boundary of the CGS shall be such that noise levels will not exceed the specified CPCB limits.
- Occasional operation of D.G. set during an emergency. Such D.G. sets shall be housed in an enclosure for noise reduction. Also, regular maintenance of the D.G. sets shall be carried out to ensure reduced noise levels.
- Operation of vehicles acting as mother/ daughter stations for CNG distribution.

3.4.3 Potential Impacts

The proposed project of NG distribution network will generate noise both during construction and operational stages. Potential impacts of both the phases are described below.

3.4.3.1 Construction phase

Due to operation of construction equipment, D.G. sets and vehicular movement, there will be an increase in noise levels on site. However, this cannot be avoided completely and the increased noise levels will be confined within and in the immediate vicinity of the construction area.

Appropriate mitigation measures such as use of low noise generating state-of-the-art construction equipment and construction techniques shall be used. Personnel working in noisy areas shall be provided with personnel protective equipment such as ear muffs and ear plugs. Other mitigation measures such as given in **Chapter 3** of the report will be taken during this phase to keep the noise level to the minimum feasible.

In light of the above discussion, it can be said that the proposed project will have minor negative and temporary impact on noise level in the study area during construction phase.

3.4.3.2 Operational phase

As described above, the noise generating equipment such as compressors at CNG stations, PRV & Relief Valves at CGS stations, D.G. sets used during emergency shall be the major sources of noise generation

At the CNG stations, though the compressors will be housed in acoustic enclosures, the noise levels outside the enclosure will be in the range of 85 - 90 dB(A), which is higher than the specified limits for commercial

However, at the CGS, it shall be the endeavor of the project proponent to ensure that noise levels at the boundary will be within applicable CPCB noise standards i.e. within 55 dB(A). However, being in commercial areas, it may not be practically possible to achieve these noise levels at all times, particularly

Moreover, it would be ensured that personnel working near noisy areas would be provided with adequate personnel protective equipment as a protection against noise, use of which will be strictly enforced.

In view of the above, ambient noise levels in the study area are not expected to increase significantly during operational phase of the proposed project. Hence, it may be said that the proposed project in its operational phase will have minor negative impact on ambient noise levels in the study area.

ENVIRONMENTAL SETTING AND POTENTIAL ENVIRONMENTAL

3.5 Land environment

This chapter documents the land environment in the study area and expected impacts of the proposed NG distribution pipeline project on the land environment in the study area. The issues discussed in this chapter are land use, topography, drainage pattern, geology and soil quality, seismicity and land pollution.

3.5.1 **Baseline Data**

3.5.1.1 Land Use

The proposed NG distribution project falls in and around the city of Ahmedabad as well as covers the industrial areas around the Ahmedabad city. The study area falls within the limits of AMC and AUDA. Being a well developed area, the present land use of the study area comprises mainly built-up land including domestic, commercial and industrial areas, road network, railway lines, existing pipeline corndors, etc. Some portions of the area in the study area comprise agricultural land too.

Within the area of the proposed NG distribution network, the road network in the old parts of the Ahmedabad city is extremely congested and ROU is not available all through. However, in the recently developed city areas of Ahmedabad, the road network is well developed having adequate ROU for the purpose of laying utility pipelines/ services. The present land use of the areas near Bibipura (near Ramol) and Koba (near Koba circle) is agricultural private owned land.

3.5.1.2 Topography & Geology

The topography of the area is fairly level ground. There are no major undulations, hills and abrupt changes in the terrain. Being a well developed area, vast expanses of built-up areas can be seen with some portions of agricultural land in the NG distribution area network. Industrial areas comprise small and medium scale units within well developed industrial estates as well as large industrial units such as Arvind Mills, Ahmedabad Electricity Co. Ltd., Torrent Pharmaceuticals, etc.

The terrain is generally flat with no major undulations. The altitude of the area ranges from 78 - 40 m above

The geology of the region comprises mainly sedimentary and metamorphic rocks. The geological formations arranged in order of antiquity are provided in Table 3.5-1.

Table 3.5-1: General geology of the area

Age	Thickness (in m)	Lithology
	100	Unconsolidated coarse sand, pebbly with kankar and minor clays
Post Miocene	100	Sand, coarse grained, occasional gravels and clays
	125	Greenish brown days, and sand day alterations with variegated day stone
	300	Greenish grey to variegated day stone with coarse to medium grained sand minor coal
	200	Greenish grey clay stone with occasional, banks of medium to fine grained sands
	125	Alternate bands of clay stone and shale with minor sand-stone beds
Miocene	125	Shale with minor clays and clay stones with coarse to medium grained sands towards bottom
Oligocene to upper Eocene	175	Grey to greenish grey shale with argitlaceous sandstone in the basal part

Age	Thickness (in m)	Lithology
Upper Eocene to Middle Eocene	250	Grey to dark grey shale with sitty sandstone, sitstone and coal beds with minor sidreitic day stone and Oolite with sideritic matri
Lower Eocene	1500	Dark grey to black fissile, Pyritic, carbonaceous shale with occasional sittstone bands towards bottom and recklish brown shale.

The soils in the study area can be classified mainly under the categories of silty clay, sandy clay and black cotton soil. Although these soils are difficult to work and manage, they usually have good supplies of plant foods and lime. The main drawbacks are the high water holding capacity and the effort required to work them. Utmost care should be taken while excavating in black cotton soil due to collapsing of sides.

To assess the soil quality in the study area, particularly from the green belt development point of view, soil sampling and analysis were done at 4 different locations, as described in Table 3.5-2. The results of soil sampling along with acceptable values to sustain healthy plant growth are given in Table 3.5-3. As can be seen from Table 3.5-3, though the overall soil quality in the study area conforms to acceptable values specified for healthy plant growth, the following need to be noted:

- The nitrogen content of all soils samples except for soil at Vatva viiiage is low.
- The soils are rich in phosphorus and potassium.
- The heavy metals content of various soil samples is well within acceptable limits.

Hence, the nitrogen content of the soils needs to be enhanced to make them suitable for green belt

Table 3.5-2: Soil sampling locations

Station no.	Description	Approximate distance from reference point (km) ¹	Approximate direction	
S-1	Amiyapur Village	6.6	from reference point 1	
S-2	Khanba Village	10.8	NW	
S-3	Vatva Village (outside Vatva	15.6	SSE	
	GIDC)	13.6	SSW	
S-4	Odhav Village (outside GIDC near housing society)	7.3	S	

Table 3.5-3: Soil sampling analysis results

Sr. No.	Parameter (units)		Soil Sam	ions	Acceptable	
	0	S-1	S-2	S-3	S-4	values
1.	Particle size distribution:			1	1 34	<u></u>
	Sand (%)	26	10.8	30.7	T ===	T
	Sitt (%)	31			39	≤75 and ≥20
	Clay (%)	 	48.3	32.2	18	Silt: ≤60 and ≥5
	Texture	43	40.2	37.2	43 ,	Clay: ≤30 and ≥5
		Clay	Silt Clay	Clay Loam	Sandy Clay	5.57. 250 and 25
	Electrical Conductivity (mS/cm)	0.209	0.242	0.308	0.065	<1.5

¹ Considering the meteorological monitoring station at Naroda GIDC as the reference point

Sr. No.	Parameter (units)		Soil Sa	Acceptable		
		\$-1	S-2	\$-3	5-4	values
4.	Water Holding Capacity (%)	?5.5	32.7	26.3		
5.	Porosity (%)	56.3	70.6	57.2	26.3	-
5.	Sodium Absorption Ratio (SAR)	1.6	1.78		21.5	
7.	pH	7.4	7.5	1.23	1.56	_
3.	Moisture Content (%)	0.213		7.7	7.6	5.5-7.8
)_	Organic Carbon (%)		0.162	0.14	0.1	-
0.	Chlorides (mg/gm)	1.03	1.15	0.196	1.836	-
1.	Nitrogen (%)	0.146	0.195	0.342	0.0978	-
2.	Phosphorous (%)	0.06	0.13	0.05	0.22	> 0.2
3.	Potassium (%)	0.64	0.56	1.28	0.86	>0.0005
1.		0.22	0.31	0.23	0.28	> 0.024
	Alkalinity (mg/gm)	0.72	0.72	0.45	0.54	
	linn (mg/gm)	1.6	0.9	1.1	1.3	-
	Copper (mg/gm)	0.003	0.005	0.01		•
-	Zinc (mg/gm)	0.08	0.12	0.09	0.008	< 130
	Lead (mg/gm)	8.0	6.0		0.11	< 300
	Cadmium (mg/gm)	1.0	2.0	2.0	5.0	<2000
	Chromism (males)	0.03		15.0	9.0	<15
- 1	Permanhite.	0.023	0.08	0.07	0.22	<1000
.1.4	Seismicity	0.023	0.047	0.044	0.055	

Seismicity

The study area falls under Zone-III as per the as per the earthquake zoning map of India in IS classification 1893-1984. In this Zone, intensity of earthquake as per the Modified Mercalli scale is VII or below. Modified Mercalli scale VII specifies the following:

"Everybody runs outdoors, negligible damage in buildings of good design and construction; slight to moderate in well built ordinary structures; considerable in poorly built or badly designed structures; and some chimneys broken, noticed by persons driving motor cars".

Heavy tremors were felt and damage occurred in Ahmedabad city during the Bhuj earthquake of January 2001. In fact, many after-shocks have been felt in the Ahmedabad city and which continue to occur, though

3.5.2 Solid Waste Generation from the proposed project and their proposed

3.5.2.1 Construction stage

During the construction phase, solid/ hazardous wastes will be generated due to:

- Demolition/ removal of structures/ vegetation obstructing the pipeline route. This solid waste shall be disposed off suitably in designated areas demarcated by local statutory authorities such as municipal
- Temporary storage of excavated soil prior to backfilling. This shall be stored along side the excavated
- Maintenance activities of construction equipment/ vehicles. Spent oils, classified as hazardous waste would be collected in barrels for off-site third party recycling. Oil-contaminated cotton waste shall be

Domestic activities at construction camps for workers. This municipal solid waste shall be disposed off in designated disposal sites of AMC or GIDC.

3.5.2.2 Operational phase

During the operational phase, solid wastes / hazardous wastes will be generated due to:

- Domestic activities at CGSs and CNG stations. This shall comprise domestic solid wastes and shall be disposed off along with municipal waste.
- Maintenance activities at the CGSs and CNG stations. The spent (waste) oil from the D.G. set at CGS and CNG stations, classified as hazardous waste shall be collected in barrels for off-site third party recycling. The oil contaminated cotton waste and some amount of maintenance spares shall be disposed off along with municipal waste.

3.5.3 **Environmental Impacts**

The potential environmental impacts of the proposed NG distribution project on land environment in the study area during construction and operation phases are described as follows:

3.5.3.1 Construction stage

3.5.3.1.1 Land use / land requirement

For the proposed project, land will be required for the development of the CGSs at Bibipura (near Ramol) and Koba (near Koba circle). For laying the pipeline, the existing ROU shall be used to the extent possible. Np private ROU shall be used, only permissions from relevant authorities shall be taken.

Total land required for each of the CGSs is about 10000 m² (100 m X 100m) and ar proximately 1050 m² (35 m X 30 m) area of land will be required for each of the CNG stations.

Considering that the CGSs will be located close to the GSPL terminals, some portion of private owned agricultural land may need to be acquired and converted to non-agricultural use.

Similar is the case with CNG stations which will require land if established as stand-alone independent units. Though for each of the CNG stations, land requirement is to the extent of 1050 m², considering that 5 units will be developed during the Phase 1 & 2 of the project, land to the extent of 5250 m2 will be required. This requirement will increase by 26250 m² during the entire life of the proposed project, thereby making the total land requirement as 31500 m^2 over a period of 6 - 7 years. This land could be partly privately owned agricultural land, depending upon the location of the CNG station.

As for ROU for laying the pipeline, permission from relevant authorities will need to be obtained. No permission is required to be obtained for agricultural land ROU. Hence, there shall be moderate negative impact on land requirement/ land use due to the proposed project.

3.5.3.1.2 Topography and geology

Due to the construction of the proposed pipeline network, topography of the area will be temporarily affected considering the sight of excavated soils, construction equipment, etc. on the construction site. However, the topography will be restored to the original extent once the pipeline is buried underground. The only exception will be the additional CGSs and CNG stations spread over the study area that will be a permanent change in the topography of the area.

As for the pipeline construction in congested areas, topography will not be affected considering the use of

As for geology, the construction work will be restricted mainly to the upper layers of the earth, having no

Thus, there will be minor though temporary impact on topography and drainage pattern due to the proposed project in the study area.

3.5.3.1.3 Seismicity

The study area is not majorly earthquake prone though tremors were felt and damage experienced in Ahmedabad city during the Bhuj earthquake. However, as no major heavy structure is planned as part of the proposed project to after the seismic characteristics of the study area, no impact is expected on this parameter due to the proposed project.

3.5.3.1.4 Soil and land pollution

As described above, all construction solid and hazardous waste shall be disposed off suitably without causing adverse effects on the land environment. The excavated soil shall be stored properly along the excavated trench prior to backfilling.

Spent oil waste generated due to maintenance activities of construction equipment/ vehicles shall be collected in barrels for off-site third party recycling. Oil-contaminated cotton waste shall be disposed along with municipal waste.

The municipal solid waste from construction camps for workers shall be disposed off in AMC identified areas.

Thus, it can be said that there will be no significant adverse impact on land environment during construction phase of the project in the study area.

3.5.3.2 Operational stage

3.5.3.2.1 Land use/ land requirement

As such, once the CGSs and the CNG stations are constructed, the pipeline is laid and in operation, no impact is expected on the land use in study area.

Hence, there shall be no impact on land use/ land requirement due to the proposed project in the operational stage.

3.5.3.2.2 <u>Topography and geology</u>

Due to the proposed project, CGSs and CNG stations will be a permanent addition in the topography of the area.

Thus, there will be minor impact on topography due to the proposed project in the study area.

3.5.3.2.3 Seismicity

As part of the operation of the proposed pipeline project, no major heavy structure is planned so as to alter the seismic characteristics of the study area. Hence, no impact is expected on this parameter due to the proposed project.

3.5.3.2.4 Soil and land pollution

As described above, all solid and hazardous waste generated from the activities at CGSs as well as CNG stations shall be disposed off suitably without causing adverse effects on the land environment.

Spent oil waste generated due to maintenance activities of construction equipment/ vehicles shall be collected in barrels for off-site third party recycling. Oil-contaminated cotton waste shall be disposed along with municipal waste.

Thus, it can be said that there will be **no impact** on land environment during operational phase of the project in the study area.

TALSETTING AND POTENTIAL ENVIRONMENTAL

3.6 Terrestrial and Aquatic Ecology

This chapter document the baseline data on terrestrial and aquatic ecology comprising flora and fauna in the study area. It also predicts the probable environmental impacts on the existing ecology, both terrestrial and aquatic, due to the proposed NG distribution pipeline project in the study area.

Ecology can be defined as "Science that concerns itself with the interrelationships of living organisms, plants and animals and their environment" (A. Macfadyen, 1957). As ecology of an area is influenced by both abiotic (non-living) and biotic (living) factors, a change in either of these can bring about a change in the ecology. Hence, it is important to identify the existing ecology of the area to identify the likely impacts due to

3.6.1 **Baseline Scenario**

The baseline scenario of terrestrial and aquatic flora and fauna in the study area based on available secondary data of Ahmedabad district (i.e. from Ahmedabad district Gazetteer, 1984) and site observations during the study period (i.e. during the month of March, 2003) is presented as follows:

3.6.1.1 Flora

Though the area is fertile and has good vegetation typical of both rural as well as urban areas, the high growth rate of the city marked by a substantial influx of population, growth of slums and unauthorized colonies has led to the deterioration of the environment. However, efforts to improve the environmental quality have led to greening projects in Ahmedabad due to initiatives taken by the AMC along with various industrial houses. Under this initiative, development of road side plantations, maintenance of new and existing parks as well as traffic islands has been taken up.

Flora generally found in the Ahmedabad district is presented in Table 3.6-1. Species of trees having aesthetic value and having fast growth rate are provided in Table 3.6-2.

Table 3.6-1: General flora in the study area

Sr. No.	Common Name	Rotanicata
1.	Amta	Botanical Name
2.	Babool	Phyllanthus emblica
3,	Bamboo	Acada nilotica
4.		Dendrocalamus spp
5.	Banyan	Ficus bengalensis
	Bel	Aegle marmelos
6.	Cherry	Prusius avium
7.	Cluster Fig	
8.	Coconut	Ficus gloerata
9.	Cotton	Cocos nucifera
10.	Doob Grass	Gossupium sps.
11.	Eucalyptus	Cymodon dactylon
12.	Guava	Eucalyptus sps.
		Psidium guyava
13.	Harde	Terminalia chebula
14.	Indian Ber	Zizyphus jujube
15.	Jambu	Eugenia jambolina

Sr. No.	Common Name	Botanical Name
16.	Jamun	
17.	Lemon	Eugensia jurosbalanam
18.	Mahua	Citrus limon
19.	Mango	Madhuca indica
20.	Meethi Limbdi	Mangifera indica
21.	Moringa	Murraya koengii
22.	Neem	Moringa indica
23.	Nerium	Azardiracta indica
24.	Opuntia	Nerium odrum
25.	Papaya	Opuntia dillenii
26.	Peacock Flower	Carica papaya
27.	Peepal	Delonix oragia
3.	Polyathia	Ficus religiosa
9.	Rose	Polyalthia longifolia
30.	Sag	Rosa domascena
31.		Tectona grandis
12.	Sugar Apple	Annona squamosa
3.	Sugar cane	Saccharum officinarum
35. 14.	Surpodiffa	Actinus sapta
	Sweet Acacia	Acacia fernesiona
	Tamarind	Tamorindus indica
	Thevetia	Tevelia nerofelia
	Tulsi	Ocimum sanctum
	-	Prosopis spicigera
		Salvadora deoides
)		Salvadora persica
. -		Capparis aphylia
. -		Ficus benghalensis Pongamia glabra

Table 3.6-2: Trees having aesthetic value and having fast growth rate

or. No.	Local Name	hetic value and having fast grow
1.	Baval	· Technical Name
2.	Siras	Acacia Arabica auct.
3.	Limdo	Albizia lebbeck Linn
4.		Azardirachta indica A. Juss
5.	Gunda	Cordia dichotoma Forst
	Sissoo	Datbergi Sissoo Roxb
6.	Gulmohar	
7.	Nilgiri	Delonix religa (Boj)
8.	Nani padar	Eucalyptus L. 'Herit
	regul padar	Kigalia pinnata DC

9.	Ambo (mango)	Mangifera indica
10.	Pardeshi Baval or Ram Baval	Parkinsonia acuteate Linn.
11.	Goras Amli or Vilayati Amli	Pithecellobium dulce Roxb.
12.	Karanj	Pongamia pinnata Linn.
13.	Sami or Khijdo	Prosopis cineraria Linn
14.	Ambli or Amili	Tamarindus indica Linn

Being a fertile area, some portions of the study area comprise agricultural land. Wheat, onions, erandel, tobacco and banana are the largely grown crops in the cultivated areas in the study area.

3.6.1.2 Aquatic Flora

Aquatic flora comprises species of lilies and lotus, water hyacinth, along with a variety of phytoplankton. The dominant phytoplankton species found are cerratium, aeruginosa, saggetaria, volvox, chlorosterium, diatoms, spirogyra, hydrilla and vallisneria.

3.6.1.3 Terrestrial Fauna

The fauna of the study area is mixed type typical to both urban and rural areas. Livestock comprises cattle, buffaloes, sheep, goats, etc.

A general listing of terrestrial fauna in the district of Ahmedabad is presented in Table 3.6-3.

Table 3.6-3: List of fauna found in the Ahmedabad district (based on Ahmedabad district Gazetteer, 1984)

Sr. No.	Common Name	Scientific Name	Family
	Birds		- Lamity
1.	Little Grebe	Podiceps ruficollis	D 61 WA
2.	Surface Feeding Pintail	Anas acuta	Podicipitidae
3.	Shovellor	Anas dypeata	Anatidae
4.	Common Teal	Anas creoca	Anatidae
5.	Diving Ducks	Arias creoca	Anatidae
6.	Brahmini Duck		
7.	Kestrel	Tadoma Ferruginea	Anotidae
8.	Peregrine Falcon	Falco finnunculus	Falconidae
9.	Lanner Falcon	Falco Peregrinus	Falconidae
<u> </u>		Falco biarmicus	Falconidae
11.	Red Headed Merlin	Falco chicquera	Falconidae
12.	Shikta	accipiter badius .	Accipitridae
	r diam Nie	milvus migrans	Accipitridae
13,	Brahmini Kite	haliastur indus	Accipitridae
18 .	Black Winged Kite	elanus caeruleus	Accipitridae
15.	Harriers	****	
16.	Pea fowl •	pavo cristatus	
17.	Grey Patridge	francolinus pondicerianus	
18.	Painted Patridge	francolinus pictus	
19.	Rain Quail	columix commandelica	

Sr. No.	Common Name	Scientific Name	Family
20.	Sans	grus antigone	ramity
21.	Demoiselle Crane	Anthropoides virgo	
22.	Crane	grus grus	
23.	Blue Rock Pigeon	columba livia	
24.	Ring Dove	streptopelia decaocto	Columbidae
25.	Little Brown Dove	streptopelia senegalensis	Columbidae
26.	Red Turtle Dove	streptopelia tranquebarica	Columbidae.
27.	Rose Ringed Parakeet	psittacus kramers	Columbidae
28.	Koel	Eudynamis seolopacca	Psittacidae
29.	Cuckoo	cuculus canorus	Cuculidae
30.	Plaintive Cuckoo	Cacomantis passerinus	
31.	Bam Owl	Tyto alba	
32.	Spotted Owlet	Athene brama	
33.	Eagle Owl	Bubo tubo	
34.	Indian Nightiar		
35.	Indian Myna	Caprimulgus asiatius	
36.	House Crow	Acridotheres tristis	
37.	Crow Pheasant	Corvus splendens	
38.	Red Jungle Fowl	Centropus sinensis	
39.	House Sparrow	Gallus gallus	
40.	Baya	Passer domesticus	
41. ,	Indian Robin	Ploecious philippinus	Breasa.
42.	Redwhiskered Bulbul	Saxicoloices fulicata	
	Animals	Pycnonolus jacosus	
43.	Grey Musk Shrew		
44.	Pale Hedgehog	suncus murinus	Soricidae
45.	Flying fox	paraechinus micropus	di di santa dan dan pagangangangangangangangangangangan dan dan dan dan dan dan dan dan dan d
¥6.	Common Langur	pteropusgiganteus	Vespertifionidae
	Desert Hare	presdvytis entellus	Ceropithecidae
		lepusdayanus	
	Five stripped squirrel	Funambulus pennanti	Sciuridae
	Striped Palm Squirrel Indian Garbitles	Funambulus palmatum	Sciuridae .
		Tatera indica	Muridae
	Long Tailed Tree mouse	Vandelcuria oleracca	Muridae
<u> </u> -	Common Grass Yellow Butterfly	Eurema hecabe	
—— <u> </u>	Common Evening Brown Butterfly	Melantis leda	
	Common Mormon Butterfly	Papilio polymnestor	
1	Common Emigrant Butterfly	Catopsilia Pomona	
	Common Grasshopper	Chorthippus bicolor	
	Vrmy ant	Cheliomymnex andicolus	
58. H	loney Bee	Apis mellifica	

Sr. No.	Common Name	Scientific Name	Family
59.	Jumping Spider	Attidae sps	
60.	Skipper Frog	Rana cyanophlyclis	
61.	Rhesus Monkey	Macaca mulata	
	Reptiles		
62.	Rat Snake	Ptyas mucosus	
63.	Common Krait	Bungarus coeruleus	
64.	Common Garden Lizard	Calotes versicolor	

3.6.1.4 Aquatic Fauna

The major river body in the study area is Sabarmati river with Vaheva nadi with Khari nadi being the smaller ones. The other water bodies are Vatva Branch canal, Kharicut canal and Narmada Main canal, Chandola and Kankariya lakes as well as small water ponds.

These water bodies and other irrigation reservoirs/ tanks/ perennial ponds provide for fish culture in the area. The important inland fish species found in the area is presented in **Table 3.6-4**. The dominant zooplankton species found are cladocerons, ostracods, rotifers, euglena and copepods.

Table 3.6-4: Typical inland fish found in the study area

Sr. No.	Scientific Name	English Name	1 and No.
1.	Catla catla		Local Name
2.	Labeo robita	Major Carp	Ravas, Katla
3.	-	Rohu	Rohu, Böyee
	Cirrhinus mrigala	Mrigala	Nagri
4.	Labeo gonius	Gonius	Kurcha, Khurshi
5.	Ompok birnaculatus	Butter Cat Fish	Gungwari
6.	Wallago attu	Fresh water Shark	Mulley, Padhin
7.	Mystus seenghla	Cat Fish	Katiya, Singala
8.	Labeo calbasu	Kathasu	·
9.	Ophiocephalus striatus	Snake head Fish	Bagado, Kavchi
10.	Notopterus notopterus	Razon Fish	Murral, Dori Patra

3.6.2 Potential Impacts

3.6.2.1 Construction Impacts

Any construction activity brings a change in the existing flora on and near the site due to changes in top soil as a result of construction activities involving movement of construction equipment and materials, vehicles, project construction site and to some extent its immediate vicinity. Moreover, the impacts are restricted to the the extent of the construction activity. Impacts on flora can be major if land requirement for the purpose of the project entails removal of vegetation. The noise generated due to operations of the machinery during construction can also have negative impacts on fauna, especially birds in respect of physiological and behavioral changes that they may encounter.

For the proposed project, land requirement is only for the CGSs as well as CNG stations as for laying the pipeline, existing ROU shall be used. Thus, the impacts on flora and fauna will be restricted to the land requirement of the CGSs and CNG stations numbering 30 (over a period of about 6-7 years). As the CGSs will be located close to the GSPL terminals, agricultural private owned land to the extent of 100 X 100 m shall be required.

Similar is the case for CNG stations, which if being stand-alone units shall require land for development. It shall be the endeavor of the project proponent to develop the CNG stations in the premises of existing petrol pumps. However, considering the large number of CNG stations to be developed, this may not be possible all the while. Hence, care shall be taken by the project proponent to ensure that non-agricultural private land shall be used for development of CNG stations.

For the pipeline network, existing ROU shall be used and route chosen such that minimum number of trees will be felled. Since most of the pipelines shall be constructed along the existing roads within the available ROU, project does not envisage felling of trees. Adequate care shall be taken whilst carrying out construction work by utilizing appropriate mitigative measures such as erosion and sediment control, noise and fugitive dust reduction procedures that will help in reducing the likely temporary impacts on the flora at

Temporary impact on fauna mainly birds is expected due to construction activity noise and dust. However, once the construction activity is over, the impact shall be reversed.

Thus, there will be a negligible temporary impact on the flora and fauna of the study area during the construction stage of the proposed project.

3.6.2.2 Operations Impact

Impacts on flora due to the operation of the development project are expected to occur when discharges/ emissions from the proposed project exceed a certain threshold. This is considering that pollutants can interfere with the biotic and abiotic components of the ecosystem and may induce injurious effects when concentrations exceed threshold limits. Impact on vegetation can also be due to particulate emissions that may settle on the plant leaves at and around the proposed activity. This affects the normal pattern of growth and photosynthetic activities of the plants, which in turn also affects the avifauna in the area forcing the birds in the area to migrate to an area with better vegetation. Also, pollutant emission such as SO₂ and NO_X can also cause health problems to the birds with respect to their loss of plumage, respiratory dysfunction and poor visibility. Noise is another stress factor having a disturbing effect on the normal patterns of the flora as

As for the proposed NG distribution project, discharges and emissions will be restricted to the operation of the CGSs and CNG stations. These will be in the form of domestic waste waters and housekeeping effluent, air emissions from fuel combustion products i.e. SPM, SO₂, NO_x and CO from D.G. sets and solid/ hazardous wastes comprising waste oils and general solid waste.

These discharges and emissions shall be well within the permissible standards as has been discussed in the earlier chapters in the report. Hence, the pollution stresses on the environment shall be kept to the minimum. In fact, at the CGSs, development of suitable green belt will add to the beneficial impact on the

Thus, there will be no impact on the flora and fauna of the study area during the operational phase of the

3.7 Socio-economic environment

Tr. s chapter discusses the baseline scenario of the socio-economic environment in the study area and the expected impacts of proposed NG distribution project on the socio-economic environment in the study area. The issues discussed in this chapter are population, population displacement, education, employment, community services, cultural and aesthetics aspects and transportation.

3.7.1 Baseline scenario

For assessing the baseline socio-economic data, information from secondary data sources i.e. the Provisional Population Totals, Census of India 2001 has been considered.

3.7.1.1 Population

The study area comprises the city of Ahmedabad and the surrounding industrial and rural areas falling in the Ahmedabad district. The urban areas include Ahmedabad Municipal Corporation and other outgrowths (OG) i.e. Asarva OG, Naroda OG, Nikol OG, Odhav OG, Shahwadi OG, Gyaspur OG, Maktampur OG and Saijpur-Gopalpur OG, Ahmedabad cantt., municipalities comprising Ranip (M), Chandlodiya (M), Ghatlodiya (M), Memnagar (M), Vejalpur (M), Sarkhej-Okaf (M), Kali (M) and Jodhpur (M) as well as Vastrapur (CT) and Makarba (CT). The industrial areas comprise Narol, Vatva, Odhav and Naroda.

The population data of the study area based on Provisional Population Totals 2001 of Census Department is presented in **Table 3.7-1**. The provisional population totals for the Ahmedabad Urban area are presented in **Table 3.7-2**. As can be seen from **Table 3.7-1**, the total population of the study area is 4214368 of which 2234720 is the total male population and 1979648 is the total female population.

Thus, the male and female population density in the study area is 53.03% and 46.97% respectively. The population distribution is quite comparable with the Ahmedabad district values being 52.85% for male and 47.15% for female population.

The female to male ratio in the study area is 0.886 (i.e. 886 females to 1000 males). This is lower than the female/male sex ratio of 0.892 for the Ahmedabad district.

3.7.1.2 Education

The city of Ahmedabad is today one of India's most important seats of learning. It's well known both for the number of institutions that are located there and for the high quality of education that they bring.

Details on educational status in terms of literates as well as literacy rates are provided in **Table 3.7-1** and information on schools, colleges and universities is provided in **Table 3.7-3**. Total number of literates in the study area is 3135243 of which there are 1769194 males and 1366049 females. The overall literacy rate in the study area is 84.09% and the male and female literacy rates are 90.1% and 77.41% respectively. As compared to the literacy rate of country which is 65.83% (based on Census 2001) and that for the Ahmedabad district which is 79.89%, it can be said that the overall literacy rate in the study is higher as compared to the national levels as well as district levels.

The educational facilities in the study are very good. There are a large number of primary as well as secondary schools in the study area. Also, there are a number of colleges as well as universities offering various disciplines in the study area. In fact, Ahmedabad boasts of some of the premier institutes in the country – these being the ladian Institute of Management (IIMA), National Institute of Design (NID), Entrepreneurship Development Institute of India, Sardar Patel Institute of Economic and Social Research, School of Architecture, Center for Environment, Planning and Technology and Gandhi Labor Institute.

3.7.1.3 Employment

The employment data for the study area is provided in **Table 3.7-4**. As can be seen from **Table 3.7-4**, the total workers in the study area is 134236 of which 1177255 are males and 165181 are females. Thus, the overall rate of employment in the study area is 31.85% and the male and female employment rates are 52.68% and 8.34%

respectively. Also, as can be seen from **Table 3.7-4**, there are 1281012 main workers in the study area of which 1147005 are males and 134007 are females. There are 61424 marginal workers of which 30250 are males and 31174 are females. There are 2871932 non-workers workers of which 1057465 are males and 1814467 are females. Thus, approximately 30.4% of the total population in the study area falls under the category of main workers, 1.46% under the category of marginal workers and 68.15% under the category of non-workers. In the category of non-workers, the number of females is higher than the males. Thus, the major portion of the population is in the non-workers category.

of the total workers, cultivators and agriculture laborers form 0.67% and 0.28% respectively whereas persons employed in other trades is approximately 96.66%. A small portion of workers i.e. 2.88% are employed in household industries.

Based on an official survey, it is reported that although there is a rise in industrial investment in the area, this has not led to any significant employment growth. This is attributed partly due to induction of new technology and downsizing by companies. Hence, more and more people are turning to the informal sector for their livelihood or remain unemployed.

3.7.1.4 Other facilities/ services

As can be seen from **Table 3.7-3**, the medical facilities in the study area are fairly good. There are government hospitals as well as private hospitals in the area. The hospitals are well equipped for emergencies of various kinds including chemical emergencies.

The drinking water in the study area is mainly through the municipal corporation water supply network which gets its source from Kadana Dam located on Sabarmati river, approximately 165 km from the city of Ahmedabad. Ground water is also a major source of water supply in the study area through tube wells, bore wells, hand pumps, etc.

The study area is well connected in terms of communication facilities by way of telephones, fax, internet, post and telegraph.

The power supply in the area is through the Gujarat State Electricity Board (GSEB). There is the Ahmedabad Electricity Company coal based power plant which supplies power to the GSEB grid. The city does not generally face power shortage.

Piped gas supply is not available in the Ahmedabad area for industrial, commercial or domestic use. However, GAIL supplies piped NG to IFFCO and AEC.

Fire brigade stations are located at Memnagar, Sabarmati, Odhav, Danapith, Gomtipur, Jamalpur, Maninagar, Naroda, Panchkuva & Shahpur.

The solid waste collection and disposal in the urban areas is scientifically managed by the AMC.

3.7.1.5 Transportation

Ahmedabad, the seventh largest city in India, Ahmedabad is well-connected with the rest of the country via a large air, rail and road network. All major domestic airlines fly to and from the city, connecting it to most important cities of India. It also has an international airport with connections to various cities in Europe and the USA.

Ahmedabad is on the Western Railway network and is well-linked with the rest of the country. The prestigious Rajdhani Express connects it tri-weekly to New Delhi. The Shatabdi Express and Karnavati Express provide convenient daily connections to Ahmedabad from Mumbai.

National Highway No. 8 connecting Mumbal to Delhi passes through the study area. By road, the State Transport Corporation connects it to all the major cities and towns of Gujarat and other states of the country.

Public transport vehicles within the city include buses, auto rickshaws and taxis. There are a few private bus services too. Of sourse, there are many people who use their own vehicles – cars; scooters, motorcycles and bicycles. Private taxis are also available.

3.7.1.6 Economic scenario

The economic scenario in Ahmedabad area is mainly dependent on the industrial development, textiles trade, small and medium sized cottage industries and to some extent on agriculture. The city is famous for its textile industry, mainly block printed fabrics and sarees.

Facing neither power cuts nor water shortages, the city has attracted several multinationals and large Indian industrial houses in the fields of power, telecommunications, textile, chemicals, engineering, etc.

Various other industrial units comprising the chemicals, plastics, metallurgical, etc. are located in the GIDC industrial

Various large industrial units in and around Ahmedabad are the Arvind ₩ills, Ahmedabad Electricity Company Ltd.,

3.7.1.7 Health environment

Based on secondary data, the most prevalent health issues are the respiratory infections such as asthma, bronchial ailments, etc. mainly due to the high pollution levels in the city.

In summers, heat stress disorder is prevalent. Sporadic outbreaks of viral fever, allergies, incidences of gastro-

3.7.1.8 Historical, cultural and archaeological sites/ places

Ahmedabad boasts of some of the finest examples of Islamic architecture in India as well as the blend of Hindu and Islamic architectural styles known as the Indo-Sarcenic. Also in Ahmedabad is one of the best examples of the step

Various places of historical, cultural and archaeological sites/ places in and around the city of Ahmedabad are as

Gandhi Ashram - This is situated alongside the Sabarmati River and was the nerve-center for Indian Freedom movement and remains one of Ahmedabad's most important sites of its recent history. The beautiful ashram complex with its shade trees offers a refuge from the loud streets of the city. There is a museum inside the Ashram

Calico Museum: Ahmedabad houses one of the finest textile museums in the world in one of Gujarat's famous carved wooden havelis. The museum displays a magnificent collection of rare textiles dating back to the 17th century.

Adalaj Wav: About 19 km. north of Ahmedabad, this stepwell is an architectural wonder built by Queen Rudabai and is certainly one of the finest monuments of Gujarat. It is a seven-storied structure in the form of a well with chambers

Jama Masjid: Located in the centre of old Ahmedabad city, this congregational mosque was built by Sultan Ahmed Shah in 1423. Built in yellow sandstone, it combines the best of Hindu and Muslim styles of architecture, standing on 260 pillars supporting 15 domes at varying elevations.

Kankaria Lake: One of the best places to witness the sunset in Ahmedabad is the artificial lake of Kankaria constructed in 1451. It attracts good bird life and has an island garden, called Nagina wadi.

Gandhinagar. This is the modern capital of Gujarat, was named after Mahatma Gandhi, father of the Nation. Situated on the banks of river Sabarmati, it is the second planned city in India after Chandigarh. The famous Akshardham -

Akshardham: This is the highlight of Gandhinagar and houses a beautiful Swaminarayan temple, with a theme park containing tableaux of the Ramayana and Mahabharata. The village Pethapur outside Gandhinagar is known for its

The other attractions are Ahmed Shah's Mosque, Balvatika, Teen Darwaza and Bhadra Fort, Daria Khan's Ghummat, Siddi Sayyad's Mosque, Gita Mandir, Hathisinh Mandir, Jhulta Minar, Rani Sipri's Mosque and Tomb, Rani Roopmati Mosque, Rauza of Shah Alam and Siddhi Sayyad Mosque. 3.7.2

Potential impacts

During the construction phase, approximately 100 persons are expected to be employed as construction workers, both skilled and unskilled.

During the operational phase, approximately 30 persons shall be employed at each of the CGSs and about 5 persons at each of the CNG stations. Thus, about 85 persons are expected to be employed during the Phase 1 & 2 of the project, increasing to about 210 persons during the entire life of the project over a period of 6 – 7 years.

It shall be the endeavor of GAEL to source the persons for both the construction as well as operational phases (i.e. in the management category, skilled and unskilled workers) from within the study area based on the availability of required skill set. It is indicated that at least 40 persons during the construction stage shall be sourced from within the study area and about 60 persons from outside nearby areas.

Hence, the socio-economic impacts of the proposed project would due to employment in both the construction and operational phases. In fact, during the operational phase, the significant contribution to socio-economy of the area is by way of improvement of air environment resulting in healthy quality of life for people in and around the city of Ahmedabad.

3.7.2.1 Population

3.7.2.1.1 Construction phase

At peak period a maximum of 100 persons shall be employed. Of this, 40 construction workers shall be employed from within the study area and about 60 from close by areas, thus generating employment and resulting in temporary migration of construction workers to the site from within and close vicinity to the study area. However, since the construction phase shall be relatively short term being limited to 6 months for each of the phases of development, the impact is expected to be **minor negative but temporary**.

3.7.2.1.2 Operational phase

In the operational phase during Phases 1 & 2, approximately 85 persons are expected to be employed. Of this, there will be about 60 persons employed for operations at CGSs of which about 10 persons will be in the Management category and the rest as workers and supervisors. Similar is the case with each of the CNG stations where 5 persons will be employed of which there will be 1 each in the management category and the rest 4 as workers and supervisors:

However, there will be additional about 125 persons expected to be employed over the entire life of the project considering the development of additional 25 CNG stations.

It shall be the endeavor of GAEL to source as many persons from within the study area, subject to the availability of skilled manpower requisite to the job requirement. Hence, there are chances that some of the persons from outside the study area may settle in the study area with their families. In the worst scenario, the increase in number of persons is expected to be about 840 persons (considering a family size of 4 persons) due to the proposed project. Moreover, an increase in population is expected due to the ancillary development in the area due to the proposed project.

Thus, there will be a **moderate negative impact** on population due to an increase in population due to proposed project in the study area.

3.7.2.2 Education

3.7.2.2.1 Construction phase

During the construction phase of the project, approximately 60 persons are expected to be migrating from outside the study area apart from the 40 workers from within the study area. Considering that the construction phase will be relatively short term being 6 months for each of the two phases, it is not likely that the construction workers would shift with their families to the construction sites. Hence, it can be said that **no significant impact** is expected on education due to the proposed project.

3.7.2.2.2 Operational phase

Considering that some of the persons from outside the study area shall be employed for the proposed project, the children of such persons may require schooling/ college education. As such for schools as well as higher college education, adequate facilities are available in Ahmedabad itself. Moreover, for safe handling of NG, necessary training and education shall be provided by GAEL to their employees as well as general public. Hence, it can be said that there will be **positive impact** on this parameter due to the proposed project.

3.7.2.3 Employment

3.7.2.3.1 Construction impacts

As explained earlier, there shall be **minor positive impact** considering that to the extent possible construction workers shall be employed from within the study area. Also, there will be indirect employment opportunities due to related ancillary development in the area.

3.7.2.3.2 Operational phase

As mentioned earlier, approximately 85 persons of whom 10 will be in management category and the rest as workers and supervisors are expected to be employed during Phases 1 & 2 of the project. Additionally, 125 persons are expected to be employed in the latter phases of the project development. As for the manpower required, it shall be the endeavor of GAEL to source as many persons from within the study area, subject to availability of skilled manpower requisite to the job requirement.

Moreover, due to the availability of NG due to the proposed project, development of secondary industry is also likely resulting in additional employment in the area, which to a certain extent will be offset by the loss of employment of the vehicular traffic for fuel transportation in the area due to NG substitution.

Thus, there shall be moderate positive impact on this parameter.

3.7.2.4 Community services and transportation

3.7.2.4.1 Construction phase

As mentioned earlier, about 60 persons are expected to be employed from outside the study area during the construction phase. For these persons, GAEL shall ensure that the construction contractor makes adequate provision to handle the water, sanitary, medical and fuel requirement of construction workers, as required to ensure that the existing infrastructure is not strained.

Moreover, considering that the construction phase is relatively short term, no significant impact is expected on this parameter.

3.7.2.4.2 Operational phase

As mentioned earlier, a small increase in the population is expected due to the proposed project during the operational phase.

Facilities such as housing, sanitary, medical, water, etc. are adequate in the area and accommodating a small population increase of 840 persons in the worst case scenario will not be difficult considering the sporadic development of housing infrastructure in and around the area. However, where need be, GAEL shall make necessary arrangements to provide such facilities to their employees.

As regards transportation, a likely decrease in vehicular traffic is expected due to the proposed project. This is due to the "on-tap" concept of supply of fuel for various consumers such as industries, commercial usage, vehicular fuel as improvement in traffic situation is expected due to the proposed project.

Due to the reduced traffic as well as improved air quality due to substitution by NG, the need for medical facilities will also the reduced.

Thus, there shall be positive long term impact on this parameter.

3.7.2.5 Economy

3.7.2.5.1 Construction phase

There shall be **temporary positive impact** due to influx of capital needed for construction activities as well as related ancillary development.

3.7.2.5.2 Operational phase

There shall be both direct and indirect contribution to the economy of the study area due to the proposed project.

Direct contribution shall be in terms of sales tax earned by the sale of NG in the city. Other sources of revenues for the state and local bodies will be in terms of octroi on the project plant & machinery.

Indirect contribution will be due to reduction in health related expenses considering decreases levels of air pollution due to substitution of conventional fuels by NG.

Hence, positive long term impact is expected on this parameter.

3.7.2.6 Health environment

As the substitution of conventional fuels by NG is expected to improve the air quality in the area, the illnesses related to air pollution are expected to decrease. Thus, it can be said that there will be **positive long term impact** on health parameter in the study area.

3.7.2.7 Population displacement details

There shall be no population displacement due to the proposed project as the land required for the CGSs as well as tap-off points is devoid of any habitation. Moreover, the routing of the pipeline shall be all along the existing roads, thus almost eliminating any population displacement.

Thus, there will be no impact on this parameter in the study area.

Table 3.7-1: Population data of urban and rural

1107							מ מ	reas in	the stu	dy area	based	on prov	, lanoisi	ally luid areas in the study area based on provisional 2004		,	
Name	S S S S S S S S S S S S S S S S S S S		Total Pc	Total Population		%	% Population	6					, miles		sns de	## ##	
	of Area								ulation o	ropulation of children in age	9 8 8 P		Literates	_			
		Total							Broup of	Broup of 0 - 6 years					******	% Literacy	licy
		<u> </u>	waie.	Female	Sex	Male	Female	1000									
					Ratio				e Ru	Female	8ex	Total	Male	Female Total	Total	1	
hmedabad	2	4552	20.0			+		i		-	Ratio	,			18101	Male	Fernai
4.	20.00	400	2485	2068	832	54 58	15.40	100									
<u> </u>	1 140					20.7	10.44	\$	410	354	583	95.50				i	
	Ordan	4208815	2232235 1977580	1977580	888	53.00	10.00				200	2519	1850	1059	77.02	70 00	
4						20.05	40.40	485260	485260 270849 214611	214611	203	10000			5	08.04	51.79
IOIAL	1	421438	22347	197964	888	53.03	48 07	1000			-	3132324	1787334	1364990 84.10	84.10	90 10 27 43	77 43
		•	ç	c			10.01	48802	27105	48602 27105 214985	702	242801				2	24.
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													-	מ		<u>_</u>	

Table 3.7-2: Break-up of population data of Urban Areas along with Outgrowths in the Ahmedabad city study area based on provisional 2001 census data

)	יי ביי כייטוסוומו בססו		census data	ra La	,				
Name of Urban		Total Population	oulation		% Pos	% Population	Popula	ition of ch	Population of children in age group	e group		Literates	80		% Literacy	20
Area								70.10	or u - b years							
	lota	Male	Female	Sex Ratio	Male	Female	Total	Male	Female	Sex	Total	Male	Female	Total	Male	Female
Ahmedabad MC	3515381	1863888	1651475	886	530.07	46.98	408814	228125	180539	792	2579417	1460175	1119242	83.03	00 02	0,01
(Ward 1-43)									***************************************	-				8	77:60	0. 0.
New Asarva OG	3528	2042	1486	728	57.88	42.12	612	293	319	1089	2215	1525	069	75.96	87.19	59.13
New Naroda OG	44636	24074	20562	854	53.93	46.07	5357	3016	2341	778	36916	20511	16405	93.98	97.40	90.03
Vew Nikol OG	17035	9231	7804	845	54.19	45.81	469	1425	1044	733	12759	7314	5445	87.59	93.70	80.55
Vew Odhav OG	21472	11548	9924	859	53.78	46.22	2697	1475	1222	828	16970	9529	7141	88.79	94.60	82 78
Shahwadi OG	8801	4532	4269	942	51.49	48.51	1098	587	511	871	6544	3566	2978	84.95	90.39	79.24
3yaspur part) OG	10070	5287	4803	912	52.30	47.70	1622	878	744	847	8404	3748	2656	75.80	85.40	65.43
vlaktampur 3G	14398	7360	7038	926	51.12	48.88	1531	818	713 8	872	11633	6218	5445	90.64	95.05	86.09
Saijpur - Sopalpur OG	5464	3363	21(1	625.	61.55	38.45	767 4	412 3	355	862 3	3311	2480	831	70.49		47.59
hmedabad ant. (CB)	14713	8835	5878 6	665	60.05	39.95	1716 9	929 7	787 8	847	11877	7678	4199	91.38	97.12	82.48
(M)	87573	47032	4054; 8	862 5	53.71.	46.29	9088 5	5242 3	3846 7;	734 7	71458	39895	31563	90.40		
Shandlodiya M)	56135	30055	26080 8	868	53,54	46.46 6	6559	3670 2	2889 78	787					90.49	86.01 76.15

3.7-8 REIA study for the proposed City Gas Distribution networks for Ahmedabad city in Gujzrat

Name of Urban		Total Po	Total Population		6 %	% Population	Popul	ation of ch	Population of children in age group of 0 - 6 years	ge group		Literates	87		% Literacy	ts.
Aron	Total	Male	Female	Sex Ratio	Male	Female	Total	Male	Female	Sex	Total	Male	Female	Total	Male	Fomale
Chandlodiya (Nimay Nagar) (parl) OG	6338	3310	3028	915	52.22	47.78	597	331	266	808	5460	2917	2543	95.11	87.82	92.07
Ghatlodiya (M)	106259	56040	50219	896	52.74	47.26	11115	6138	4977	811	87910	47874	40236	92.40	95.54	88.94
Ghatlodiya (Nirnay Nagar) (part) OG	3220.	1681	1539	916	52.20	47.80	345	203	142	700	2619	1419	1200	91.10	96.01	85.90
Memnagar (M)	37290	19324	17968	830	51.82	48.18	3043	1734	1309	755	32488	17140	15348	94.86	97.44	92.14
Vastrapur (CT)	24438	12852	11588	901	52.59	47.41	2068	1214	854	703	21195	11441	9754	94.75	98.31	90.89
Vejalpur (M)	113304	58828	54478	928	51.92	48.08	11901	6444	5457	847	01063	accor	10077	\top		
Makarba (CT)	18090	9651	8439	874	53.35	46.65	2881	1537					41/2/	71.85	94.18	85.12
Sarkhej- Okaf (M)	23086	12088	10998	910	52.36	47.64	3345	1847	1498	811	15099	8910	6189	76.49	87.00	65.15
Kali (M)	34223	18266	15957	874	53.37	46.63	3470	2016	1454	721	27964	15891	42273	6		
Jodhpur (M)	44381	22970	21411	832	51.78	48.24	4165	2315	1850					-	95.19	87.90
TOTAL	4209815	2232235	1977580	886	53.02	48.07	483260	270649 2	214611	793	3132324 1	1767334	1364990	74.4	79.17	69.02
													-		-	10:01

Table 3.7-3: Details on educational and medical facilities in Ahmedabad city

	The state of the s
Schools	Eklavya Education Foundation, Amritjyoti Primary School; Amrut High School, Ankur Primary School, Army School, Aroma English Primary School, Baljatan Primary English School, Best High School, Bhaktavallabh Dhola Primary School, Cadila Infant School, Central English School, Classical English School, Don Bosco School, Evergreen Primary School, Goklen English Primary School, Gujarat Law Society Primary School, Gyandeep Vidyalaya, Hebron Primary School, Jagruti Primary English School, Kendriya Vidyalaya, Kishorimal English School, Lalita English School, Lions Club of Naroda English Primary School, Little Star English School, Maharaja Agarsan Vidyalaya, Mount Carmel High School, Nelson English School, New Samarth Primary School, Parag English School, Parsi Montessory Primary School, Prakash Senior Secondary School, Rachana Primary School, S.D.A. Higher Secondary English Medium School, Shri Shivkumar Sharma Memorial School, St. Ann's High School, St. Joseph English School, St. Mary's School, St. Xavier's High School, St. Xavier's Primary School, Synex English Primary School, Vasant Primary School, Tripada Primary School, Udgam School For Children, Vandana Primary School, Vasant Primary School
Colleges & Institutes	Indian Institute of Management, Mudra Institute of Communications, CEPT School of Building Science and Technology, School of Architecture Centre for Environment Planning & Technology (CEPT), Municipal Medical College, L.M. College of Pharmacy, L.D. College of Engineering, L.D. Arts College, Nirma Institute of Technology, Govt. Polytechnic, R.C Technical Institute, B.K. School of Business Management, M.D. Gram Vivasthapan Mahavidyalaya, Govt. Akhandan and Ayurvedic College, College of Fire Technology, H.K. Arts College, National Institute of Design, Nirma Institute of Management, Som Lalit Institute of Management, A.G. Teachers College, Ahmedabad Arts and Commerce College, Ahmedabad Aviation Academy, Ahmedabad Homoeonathic Medical College, B.D. Arts College, R.D.
	Management, Bhavans Sheth R.A. College of Arts and Commerce, Bhavans Sheth R.A. College of Science, B.J. Medical College, B.V.D. Arts and Commerce College, C.C. Sheth College of Commerce, Central Institute of Plastics Engineering and Technology, Cessna Pitlar Centre, C.N. College of Arts, College of Nursing, C.U. Shah Arts College, C.U. Shah City Commerce College, C.U. Shah Science College, Daulatthai Trivedi Law College, Dr. Babasaheb Ambedkar Open University, Entrepreneurship Development Institute of India, F.D. Arts and Commerce College for Women, G.B. Shah Commerce College, G.L.S. Institute of Business Administration, G.L.S. Institute of Commerce, G.L.S. Institute of Computer Applications, G.L.S. Institute of Computer Technology, G.L.S. Institute of Under-Graduate Business
	Arts and Commerce College, Gujarat Arts and Science College, Gujarat Commerce College, Gujarat Law Society Institute of Information Technology, H.A. College of Commerce, H.K. Arts College, H.K. Commerce College, H.L. College of Business Management, H.L. College of Commerce, H.L. Institute of Commerce, H.L. Institute of Commerce, H.L. Technology and Applied Nutrition, Institute of Medical Postgraduate Studies and Research, J.G. College of Commerce, K.K. Shah Jarodwala Maninagar Science College, Lalumanus C. T. College of Pharmacy, L.J. Institute of Pustiness Administration, Lalumanus C. T.
	Science, M.D. Gram Vivasthapan Mahavidyalaya, M.D. Gramseva Mahavidyalaya, M.G. Science Institute, Motital Nehru Law College, M.P. Arts and M.H. Commerce College for Women, National Institute of Design, N.C. Bodiwala Commerce College, P.D. Pandya Mahila Commerce College, Prakash College of Education, P.T. Arts and Commerce College, R.B. Sagar College of Education, R.C. College of Commerce, R.C. Technology Institute, R.G. Shah Science College, R.H. Patel Arts and Commerce College, Sabarmati Arts and Commerce College, Saraspur Arts and Commerce College, Sheh K.M. School of Post Graduate Medicine and Research, Shree Swaminarayan Arts College, Shr B.V. Patel Pharmaceutical Education and Research Dept.
•	Computer Applications, Shri K.K. Arts and Commerce College, Shri M.N. Shukla Education College, Shri Sahajanand Arts and Commerce College, Shri Sahajanand Vanijya Mahavidyalaya, Shri Umiya Arts and Commerce College for Girls, Sir L.A. Shah Law College, S.L.U. Arts and H.P.T. Commerce College for Women, Smt. A.P. Patel Arts College, Smt. D.J. Shah Parivar Science College, Smt. Laxmibahen and Chimantal Mehta Arts College, Smt. M.N.K. Datal Education College for Women, Smt. N.H.L. Municipal Medical College, Smt. Sadguna C.U. Arts College for Girls, Smt. Susitabahen Ramaniklal Mehta Arts College, Smt. Ullasbahen Gordhandas College of Education, Smt. N.H.L. Municipal Medical College, St. Xavier's College, S.V. Arts College, S.V. Commerce College, S.V. Vanijya Mahavidyalaya, Vivekanand College of Law
Hospitals and dispensaries	ESIS Hospital, V S Hospital, L G Hospital, New Civil Hospital, SC Hospital, SVS Hospital, Shardaben General Hospital, Civil Hospital, Dr. J.J. Vora Memorial Gen. Hospital, Rajasthan Hospital, Jivraj Mehta Hospital, Nagri
Ambulance services	Navdeep Emergency Service Day , Navdeep Emergency Service Night, Sadvictiar Parivar
Fire Brigade	Memnagar Fire Station, Sabarmati Fire Station, Odhav Fire Station, Danapith, Gomtipur, Jamalpur, Maninagar, Naroda, Panchkuva & Shahpur Fire Station

Table 3.7-4: Employment details for the city of Ahmedabad based on provisional 2001

Neme	10	1									Bigg sacion college has half	no nata	
Anne	CI838	0-	i otal Workers	-	.	Main Workers	•	Mar	Marginal Workers	kers	2	Non Works	
R P	ŏ	701	9 - 10 10		1						•	194 JOH - 110	zô.
	Area	100		remaie	Total	Male	Female	Total	Male	Female	Total	Male	Female
Abmodoing	0	1000											
Cit.	Rurai	1565	1419	146	1420	1294	126	145	125	20.	3000	5007	
<u> </u>	11411	l		1-			1	ì		2	7200	200	1922
	Oroan	1340871	1175838 165035		1279592	1145711 133881		61279	30125	31154	2869044	4000000	
-1-1-1	-	20.00								2		BASSCOIL	1312545
IR10 I	=	1342438	1342438 1177255 165181	165181	1281012	1281012 1147005 134007 61424 30250	134007	61424	30250	31174	31174 2874022 4087467	4084404	
									•	•	7001 107	004/001	1314467

Table 3.7-5: Break-up of Total Workers by class of employment for the city of Vadodara based on provisional 2001 census data

<u>ა</u>		Cultivators	52	Agr	Agricultural Laborers	borers	Workers	n Househol	Workers in Household Industries		146 146	
Area Area	Total	Mala	-				1_			ر ر	Uner Morkers	e
	10101		romaic lota	Total	Male	Female	Total	Male	Female	To 4 a 1	N.9 = 1.2	
Ahmedabad Rural	118	113	4	40,	50,					- Otal	D	remale
	2	2	0	00	200	9	28	15	4-	1033		
Cath	2424 4022		77.6	77.00						203	77	
Cicai.	4161		444	5511	2340	1271	38695	16305	22330	120011		
70401	2220	0007	<u>.</u>						2224	1230444	1155314 141130	141130
10.00	4438	ORRI		3759	2509	1290	38721	18320	22401	1297877	00000	
						Ţ				110104	0040011	141241
Total	2239	1990	249	3799	1 1	2509	2509 1290	1290	1290 38721	1290 38721 18320	1290 38721 16320 22401	1290 38721 16320 22401 1297677

¹ Total Workers includes Main Workers and Marginal Workers



4 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

4.1 General

In the earlier chapters, the baseline setting of different relevant environmental components in the study area and predicted potential impacts (both beneficial and adverse) on those components due to the proposed NG distribution project of GAEL are documented. In this chapter, mitigation measures for the identified adverse impacts are documented for both construction and operation stages of the proposed project in the form of an Environmental Management Plan (EMP). It should be kept in mind that for many environmental parameters potential impacts documented earlier are predicted considering the mitigation measures presented/ recommended here.

4.2 Construction phase

The construction phase of the proposed project shall be in phases depending on the demand for NG in the study area. The initial phases shall be developed during 12 months (6 months for each phase of development) though the entire project is anticipated to be developed over a period of 6 – 7 years based on future demand potential. However, at all times during the construction periods, the project proponent shall ensure that all reasonable care within their control is taken to meet the construction schedule and to minimize construction impacts. In fact, the Adani Group being an organization having a strong commitment towards safety of personnel and property as well as environmental concerns, the project proponent other than following their stringent corporate safety requirements during the construction phase shall ensure that all safety measures suggested/ recommended by the design consultants shall be adhered to in its true spirit. GAEL is also committed to implement the proposed EMP in its true spirit.

The mitigation measures that will be adopted during the construction phase to control the negative impacts on various environmental components of the study area are given below.

4.2.1 Water resources

Water for construction purposes shall be used judiciously.

4.2.2 Surface water quality

- Excavation work shall be avoided during monsoon season to the extent possible. This way the potential for erosion during construction phase will be reduced.
- Care shall be taken to ensure that excavated soil will be stored along the excavated trench maintaining proper slopes. This shall minimize water and land pollution problems.
- 4) Temporary collection system shall be provided for routing run-off due to washings from soil stockpiles during monsoon season to minimize chances of contamination of nearby water bodies.
- 5) It shall be ensured that maintenance activities/ washing of construction vehicles shall be carried out at designated workshop. The wash water shall be suitably treated before discharging to the existing sewer.
- 6) The project proponent shall ensure that the construction contractor shall provide proper sanitation facilities to the construction workers to ensure proper handling of waste water generated due to domestic activities at the construction camps.

4.2.3 Ground water quality

 It shall be ensured that construction wastes are handled properly and shall not be discharged to ground water bodies.

4.2.4 Air quality

- Regular water spraying, if required shall be carried out during dust generating construction activities e.g. clearing of vegetation, earth moving, stock-piling excavated soil, material handling, etc. to suppress dust generation.
- Use shall be made of state-of-the-art equipment to reduce dust emissions due to construction activities.
- 3) Fuel of suitable quality shall be used for operation of D.G. sets for construction power requirement.
- 4) It shall be the endeavor of the project proponent to ensure that any vehicle not meeting vehicular pollution standards will not be allowed within the construction site and for the construction activity. Also, care shall be taken to ensure that construction equipment and vehicles are maintained in proper condition at all times. Fuel of a proper quality shall be used to ensure that exhaust emissions are well within the specified CPCB standards for vehicles.

4.2.5 Noise

- Construction equipment generating minimum noise and vibration will be chosen. The construction
 equipment as well as vehicles shall be appropriately maintained to keep the noise and vibration level at
 construction activities.
- 2) Vehicles and construction equipment with internal combustion engines without proper silencer, where applicable, will not be allowed to operate at the site. Also, it shall be ensured that the construction equipment and vehicles are maintained properly at all times to ensure reduced noise levels.
- 3) Construction D.G. set shall be maintained at all times in proper condition to ensure reduced noise levels. Also, workers shall be provided with noise protection equipment.
- Noise generating construction activities shall be carried out at night time only on need basis and shall be limited to minimal.

4.2.6 Land

- Demolition wastes generated due to removal of minor structures/ vegetation obstructing the pipeline route shall be disposed off suitably in designated areas demarcated by local authorities. In fact, trenchless construction methods shall be used in particularly highly congested areas to minimize demolition of existing structures to the extent possible.
- It shall be ensured that proper storage of excavated soil prior to backfilling shall be carried out along side the excavated trench.
- 3) Spent oils generated due to maintenance activities of construction equipment/ vehicles shall be collected in barrels for off-size third party recycling. Oil-contaminated cotton waste shall be disposed along with municipal solid waste.
- 4) The municipal solid waste from construction camps for workers shall be disposed off in designated disposal sites of AMC or local authorities.

4.2.7 Ecology

- Operation of high noise producing equipment will be avoided during night-time to avoid impact on avifauna as well as human habitation in the vicinity of the construction area.
- 2) Construction activities, particularly at the CGSs as well as CNG stations shall be carried out within terriporary enclosures to minimize noise and dust nuisance, resulting in impact on plant as well as animal life in the vicinity of the construction site.
- The grass removed during land cleaning activity shall be collected and disposed off suitably along with municipal waste.
- 4) Regular water sprinkling, if required shall be carried out at the construction site and on the material handling roads to minimize the impact of dust on surrounding vegetation.

4.2.8 Socio-economic factors

- Local people from within the study area will be employed for construction work to the maximum extent possible.
- 2) Proper facility for domestic water supply, sanitation, domestic fuel and other essential community services will be made available to the construction workers.

4.3 Operational phase

The mitigation measures to be adopted during the operational phase to control the negative impacts on various environmental components of the study area are given below.

4.3.1 Water resources

- 1) Water requirement of 12.5 KL/day for the purpose of domestic use as well as housekeeping at the CGSs as well as CNG stations during Phases 1 & 2 as well as the additional water demand of 35 KL/day during the latter phases of project development shall be sourced from AUDA/ AMC/ GIDC water supply network, as necessary.
- 2) Ground water for the proposed project shall be tapped, only if required, depending upon the lean season water availability from the relevant authorities.

4.3.2 Surface water quality

- Waste water at the rate of approximately 10 KL/day will be generated mainly from domestic activities as well as housekeeping at the CGSs and CNG stations. The waste water shall be discharged to septic tanks and soak pits for treatment and disposal.
- Regular maintenance of the septic tanks and soak pits shall be carried out to ensure that untreated waste water does not find its way into nearby water bodies.

4.3.3 Ground water quality

1) No wastewater stream or solid/ bazardous waste shall be discharged to ground water body.

4.3.4 Air quality

- All required safety systems shall be provided for the NG distribution network to ensure that accidental release of NG vapors at the CNG stations as well as CGS are minimized, to the extent possible.
- 2) Stack attached to D.G. set at the CGSs as well as CNG stations shall conform to the requirements stipulated by CPCB for stack height. As per the CPCB requirement, the stack height for D.G. set of 95 KVA capacity should be at least 5.25 m from ground level which shall be provided. Moreover, emissions from D.G. set shall not be continuous as the D.G. sets shall be operated only during grid power failure or during an emergency.
- 3) Regular maintenance of the D.G. sets shall be carried out as per requirements specified by CPCB.
- 4) Vehicles used at the CNG stations shall conform to the vehicular emission norms specified by the CPCB.
- 5) Improvement in air quality due to substitution of conventional fuel oils by clean fuel i.e. NG.

4.3.5 Noise

- Noise generating compressors at the CNG stations shall be provided within acoustic enclosures for ambient noise reduction. It shall be the endeavor of the project proponent to ensure that noise levels are well within the specified ambient noise level standards at site boundary.
- Compressors and other noise generating equipment would be maintained properly in order to reduce the noise from the wom-out parts.
- 3) The D.G. sets shall be provided in an acoustic enclosure and regular preventive maintenance shall be carried out to ensure noise levels are within acceptable limits.

4) Personnel working in noisy areas shall be provided with personnel protective equipment, use of which shall be strictly enforced.

4.3.6 Control of solid/ hazardous wastes

- The spent waste oil generated from the D.G. set at CGSs as well as CNG stations, classified as hazardous waste, shall be collected in barrels for off-site third party recycling.
- The domestic solid waste from the CGSs and CNG stations shall be disposed off along with municipal waste.
- Solid wastes comprising oil contaminated cotton waste and maintenance spares generated from maintenance activities at CGSs and CNG stations shall be disposed off along with municipal waste.

4.3.7 Land requirement

- 1) Land proposed for the CGSs at Bibipura (near Ramol) and Koba circle shall be close to the GSPL terminal. The land chosen will be such that minimum agricultural land shall be used and there shall be no inhabitation.
- 2) Similar will be the case for the land requirement for CNG stations.
- Suitable green belt shall be developed at the CGSs for aesthetics in and around the area.

4.3.8 Ecology

The following measures are proposed to have minimum impact on ecology of the study area:

- 1) Domestic wastewater shall be discharged after appropriate treatment.
- 2) Air emission from D.G. sets will be maintained well within the applicable CPCB standards.
- 3) Solid wastes generated shall be disposed off in a manner that will not contaminate the soil and ground water body.
- 4) Suitable green belt shall be developed and maintained at the CGS as well as along the pipeline route where necessary, for noise and dust control.

4.3.9 Socio-economic factors

- Approximately 85 persons are expected to be employed during the Phases 1 & 2 of the project with a likely increase of about 125 additional persons for the latter phases of the proposed project development. Thus, a total of about 210 persons are expected to be employed.
- The existing housing, educational, medical, fire fighting, transportation, water supply, sanitation, garbage collection & disposal and other necessary community services infrastructure are adequate for the proposed project.

4.4 Post-project environmental monitoring

Post-project environmental monitoring for environmental components shall be carried as given below in **Table 4.4-1**.

Table 4.4-1: Post Project Environmental Monitoring

Sr. No.		Particulars	Monitoring Frequency	Duration of Sampling	Important Monitoring
1.	Air (Quality			Parameters
	Ami	bient Air Quality Monitoring	•		
	1.	Near the CGSs	As specified by	24/8 hourly	SPM, RPM, SO ₂ ,
	2.	In select villages around the CGSs as well as along the pipeline route	GPCB		NOx, CO and Pb
	Stac	k Emissions			
	1.	D.G. set stack	As specified by GPCB	Grab sampling	SPM, SO ₂ , NO _X and
2.	Wate	er and Waste Quality			CO
	Indu:	strial / Domestic			
	1.	Domestic sewage (untreated and treated)	Once in a month or as specified by GPCB	Grab sampling	As per EPA guide lines, 1986
3.	Indus	strial Noise Levels		i	1
	1.	Near D.G. sets / other noisy areas	Once in a month or as specified by GPCB	Grab sampling	Noise levels in dB(A)
4.	Ambi	ent Noise Levels			
	1.	At CGS boundary	Once in a month or as specified by GPCB	24 hr continuous with one hr interval	Noise levels in dB(A)

4.5 **Environmental Management Cell**

An environmental management cell comprising personnel having sufficient educational and professional qualification and experience in the field of environmental management shall be formulated. This cell will be responsible for statutory compliance, pollution prevention, environmental monitoring, preventive maintenance of pollution control equipment and green belt development. The head of this cell shall report directly to the Operations In-charge of the facility.

4.6 Green belt development

A green belt or plantation around an industrial operation is provided to reduce the impacts due to industrial emissions. Green belts are wide strips of trees, shrubs and grasses planted in rows to reduce the air velocity thereby facilitating settling of the particles on the leaf surfaces and allowing absorption of the pollutant gases. The green belt also serves to cool the atmosphere by transpiration from the leaf surfaces.

The Ministry of Environment and Forest (MOEF) has recommended that project proponents should develop green belt around the project site to attenuate pollutants emitted.

The advantages of Green Belt are given below:

- Greenbelts are important habitats for birds and animals, which add to the aesthetic value of the environment. Generally, birds prefer to make their habitat, nest, on trees. Further, trees provide shade and hiding places to the wildlife. Trees like pipal (Ficus benghalensis), Neem (Azadirachta indica) and Semal (Salamlia malabarica) attract birds by their flowers and fruits and provide a very suitable shelter
- Greenbelts help to reduce the ill effects of industrial wastes.

- It protects rivers and other water bodies
- Greenbelts help clean air by absorbing smokes and gases and act as a windbreak resulting in
- Dense planting of trees causes competition for space which forces the roots to grow deeper and the trees to grow taller for sunlight. This results in more biomass per unit area and more efficient absorption
- The green belt also diminishes noise pollution by absorbing high degree of noise due to their spongy
- Green belt also helps in reuse of the treated wastewater to the extent possible.
- Green belts help restore the ecological balance.
- Green belts help in prevention of soil erosion.
- Green belts help improve the aesthetics in the area.

For the proposed NG distribution project, a suitable green belt shall be developed around the periphery of the CGS plot (around 2 to 3 meter width) keeping in view the soil and water quality available in and around the site and the topography of the land. Moreover, suitable trees shall be compensated for those trees that shall be felled due to the pipeline routing.

The aspects that shall be considered for green belt development are as follows:

Basis for selection of plant species for Green Belt Development

Most importantly, the plant species selected for green belt development shall be indigenous and locally available. However, the other criteria for selection of species for plantation shall be as follows:

- Species that are fast growing and providing optimum penetrability
- Species that are wind-firm and deep-rooted
- Trees with high foliage density, leaves with larger leaf area and hairy on both the surfaces
- Species tolerant to air pollutants like SPM, SO₂ and NO_x should be preferred
- Ability to withstand conditions like inundation, salinity and draught
- Attractive appearance with good flowering and fruit bearing
- Bird and insect attracting tree species
- Sustainable green cover with minimal maintenance

4.6.2 Green Belt Development Plan

The technique adopted for green belt development shall comprise planting saplings in pits of 0.3 m x 0.3 m x 0.3 m size with a spacing of 2 m x 2 m. Soil replacement shall be carried out where the original soil may not be suitable for the growth of the plants. Soil conditioning will be carried out for the proper nutritional balance and nourishment of saplings.

Local species as mentioned in the chapter on ecology shall be used for green belt development. Landscaping aspects shall also be taken into consideration while developing the site.

Plant species suitable for greenbelt and plantation

The list of species suitable for green belt development based on the local and native plant species is

r. No.	Local Name	
1.	Babool	English Name
2.	Neem	Acacia nilotica
		Azardiracta indica
J.	Eucalyptus	Eucalyplus sps.

Sr. No.	Local Name	English Name
4.	Rose	Rosa domascena
5.	Tutsi	Ocimum sanctum
6.	Peacock Flower	Delonix oragia
7.	Sweet Acacia	Acacia fernesiona
8.	Doob Grass	Cynodon dactylon
9.	Polyathia	Polyalthia longifolia
10.	Baval	Acacia Arabica auct
11.	Siras	Albizia lebbeck Linn
12.	Limdo	Azardirachta indica A, Juss
13.	Gunda	Cordia dichotoma Forst
14.	Sissoo	Dalbergi Sissoo Roxb
15.	Gulmohar	Delonix religa (Boj)
16.	Nilgiri	Eucatyptus L. 'Herit
17.	Nani padar	Kigolia pinnata DC
18.	Ambo	Mangifera indica
19.	Pardeshi Baval or Ram Baval	Parkinsonia aculeate Linn.
20.	Goras Amli or Vilayati Amli	Pithecellobium dulce Roxb.
21.	Karanj	
22.	Sami or Khijdo	Pongamia pinnata Linn.
	Ambli or Amli	Prosopis cineraria Linn Tamarindus indica Linn



5 SUMMARY OF ENVIRONMENTAL IMPACTS



The impacts on the surrounding environment in the study area of proposed NG distribution project of GAEL in the city of Ahmedabad during construction and operational stages are summarised in **Table 5.1** and **Table 5.2** separately for ready reference to the decision-makers.

Table 5.1: Construction Phase - Potential Impacts and Mitigation Measures

					-
Sr.	Environmental	Potential	Source of Impacts	Mitigation measures	Remarks
Š	components	Impacts			
. :	Water resources	Minor negative & temporary impact on surface and ground water resources	Construction activities as well as use of water for domestic purposes by construction workers.	Judicious use of water for construction purposes; use of ground water only when required during construction. The water requirement is not large for the entire project.	Water will be sourced from the existing local authority water supply network or the surface water sources and augmented if required from ground water sources
2.	Terrestrial surface water quality	Minor negative impact	Erosion due to excavation activities particularly in the monsoon season, discharge of wastewater /	Avoiding excavation during monsoon season; proper storage of excavated soil along the trench; providing sultable systems for handling of construction waste waters; avoiding discharge of untreated waste water to any surface terrestrial water body	
3.	Ground water quality	No direct impact	Construction activities	Ensuring no discharge of construction waste waters to ground water body	
4.	Air quality	Minor negative & temporary impact	Construction equipment, vehicular traffic, excavation, etc.	Vehicular & internal combustion engine pollution check (PUC certificate); water sprinkling	Impacts shall be restricted to the length of the pipeline under construction
rç.	Noise	Minor negative & temporary impact	Various construction activities	Construction equipment selection & maintenance; usage of ear plugs/muffs by the construction workers	Impacts shall be restricted to the length of the pipeline under construction
ď	Land				
i e	Land use / requirement	Moderate negative & permanent impact	Land requirement for the purpose of construction of CGSs as well as CNG stations	Providing the CGSs close to the existing GSPL terminals, the land requirement for which shall be 100 X 100 m for each of the CGSs; ensuring that non-agricultural and nonhabitated land shall be used to the extent possible for the CGSs as well as CNG stations	No significant change in land use pattem envisaged as ownership pattern along the route will not change; pipeline shall be laid within the existing ROU to the extent possible
€	Topography	Minor & temporary impact	Storage of excavated soils, construction waste waters	Proper storage of excavated soil maintaining proper slopes; restoration of the land to near original condition	Topography shall be restored to nearly original form after the laying of pipeline which is underground
	Seismicity	No impact	Construction of the	Depth of pipeline shall be 1 m below ground causing no	All civil structures shall be

5-2 REIA study for the proposed City Gas Distribution networks for Ahmedabad city in Gujarat

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i o	Environmental components	Il Potential Impacts	Source of Impacts	Mitigation measures	Remarks
			pipeline	impact on the parameter	constructed as per updated
3	Land pollution	No significant adverse impact	Construction material handling and other waste generating activities, excavation and required land filling activities	Excavated soil shall be backfilled after laying the pipeline; where excavation for laying of pipeline is carried out in agricultural land, top soil shall be segregated and backfilled in similar order to ensure minimal loss of fertility; proper disposal of soild waste to designated authorities; proper handling and disposal of soild waste from construction camps	equivalent zone classification
~	Ecology	Minor negative & temporary	Construction activity noise and dust, removal of soil along the pipeline route, 'clearing of vegetation, cutting of existing trees on the pipeline route, if required	Use of state-of-the-art construction equipment; backfilling of excavated soil; no major cutting of trees; water sprinkling	Appropriate care shall be taken to route the pipeline such that sensitive areas such as agricultural land, forest areas are avoided to the maximum extent possible.
ထ	Socio-economic				
6	Population	Minor negative & temporary	Increase In population to the extent of 60 workers due to migration of workers from outside the study area due to construction activities	Employing local people to the maximum extent possible	Construction period for the phase 1 & 2 expected to be 6 months each respectively
E	Population displacement and rehabilitation	No impact	Displacement of people due to the construction of NG pipeline	Pipeline route shall be chosen such that there shall be no displacement of population; land chosen fro the CGSs as well as CNG stations will be devoid of habitation.	
(Education	No significant impact	Need of educational facilities for the temporary increase in population due to construction activities	e ici so	Educational facilities available in the area are adequate and can be used by the construction workers and their families if the construction to the construction families if the construction of the construction workers and their
3	Employment	Minor positive & Ji temporary impact P	Availability of construction jobs to the local population; generation of other employment	Employing local people to the maximum extent possible	

sr.	Environmental	Potential	Source of Impacts	Mistration and and and and and and and and and an	
No.	components	Impacts			Remarks
			opportunities due to related ancillary development		
3	Community services No significant & long & transportation term impact	No significant & long term Impact	Needs of the construction workers; increased traffic load due transportation of construction materials and workers	Project proponent shall ensure that the construction contractor shall provide adequate facilities for the needs of construction workers during the construction period	Existing facilities adequate for handling increased mover nent of construction materials as well as construction workers
(S)	Есопоту	Positive & temporary. impact	Influx of capital due to construction of the pipeline project as well as related ancillary development		

Table 5.2: Operational Phase - Potential Impacts and Mitigation Me

					en
Sr. No.	Environment al components	Potential Impacts	Source of Impacts	Mitigation measures	Remarks
-	Water resources	Minor negative & permanent negative impact on surface water. No direct impact on ground water resources	Water requirement mainly for domestic purposes and for housekeeping @ 12.5 KL/day for the 2 CGSs as well as the 5 CNG stations (proposed in Phase 1 & 2 of the project development); one-time water dedicated fire water storage of 700 KL at each of the CGSs; water demand likely to increase by additional 12.5 KL/day due to the development of additional 25 CNG stations	Ensuring judiclous use of water by way of training of personnel	Water requirement will be satisfied from the existing local authority water supply network, which have adequate water supply to meet this requirement. Ground water sources may be tapped in case of non-availability of water from local authority supply network
2	Terrestral surface water quality	No impact	Discharge of domestic wastewater	About 10 KL/day of domestic and housekeeping wastewater will be generated from the CGSs and CNG station operations in Phases 1 & 2. Additional increase in waste water generation is 10 KL/day in latter phases of project development. This shall also be discharged into septic tanks and soak pits for treatment.	
က်	Ground water quality	No direct impact	Discharge of domestic wastewater	No discharge of any untreated wastewater to ground water body; no discharge of solid wastes to ground water body	
4.	Air quality	Major positive impact due to reduction in generation of air pollutants particularly SPM and SO ₂ due to fuel substitution by NG	Emissions from use of fuel in vehicles, other fuel combustion sources such as industries, commercial establishments as well as domestic use	Replacement of conventional fuels by NG, a cleaner fuel option	Improved air quality due to substitution of conventional fuels by NG
ç.	Noise	Minor negative impact	Noise generating equipment such as compressors at CNG	Providing in-built acoustic endosures for compressors; proper and regular maintenance of noise generating equipment; personnel working in noisy areas shall be	

No. Compo Compo Compo (i) Land use, requireme requireme (ii) Topograph	Environment al components	Potential Impacts	Source of Impagts	Mitigation measures	Remarks
	mponents			•	
			stations, PRVs and D.G. set at the CGSs and CNG stations	provided with personnel protective equipment	
•					
••	requirement	No impact	•		Once the CGSs and the CNG stations are constructed, there will be no impact on the land use/ land requirement during
	Topography	Minor impact	The CGSs and the CNG stations will be a permanent addition in the topography of the area		
(iii) Selsmicity	nicity	No impact			No alteration to the seismic characteristics of the area due to the proposed project
(iv) Soil and polition	Soil and land pollution	No impact	Handling and disposal of solid waste from the CGSs and CNG stations	Off-site third party recycling for spent oil waste from maintenance activities of construction equipment/ vehicles; disposal of oil-contaminated cotton waste along with municipal waste to designated AMC areas	
7. Ecology	ÁB.	No impact	Operations at CGS and CNG stations	Providing acoustic enclosures for compressors and D.G. set at CGSs and CNG stations to ensure noise is within specified limits; proper handling of wastes; development of suitable green belt at CGSs	
8. Socio-e	Socio-economic factors	(3			
(i) Population		Moderate negative impact	Increased population to the extent of 340 persons (considering a family size of 4 persons per family) in Phases 1 & 2 due to the requirement of personnel	Employing persons from within the study area to the maximum extent possible	Some persons from outside the study area may migrate due to job opportunities

Sr. No.	Environment	Potential Impacts	Source of Impacts	Mitigation measures	Remarks
	components	•	•		
			at the CGS and CNG stations as well as related ancillary development; additional increase of 500 persons (considering a family) expected during the latter phases of project development:		
(E)	Education	Minor positive impact	Need of educational facilities for the increased population due to the project; need for developing related skill sets specific to NG handling	Employing persons from within the study area to the maximum extent possible; providing training to employees as well as public for safe handling of NG	Educational facilities existing in the study area adequate; GAEL shall take necessary measures for training to employees as well as public
(ii)	Employment	Moderate positive impact	Employment of approximately 85 persons (for Phase 1 & 2) for operations at CGSs and CNG stations; additional 125 persons to be employed for the latter phases of project development; generation of indirect employment due to related ancillary	Employing persons from within the study area to the maximum extent possible based on available skill sets and qualification.	
&	Community services & transportation	Positive long term Impact	Use of community facilities by project personnei	Gas being promoted as convenient, eco friendly & safe fuel for domestic, commercial and transportation sector will help bring positive long term effect on community service and transportation	Existing community services such as road network, educational and medical facilities in the area are adequate
(E)	Health environment	Positive long term Impact	Air emissions due to use of fuel for combustion for various purposes in the	Providing the infrastructure for availability of piped NG in the area for various uses	There will be avoided emissions due to the substitution of conventional

ß.	Environment	Potential	Source of Impacts	Mitigation me/sures	Remarks
	components	9			
			area		Airla His Mi
2	Economy	Positive long form			idels by 14G
	`	impacts, both direct and	revenues earned from project and health related	Providing the infrastructure for availability of piped NG in	Direct contribution in terms of
		indirect	issues due to fuel	מום מום מים למווסת תצפצ	Sales Tax eamed by the sale of
		•	Combination		NG in the city as well as Octrol
	-				on the project plant &
					machinery; Reduction in health
					related expenses considering
•					decreased levels of air pollution
					due to substitution of
					conventional fuels by NG



6 RISK ANALYSIS (RA)

6.1 Introduction

A pipeline is a system of equipment designed to allow material to flow from one location to another. Gas transmission pipelines cross through rural and heavily populated areas.

A pipeline system contains the following elements:

- Buried pipelines
- Above ground pipelines
- Compressor stations
- Isolation valves manual, remote, automatically activated
- Relief valves
- Cased sleeves under roadways or rail lines
- Control systems
- Leak detection system
- River crossing

6.2 Pipeline Preliminary Hazard Analysis (PHA)

The PHA is a tool to identify the hazards associated with a project during its concept, design and blueprint stages with the objective of reducing/ minimizing the hazards associated with the project.

The criteria used for carrying out PHA are as follows:

- Areas where large quantities of hazardous chemicals are used and processed
- Areas where operating temperatures and pressures are high
- Areas where flammable inventories exist
- Specific operations associated with the high probability of failure
- Areas where passive or active safety systems are associated with a generally high failure rate

6.2.1 Gas Pipeline Failures

Generally, failures can be caused due to the following three broad categories:

- External mechanical interference
- Corrosion defects
- Miscellaneous factors-such as pipe material defects, natural hazards or operator error

Some of these failures are time independent occurrences – such as external interference, earthquakes or over pressures, while others are time dependent such as corrosion and fatigue failures.

6.2.1.1 Failures by external mechanical interference

Failures caused by third party external mechanical interference include:

- Damage by excavators or other equipment in use by other utility or construction companies
- Damage following derailments on railroads

- Damage due to deep ploughing by farmer.
- Damage during construction of land drainage

The type of failure generally caused by third; arty mechanical interference is a puncture or split of the pipe or reduction in wall thickness of the pipe over a period of 30 - 40 years of operation. Failure can be immediate or may occur some time later by fatigue. When CNG is released as a result of immediate failure due to external mechanical interference, a high probability of ignition is likely as a result of the presence of ignition source.

6.2.1.2 Failure from corrosion defects

Pipeline failures by corrosion can be due to internal corrosion or external corrosion. External corrosion failures are due to moisture in the ground and aggressive soils & can take two forms:

- Small pinhole failures caused by pitting
- More generalized corrosion leading to a reduction in pipe wall thickness over a plane area

External pitting corrosion leads to small leaks that are often difficult to detect but which gradually increase in size over a period of time. External area or plane defects cause a generalized reduction of wall thickness, which can eventually fail catastrophically under pressure, leading to a large scale release.

Internal corrusion leads to similar failure mechanisms as external corrosions but is caused by moisture content if any in the CNG being transported.

Failures are generally caused by the formation of acids resulting from the presence of water, CO_2 or sulfur compounds in the substances being transported. Pipelines often exhibit corrosion caused by moisture/ water at the bottom half of the pipe. Gas pipelines also exhibit corrosion caused by hydrogen sulfide or CO_2 in the gas. Internal corrosion can be prevented by the use of corrosion inhibitors continually injected into the

6.2.1.3 Failure by miscellaneous causes

Pipeline can also fail for a variety of other causes. Typical causes are:

- " Construction defects
- Pipe material defects
- Operational error
- Equipment failure
- Failure due to internal corrosion
- Failure due to ground slip, flood, ground erosion, earthquake etc.

Unidentified construction defects are most frequently the type in which mechanical damage to the pipe is caused by machinery during the back filling or land restoration activity, and are often discovered shortly after pressurization.

Some defects such as inadequate welding or joint corrosion protection and corrosion coating damage during laying of the pipeline will only be identified some time later.

Pipe material defects can lead to brittle fractures or leaks.

Failures due to operator error are less likely on pipelines. Accidents occur during operation in abnormal condition such as following equipment failure or during maintenance activity. Accidents have also been reported where operators have ignored alarms. Pipeline associated equipment failures can occur at any time e.g. failure is sudden and unexpected.

6.2.2 Gas Pipeline failure rates

These can be classified as under.

Cause	Rate per 1000 mile - years (U.S)
External mechanical interference	0.68
Corrosion	0.20
Material failure / construction defect	0.26
Others	0.10-
Total	1.25

6.2.3 Parameters influencing pipeline failure rates

These comprise age of pipelines, third party activity, pipeline design and standards, corrosion, maintenance and pipeline wall thickness.

6.2.3.1 Age of pipelines

Pipeline failure rate databases show an increase in incidents involving older pipelines. This is due to various factors such as:

- Older pipelines were often laid with inadequate corrosion protection or none at all
- Welding standards were less advanced
- Maintenance was poor
- Control of construction activities was not rigorous
- Pipelines that have operated over a wide range of cyclic pressure variation may be approaching end of their expected life due to fatigue

6.2.3.2 Third party activities

Failures due to third party interference can occur because the third party is unaware of the presence of the pipeline. Alternately, the pipeline protection at the scene of a repair, excavation, or other activity may be so inadequate that an incident occurs.

Pipeline failures by third party activity can be reduced by ensuring that members of the public, land owners, and utilities are always aware of the location of the pipeline and by providing adequate protection to the pipeline in areas where the risks appear high. GAEL will provide for pipe walkers to identify any construction activities that have a potential to cause pipeline damage or to identify small leaks where effects are

Pipelines crossing other utility service lines (of water/ gas lines) have an increased potential for third party damage to the pipeline.

Pipelines crossing rivers could be protected by placing rock or concrete protection above the pipe.

6.2.3.3 Pipeline design and standards

International code for gas transmission piping systems recognizes the increased risk from pipelines in populated areas and recommends improved safety requirements. These take the form of progressive increase in pipe wall thickness with both increased population density and types of road and railroad crossing. It also recommends minimum safety distances to occupied buildings to reduce individual risk levels for pipelines carrying gas.

6.2.3.4 Corrosion

To reduce failures to pipelines exposed to wet and aggressive soil where corrosion is rapid, external coatings such as 3 layer PE coating are developed which have considerable effect in reducing failure rates. Now cathodic protection system are applied in which electrical potential differences are set up between the pipe and surrounding earth to prevent the formation of corrosion cells. Now epoxy and polyethylene coating systems have been developed that could enhance the quality of external corrosion coatings.

Cathodic protection systems are designed to reduce the likelihood of external corrosion. Regular readings of pipe to soil potentials should be carried out to ensure that rapid corrosion is not taking place locally.

Particular areas prone to corrosion are where other metallic services pass close to a pipeline and could interfere with the working of cathodic protection system, leading to accelerated corrosion. In these areas local bonding should be undertaken and the conditions monitored.

6.2.3.5 Maintenance

High maintenance standards are vital in ensuring that a pipeline operates safely. The as built condition of a pipeline should be able to be maintained almost indefinitely by high quality maintenance. Regular inspection of the cathodic protection system to ensure that high currents are not being drawn should be undertaken so that early indication of the failure of the corrosion coatings is known.

Inspection devices known as 'Smart' or 'Intelligent' pigs are available that travel internally along the pipeline and measure the condition of the pipe wall.

6.2.3.6 Other factors

Increased risk from gas pipelines in populated areas require additional monitoring. To reduce the probability of failure, the toughness of the steel wall of the pipeline should be ensured.

6.3 Consequence Analysis - Introduction & Theory

Consequence Analysis is a measure of the expected effects of an incident outcome. An incident is the loss of containment of material or energy. The primary component in Consequence Analysis is to identify various incident / hazards.

The three major hazards in a facility are fire, explosion and toxic release. These usually involve emission of material from containment followed by vaporization and dispersion of material. In GAEL, as no toxic materials are handled, the main hazard would be due to fire and explosion. The analysis would involve leakage of flammable material, mixing of material with air, formation of a flammable vapor cloud, dispersing of the cloud and finding of a source of an ignition. The cloud when in contact with an ignition would lead to a fire and/or unconfined vapor cloud explosion.

6.4 Models used

6.4.1 Source Models

Source models quantitatively define the release scenarios by estimating the discharge rate and extent of flash. The subsequent "dispersion" models convert the source "outputs" to concentration fields downwind from the source.

6.4.2 Dispersion Models

Dispersion modeling aims at estimating the distances likely to be affected due to release of certain quantity of flammable gas within an acceptable concentration limit. Depending upon the properties of the material released and the release conditions, dense gas dispersion or a buoyant gas release model is used for estimating the affected areas. Both the models describe the behavior of material subsequent to its release in the predominant downwind direction, at a particular wind speed and at the existing meteorological conditions such as humidity, temperature, etc. It should be noted that the release rate would depend on release conditions (temperature and pressure), the release/ failure point, intervention time, the release area

Wind speed and turbulence are significant factors as the amount of air entrainment into the released gas would depend on the velocity at which the cloud is traveling and also turbulence in the surroundings. Varying terrain contours in the area would affect the dispersion. The atmospheric stability class takes into account atmospheric turbulence and is another important consideration in modeling. This in turn depends on several factors such as wind speed, insulation, cloud cover and the time period i.e. day or night. Stable atmospheric conditions lead to the least amount of mixing thus resulting in larger areas for gas dispersion and unstable conditions result in maximum mixing of gas with air leading to the dilution of the gas.

Two such parameters used in gas dispersion programs are:

1. Pasquill Stability Category

Pasquill Stability Categories are related to the Richardson number and hence give an indication of thermal stratification, i.e. the magnitude of buoyancy forces which enhance or diminish turbulence and mixing. Therefore, "A" corresponds to a large negative Richardson Number and F to a large positive number i.e. night time with little cloud cover and low wind speeds stability, category 'D' is used for moderate to high wind speeds and overcast conditions.

2. Surface Ro: ghness Value

The surface roughness value determines the vertical profile of the wind and mechanical maintenance of turbulence in the boundary layer. It is a function of the terrain over which the wind flows in its approach to the vapor release point. In value it ranges from 0.03 for say closely mown grass up to 0.1 for forests and urban areas. Surrounding areas including building and other structures also have a marked effect on the dispersion of released gas. The dispersion would vary with the size and position of the building relative to the source of release, along with the other factors already discussed above.

6.4.3 Explosion and Fires

Explosions are considered as a rapid equilibration of high pressure gas with the environment. The equilibration must be rapid enough so that the energy contained in the high pressure gas is dissipated as a shock wave. Explosion can arise out of strictly physical phenomena (e.g. catastrophic rupture of a pressurized containment) or from a chemical reaction such as the combustion of a flammable gas in air. These reactions can occur both in a confined space (e.g. within a vessel, within a building etc) or in an unconfined state (Unconfined Vapor Cloud Explosion or UVCE). When the shock wave propagation velocity is less or more than sonic velocity, the explosions are categorized as either

The consequences of concern for explosion are shock wave overpressure effects and projectile effects. For fires, the consequence of concern is thermal radiation effects. When explosions arise from combustion reactions, thermal radiation effects are small (and ignored) compared to the overpressure shock wave effects.

UVCE and flash fires occur when a large amount of volatile flammable material is rapidly dispersed to the atmosphere, forms a vapor cloud which disperses and meets a source of ignition before the cloud is diluted to below Lower Flammability Limit (LFL). However, a vapor cloud explosion is not generally expected if the explosive mass is below 5 MT. If the mass is below 5 MT a flash fire is more likely. If the ignition source is reached when concentrations are between LFL and Upper Flammability Limit (UFL), damage due to both fire and blast effects may take place. Flammable vapor clouds may ignite from a number of ignition sources which may be continuous (e.g. pilot flames / flare, etc) or intermittent (e.g. from smoking, vehicles, non-spark proof type tools, etc). The main concern for a UVCE is the shockwave that causes damage whereas fire to UVCE could be a function of the flammable mass, presence of confinement obstacles (for UVCE), burning velocity of the material (higher velocity has higher chance of a UVCE) and other factors. Peak overpressures are much less with UVCE'S compared to Detonations (UVCE'S are usually deflagrations) typically 1 Bar or less and positive phase duration's (20 - 100 ms).

In case of NG the chances of UVCE is a remote possibility. More often it would lead to a flash fire. But confined vapor cloud explosion is possible. It should be noted that NG cloud explodes with difficulty in the open.

Ignition of flammable vapor clouds are a function of the pressure of ignition sources (e.g. open flame smoking vehicles etc). The clouds are thought to often be ignited at the edge as they drift. The effect of ignition is that further spread of the cloud in that direction is halted. A site with many ignition sources is expected to have smaller explosions as the ignitions source would be reached before the cloud reaches its full destructive mass. However, it would also be true that such clouds would have a low chance of diluting to safety upon release (many ignition sources).

Pool/ jet fires generally tend to be localized in effect and are of concern mainly in establishing the potential for domino effects and employee safety zones. Issues relating to spacing of critical equipment, etc. can be addressed on the basis of specific consequence analysis for a range of possible pool/ jet fires. The effects of a pool/ jet fire depends upon factors such as flammability, combustibility, amount of material released, temperature, humidity and flame length.

6.4.4 Assumptions for Models

The following assumptions have been used for the dispersion modeling study.

6.4.4.1 Cloud Dispersion

- The cloud is pancake shaped for dense cloud dispersion.
- Ground surface is level and the roughness for a given surface is uniform.
- It is assumed that the atmospheric conditions are constant for at least the time taken for the cloud to develop as a plume, to the lowest concentration of interest.
- 4) Concentration fluctuations within the cloud are ignored.
- 5) The chemical reaction and deposition of the chemical is limited.

6.4.4.2 Vapor Cloud Explosion

- 1) The flame speed through the cloud is constant.
- 2) Stoichiometric concentration of the cloud is uniform.

6.4.4.3 Jet Fires

- The flame is turbulent.
- The orifice is circular in shape.

6.4.5 Intervention Times

The actual intervention time required to respond to an emergency would vary depending upon the type of instrumentation and extent of shut off devices, extent of manual intervention, extent of confusion hampering manual intervention, level of training and other factors. At the same time, it is possible that a component of a shutdown system is disarmed or inoperative during an emergency, hence requiring some manual operation. Similarly it is possible that both the automatic and manual intervention fail during an emergency.

6.4.6 Damage Criteria

6.4.6.1 Explosion Overpressure Damage Estimates

Distances are estimated for unconfined vapor cloud explosion for the critical damage levels – heavy damage level, repairable damage and major glass damage level.

The heavy damage level corresponds to 5 psi overpressure. The severity of explosion of 5 psi blast overpressure could cause collapse of conventional buildings and rupture of pipeline connections. Such damage is considered to produce 50% mortality in humans.

The repairable damage level corresponds to an overpressure of 2 psi. Overpressure effects of 2 psi could cause damage to storage tanks at ambient pressure, booster pumps, pipelines, roads and can cause repairable damage to both domestic and office buildings. About 10% fatalities could occur.

The severity of explosion of 0.5-1 psi overpressure could cause damage to windows with the likelihood of injury due to flying glass. **Table 6.1** gives damage levels as heavy damage, repairable damage and major glass damage.

Table 6.1: Damage Effects of Blast Overpressures

	Proposition
Blast Overpressure (psi)	Damage Level
5.0	Major structural damage
3.0	Storage tank failure
2.5	Eardrum damage
2.0	Pressure vessels remain intact, light structures collapse

Blast Overpressure (psi)	Damage Leve'
0.5 – 1.0	Major window glass breakage, possibly causing some injuries
0.3	10% window glass breakage

6.4.6.2 Damage caused at different incident levels of thermal radiation

The flammable material released accidentally, from an orifice would form a vapor cloud. The cloud if encounters an ignition source would result in a jet fire.

The cloud formed due to any failure, if finds an ignition source before reaching a concentration below lower flammable limit, and the flammable mass in the cloud is less than 5 Te, a flash fire is likely to occur. The flame could also travel back to the source of leak. Any person caught in the flash fire is likely to suffer burns of varying degrees and at times could be fatal (100%). Therefore, in consequence analysis, the estimated distance upto LFL value is usually taken to indicate the area which may be affected by a flash fire.

In case of a jet fire/ flash fire, if any other combustible material is within the affected area, there is a possibility that a secondary fire may ensue. As the area close to the source of leak may be depleted in oxygen the chances of human mortality due to asphyxiation cannot be ruled out. Generally a minimum of 20% oxygen in air is considered essential for preventing adverse impact to human lives.

Table 6.2 indicates the damage effects due to thermal radiation of varying intensity.

Table 6.2: Damage Due To Incident Radiation Intensity

Incident Radiation Intensity (KW/m2)	Type of Damage
37.5	Sufficient to cause damage to process equipment unless the equipment is fully thermally fire protected (insulation, fire proofing, sprinkler protection etc.).
25	Minimum energy required to ignite wood at infinitely long exposure (non-piloted and would damage thermally unprotected tanks, equipment, etc.)
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing, etc
1.5	Sufficient to cause pain to personnel if unable to reach cover within 20 seconds, blistering of skin (1st degree burns) is likely.
1.6	Will cause no discomfort to long exposure.
0.7	Equivalent to solar radiation.

Parameters considered for failure scenarios for GAEL pipeline distribution network

3.4,7.1 Meteorological Conditions

- Wind speed of 1 m/s, 3 m/s, 5 m/s
- Ambient temperature 30 350C
- Stability Class D, F

6.4.7.2 **Ignition Sources**

Flammable vapor clouds may be ignited from a number of sources that may be continuous or occasional. The clouds are normally ignited at the edge as they drift. It is assumed that the vapor cloud release would get ignited within 100m from the source of release. The traffic movement could act as one ignition source.

6.4.7.3 Domino/ Cascading effect

The Domino effects have not been considered for the risk analysis study, though the possibility of the same cannot be ruled out. The effect distances subject to various critical damage levels have been indicated for

6.4.7.4 Intervention Time

Intervention time of 1-5 minutes has been considered for the failure cases. The operations are manned coupled with emergency shut down system.

6.4.7.5 Failure sizes

The most probable failure sizes could be 25 mm and 50 mm punctures created on the NG pipeline which have been buried. These punctures could be caused due to tampering or due to some digging/ excavation

A credible leak equivalent to 25 mm to 50 mm diameter hole is more likely scenario which can lead to a NG jet in a direction close to the vertical.

It is assumed that the pipeline will be designed and constructed in accordance with the OISD guidelines.

6.4.8 Scenarios considered

The following scenarios have been considered for the NG distribution network:

Scenario no.	Scenario type
	Release of NG from a puncture of 50 mm underground pipeline after the CGS station
	Release of NG from a puncture of 25 mm underground pipeline after DRS
	Release of NG from a puncture of 25 mm underground pipeline
<u> </u>	Release of NG from a puncture of 25 mm above ground pipeline at Industrial MRS
	Release of NG from a puncture of 10 mm above ground pipeline at Domestic meter regulator,
4	Release of NG from puncture hole of 10 mm above ground pipeline at meter (copper pipeline)
	Release of NG above ground from a puncture of 25mm after the discharge from CNG compressor for filling mother cylinder trolleys/ vehicles

The results of the scenarios considered have been provided in Tables 6.3 - 6.6. It may be noted that dispersion distances depend mostly on the pressure of the gas released and diameter of the puncture hole.

Table 6.3: Consequence Analysis Results (Vertical Jet Flame)

Sceizario	Weather Condition	5% (LFL) Distance (m)	The second second			Flash fire distance	Concentration (%) at		
			4 kW/m²	12.5 kW/m²	37.5 kW/m²	(m)	10 m	50 m	100
1	1 m/s; F	0.81	-	-	1.	18.83	ļ		m
Underground	3 m/s; D	1.18	22.49			ļ	2.9	1.6	0.9
pipe	5 m/s; D	1.27	26.00		ļ <u> </u>	9.5	2.4	0.7	0.3
11	1 m/s; F	0.15			-	8.5	2.3	0.54	0.27
Underground	3 m/s; D		-	-	-	0.65	1.1	0.4	0.17
pipe		0.21	5.13	-	-	0.73	0.7	0.1	 -
h-he	5 m/s; D	0.28	6.60	-				0.1	0.03
tri	1 m/s; F	0.1				0.94	0.6	0.07	0.02
Underground	3 m/s; D	0.15			-	0.43	8.0	0.2	0.1
pipe			2.7		-	0.49	0.5	0.06	0.02
	5 m/s; D	0.19	4.8		-	0.63	0.4	0.04	0.02

Table 6.4: Consequence Analysis Results (Horizontal Jet Flame)

i	Weather Condition	5% (LFL) Distanc		ontal Jet ion Dista		Flash	Concentration (%) at		
		e (m)	4 kW/m²	12.5 kW/m²	37.5 kW/m²	distance (m)	10 m	50 m	100 m
IV	1 m/s; F	58	11.8	10.1	8.85	84.49	14	6.2	1.7
Above .	3 m/s; D	8.5	10	8.27	6.85	13.2	3.9	0.2	0.05
ground pipe	5 m/s; D	6.5	9.25	7.4	4.94	10.02	2.5	0.1	0.03
V	1 m/s; F	2.25	2.7	2.2	2.2	7.75	1.7	0.08	0.02
Above	3 mVs; D	1.52	2.2	2	1.7	2.2	0.08	0.004	0.001
ground pipe	5 m/s; D	1.47	2	1.9	1.5	1.9	0.04	0.002	0.006
VI Above	1 m/s; F	2 ·	2.5	2	2	5.8	1	0.05	0.01
ground pipe	3 m/s; D	1.5	2	1.5	1.5	2	0.05	9.002	0.0007
	5 m/s; D	1,4	1.8	1.3	1.3	1.8	0.03	0.001	0.0004
VII							Concentr	ation (%) a	<u> </u>
Above					-		50 m	100 m	1000 m
ground pipe	1 m/s; F	62	133	117	100	184	6	3	0.2
	3 m/s; D	63	113	96	77	161	6	3	0.1
	5 m/s; D	62	104	87	76	150	6	3	0.09

Table 6.5: Explosion Effects (Late ignition)

Scienario Overprescure bar psi / bar(g)	ł		Distance (m)					
	1 m/s; F	3.0 m/s; D	5.0 m/s; D					
VII	0.3 / 0.0207	140	137	136				
Above	2/0.1379	73	72	72				
ground pipe	3 / 0.2068	68	67	67				

Table 6.6: Explosion Effects At desired distance

Scenario Distance (m)		Overpressure bar(g)						
	1 m/s; F	3.0 m/s; D	5.0 m/s; D					
VII	50	1.0 (14.5 psi)	1.0 (14.5 pul)	1.0 (14.5 ps/)				
Above	100	0.05 (0.725 psi)	0.04 (0.58 psi)	0.04 (0.58 psi)				
ground pipe	1000	0.00	0.00	0.00				

The analysis of the various scenarios considered is as follows:

Scenario I: Release of NG from a puncture of 50 mm underground pipeline after the CGS station

Parameter		Values
Gas Pressure	:	19 bar
Ambient Temperature	:	30 - 35°C
MOC of pipeline	:	Steel
Weather conditions		1 m/s, F; 3 m/s, D; 5 m/s, D
Diameter of pipeline	:	200 mm
Jet flame		Vertical

In the above scenario, as the pipeline is underground at a depth of about 1m, in the event of a leak during excavation which could create a puncture of about 50 mm, would lead to a vertical release of the gas.

The release being upwards under a pressure of about 19 bar most of the dispersion would be vertically upwards. It is estimated that horizontally about 1.27 m distance is most critical where the edge of the NG cloud would be near the LFL. As NG is lighter than air, the gas would rise upwards.

Scenario I could take place mostly in uninhabited area. The gas cloud has less chances of ignition except that it might get ignited by the excavation equipment itself. The possibility of a minor spark igniting the NG cloud is less as NG requires high heat energy to ignite it (unlike LPG cloud).

Hence, under all weather condition Scenario I is not likely to cause major harm to people/ damage to property as the habitation along the pipeline is low.

In case, the NG released gets ignited it would be comparatively easier to approach the fire because it would be a vertical flame and high radiation levels would be very close to the flame itself. But heat radiation upto a level of 4 kW/m² would be felt up to 26 m distance which could cause blistering and pain if the persons in the area are unable to reach for cover. However, professional fire fighters would be able to fight fires within this distance.

It can be seen that concentration of the gas within 10 m distance of the point of release is well below LFL concentration of 5%.

All gas fires have to be handled by first shutting of the gas supply. In the meantime water may be used if appropriate to cool down the surrounding area and put off the fires started by the gas leak and subsequent ignition.

6.4.8.2 Scenario II: Release of NG from a puncture of 25 mm underground pipeline after DRS

Parameter		Values
Gas Pressure		4.5 bar
Ambient Temperature	:	30 - 35°C
MOC of pipeline		Steel
Weather conditions		
Diameter of pipeline		1 m/s, F; 3 m/s, D; 5 m/s, D
Jet flame	<u> :</u>	100 mm
occuaine .	:	Vertical

In Scenario II we have considered a 25 mm leak from the underground pipeline transporting NG at 4.5 bar pressure. In this case too, as the discharge is vertical, the horizontal dispersion distance of the gas is less i.e. within a range of 0.28 m for LFL level of concentration (5%).

This condition could take place after the DRS on the underground pipelines during excavation. The DRS is locked and inaccessible except for maintenance.

In case, the gas release gets ignited, a 6.6 m distance would need to be cordoned of to prevent injury to public. DRS could be located in the city, or on the outskirts. Source of ignition within the city would be plenty, as well as the probability of cascading effect of a fire is also high due to nearness of combustible material in

6.4.8.3 Scenario III: Release of NG from a puricture of 25 mm underground pipeline

Parameter		underground pipeline
Gas Pressure		Values
Ambient Temperature	:	2 bar
	:	30 - 35°C
MOC of pipeline		MDPE
Weather conditions		
Diameter of pipeline	<u> </u>	1 m/s, F; 3 m/s, D; 5 m/s, D
Jet flame	:	125 mm
of notice /	1:	Vertical

This scenario is similar to Scenario II.

We recommend a safety distance of 6 m around the fire where unconcerned personnel should not be allowed, only fire fighters and maintenance personnel may be allowed in the area.

Scenario IV: Release of NG from a puncture of 25 mm above ground pipeline at 6.4.8.4

Parameter		
Gas Pressure		Values
Ambient Temperature	:	1.5 bar
Weather conditions	:	30 - 35°C
Diameter of pipeline	:	1 m/s, F; 3 m/s, D; 5 m/s, D
Jet flame	<u>:</u>	100 mm
	:	. Aorizontal

In the above circumstances the jet flame would be horizontal and above ground. In this case, under stable weather condition distances upto 58 m could be dangerous as the gas would be within LFL level, but such a fire would be at industrial MRS where the gas station would be protected and secluded. A clear distance of 12 m around the MRS should be maintained; for this purpose a barbed wire enclosure is suggested around

6.4.8.5 Scenario V: Release of NG from a puncture of 10mm above ground pipeline at Domestic meter regulator, Galvanized Iron riser

Parameter		
Gas Pressure		Values
Ambient Temperature	<u>:</u>	50 mbar
Weather conditions	<u>:</u>	30 - 35°C
Diameter of pipeline	:	1 m/s, F; 3 m/s, D; 5 m/s, D
Jet flame	<u> :</u>	90 mm
	:	Horizontal

6.4.8.6 Scenario VI: Release of NG from puncture hole of 10 mm above ground pipeline at meter (copper pipeline)

Parameter	j	N-1
Gas Pressure		Values 21 mbar
Ambient Temperature	·	
Weather conditions	:	30 - 35°C
	:	1 m/s, F; 3 m/s, D; 5 m/s, D
Diameter of pipeline	:	63 mm
Jet flame	:	Horizontal

For the above two scenarios the gas pressure being very low the heat radiation distances due to an ignited NG leakage would be less.

The possibility of an open air NG explosion is remote. But if the gas gets trapped in confined spaces of the building, the possibility of an explosion if the gas gets ignited cannot be ruled out.

6.4.8.7 Scenario VII: Release of NG above ground from a puncture of 25 inm from CNG compressor for filling Mother Cylinder Trolleys / vehicles.

Parameter	İ	Values
Gas Pressure		The state of the s
Ambient Temperature		250 bar
	:	30-35°C
Gas Outlet Temperature	:	60°C
MOC of pipeline		
Weather conditions		Steel
	:	1 m/s, F; 3 m/s, D; 5 m/s, D
Diameter of pipeline	:	150 mm
Jet flame	:	Horizontal

It is assumed that the compressed gas pipeline is above ground as it would be within the gas filling station area. The pipe line lengths are less and the possibility of a leakage is also low due to round the clock monitoring by the station personnel.

The above scenario is considered because if it materializes, the consequences would be felt upto a distance of about 140 m where 0.3 psi over pressures may be felt due to which damage to houses and glass windows may occur (possibility of UVCE is remote). Sources of ignition within 62 m could cause late ignition affected where in severe to moderate damage can take place.

The above analysis can be elaborated when the DRS, Industrial MRS Vehicle filling stations and domestic consumer pockets are actually identified on the map.

6.5 Ranking of chemical hazards by NFPA Classification for the proposed pipeline

National Fire Protection Association (NFPA) rating for Natural Gas (Methane) is provided in Table 6.7. The explanation of NFPA classification is given in Table 6.8.

Table 6.7: NFPA Classification for Natural Gas

	1	ioi Hatulai (Jas
Chemical	Nf		
Math	• • • • • • • • • • • • • • • • • • • •	Nr	Nh
Methane	4	0	1

Table 6.8: Explanation of NFPA Classification

Classification	Definition	
Health Hazard, NI		
4	Materials which on very short exposure could cause death or major residual injury even "hough prompt medical treatments were given.	
3	Materials which on short exposure could cause serious temporary or residual injury even though prompt medical treatments were given.	
2	Materials which on intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment is given.	
1	Materials which on exposure would cause imitation but only major residual injury eve if no treatment is given.	
Ō	Materials which on exposure under fire conditions would offer no hazard beyond that of ordinary combustible material.	
Flammability Mazard, Nf		
4	Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, or which are readily dispersed in air and which will burn readily.	
3	Liquids and solids that can be ignited under almost all ambient temperature conditions.	
2	Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.	
1	Material that must be preheated before ignition can occur.	
0	Materials that will not burn.	
Reactivity Hazard, Nr		
	Materials which in themselves are readily capable of detonation or of explosive decomposition or reaction at normal temperature and pressures.	
3	Materials which in themselves are capable of detonation or explosive reaction but require a strong initiating source or which must be heated under confinement before initiation or which react explosively with water.	
	Materials which in themselves are normally unstable and readily undergo violent themical change but do not detonate. Also materials which may react violently with vater or which may form potentially explosive mixtures with water.	
	Materials which in themselves are normally stable, but which can become unstable at elevated temperature and pressures or which may react with water with some release of energy but not violently.	
	Materials which in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water.	

6.6 Fire and Explosion Index

6.6.1 Introduction

In this study, Dow's Fire and Explosion Index (F & EI) has been used to identify and evaluate the existence and significance of fire and explosion hazards within the facility.

Fire and Explosion Index analysis, is a step by step evaluation of the realistic fire, explosion and reactivity potential of processes, equipments and its contents. The F & EI is used for any operation in which flammable, combustible or reactive material is stored, handled or processed. The F & EI is calculated by evaluating the loss potential of chemicals stored in the facility. The Fire and Explosion Index is a number which indicates, damage potential due to the fire and explosion of a particular unit and comparison is based on numerical value that represent the relative level of significance of each hazard. It is a product of three attributes: Material Factor, General Process hazards and Special Process hazards.

The material factor is the starting value in computation of F & El. Material factor (MF) is a measure of intrinsic rate of potential energy released from fire or explosion produced by combustion or other chemical reaction. The material factor is considered for the most hazardous material or mixture of material present in the unit in sufficient quantity actually to present the hazard. The MF is obtained from Flammability factor and Reactivity factor i.e. Nf and Nr respectively given for various chemicals by National Fire Protection Association (NFPA).

Process hazards that contribute to the magnitude of losses have been quantified as penalties, which provide factors for computation. Every penalty may not be applicable to a specific situation and same may have to be modified. The General Process hazards (GPH) and Special Process Hazards (SPH) are taken into account as penalties which are applied to Material Factor.

The F & FI is defined as:

F & EI = MF x (GPH) (SPH)

(F & EI) = MF X F1 X F2

1	TELOS RISK MANAGEN	IENT & INSURANCE BROKIN	G SERVICES (P)	
00000				
DOW'S FIRE AN	ND EXPLOSION	INDEX		
LOCATION DATE PLANT P	ROCESS UNIT	EVALUATED BY	DEVIEWS	
Ahmedahad 31.04.00	ipeline	Venugopal	REVIEWE	
Baroda		veriugopai	R.E. Abrah	
MATERIAL	S AND PROCE	SS		
PROCESS UNIT				
STATE OF OPERATION Natural	Gas (Methane)			
		IAL(S) FOR MATERIA	AL FACTOR	
Start – up Shut – Down Normal Operation Transfer	Methane		•	
MATERIAL FACTOR				
1. GENERAL PROCESS HAZARDS			-	
		PENALTY	1	
BASE FACTOR—		1.00	1.00	
A. EXOTHERMIC CHEMICAL REACTIONS (FA	ACTOR .30 TO 1.	25)	0.00	
B. EXOTHERMIC PROCESSES (FACTOR .20 TO .40) C. MATERIAL HANDLING & TRANSFER (FACTOR .25 TO 1.05) D. ENCLOSED OF MISCOSCIPPING (FACTOR .25 TO 1.05) 0.00				
D. ENGLOSED OR INDOOR PROCESS IMITS /EACTOR OF TO CO.				
		0.00		
F. DRAINAGE AND SPILL CONTROL (FACTOR .25 TO .50) 0.35 0.35				
GENERAL PROCESS HAZARDS (FACTOR F1)			0.00	
2. SPECIAL PROCESS HAZARDS				
BASE FACTOR			1.00	
A. TOXIC MATERIAL(S) (FACTOR 0.20 TO 0.80 B. SUB-ATMOSPHERIC PRESSURE (500))		0.00	
B. SUB-ATMOSPHERIC PRESSURE (500 mm Hg) C. OPERATION IN OR NEAR FLAMMABLE RANGE INERTED NOT				
INERTED IN STATE PLANIMABLE RAN	IGE INERTED NO)T	-	
TANK FARMS STORAGE FLAMMABLE	HOURS		ļ	
2. PROCESS UPSET OR PURGE FAILUR	F		-	
3. ALWAYS IN FLAMMABLE RANGE			0.00	
D. DUST EXPLOSION (FACTOR 25 TO 2 00)				
PRESSURE OPERATING PRESSURE 280	psig RELIEF	0.6	0.00	
F. LOW TEMPERATURE (FACTOR .20 TO .30)			0.0	
O GOANTITY OF FLAMMABLE UNSTABLE MA	TERIAL OLIAN		0.00	
		*	-	
LIQUIDS, GASES AND REACTIVE MAT	ERIALS IN PROC	ESS	1 000	
Z. LIGOIDS OR GASES IN STORAGE			0.00	
3. COMBUSTIBLE SOLIDS IN STORAGE	DUST IN PROCE	SS	-	
OOM COOL AND ERUSION FACTOR AND	751	0.20	0.20	
LEARAGE - JOIN S AND PACKING (FACTOR 10 TO 1 50)				
J. USE OF FIRE HEATERS K. HOT OIL HEAT EXCHANGE SYSTEM (FACTOR .15 TO 1.15) 1. ROTATING FOLIDATION 0.10 0.00				
L. ROTATING EQUIPMENT	OR .15 TO 1.15)		0.00	
SPECIAL PROCESS HAZARDS FACTOR (F2)		· · · · · · · · · · · · · · · · · · ·	0.00	
UNIT HAZARD FACTOR (F1 x F2 = F3)				
FIRE AND EXPLOSION INDEX (F3 x MF = F & EI)				
The state of the s				
FIRE EXPLOSIVE INDEX (RATINGS)				

The degree of hazard is identified based on F & El range as per the criteria given below:-

Degree of Hazard
Degree of nazard
Light-
Moderate
Intermediate
Heavy
neavy

6.6.2 Summary of DOW's Index worked out for the proposed NG (Methane) Pipeline

	T	T			(methane) Pr	penne	
Chemical	MF	ĢРН	SPH	UHF	F & EI	Rating	1
Methane	21	2.2	10	4.40		Rating	
			1.5	4.18	87.78	Moderate	İ

MF - Material Factor

GPH - General Process Hazard

SPH - Special Process Hazard

UHF - Unit Hazard Factor

F & EI - Fire and Explosion Index

6.7 Guidelines for laying the NG gas pipeline in the city of Ahmedabad

6.7.1 Pipelines

- The pipeline of the basic gas grid of varying sizes should be of carbon steel with bare minimum electro welded joints.
- 2) All the welded joints should be 100% radiographed.
- 3) Soil survey of the route of the gas pipelines should be carried out before laying the pipelines. If the CNG gas pipeline is laid parallel to any other pipeline carrying flammable liquids the minimum safety distance of at least 3 m should be maintained between the two pipelines.
- 4) The entire gas pipeline should be hydrostatically tested at 1.5 times of the maximum working pressure.
- 5) The gas pipeline should be provided with cathodic protection for protection against corrosion. The inner surface of the pipeline should be kept free from moisture. Special precautions should be taken such that water/ moisture is not left back. This can be done by providing drain points at selected locations.
- 6) The route of the pipeline should be distinctly indicated with specific signs so that other services proposing to undertake any maintenance work will be cautioned.

6.7.2 Isolation Valves

- 1) The spacing between isolation valves could be 3 = 4 km apart.
- 2) All the Isolation valves should be motor operated, remote controlled from the main console located at the CGS. These valves could be located in underground chambers having dimension 1 X 1 X 2 meters. Covers in the form of grating could be provided to these chambers which should be kept under lock and key. The chambers should be vented adequately and protection should be provided by sealing the chambers to prevent ingress of water.

- 3) The District Regulators (DRS) should be installed above ground in aluminum cabinets and should be so located that they are not directly exposed to vehicular traffic. As far as possible they should be located near a compound wall of a building or on a private or public land wherever feasible. Crash barriers should be erected around the DRS.
- 4) Warnings against use of naked light or smoking should be displayed on the DRS cabinets on all sides.
- 5) The DRS cabinets should be kept under lock and key to prevent them from being tampered by unauthorized persons.
- 6) The DRS should have automatic shut off valves and safety relief valves. In the event of increase in pressure beyond 4 bars the mechanism should shut off the inflow of CNG. The system should be integrated to such an extent that variation in the pressure should automatically be indicated in the CGS control room.

6.7.3 Protection for Tap-off Point from Main GSPL pipeline

- Since the intake of high pressure gas commences from this point, the valve assembly and other allied fittings should be of approved type having motorized valves.
- 2) The mechanism of the valve assembly should be such that in the event of rise in pressure in the pipeline beyond the normal operating pressure, the inlet valve should be closed from the control room by remote control.

6.7.4 Fire Protection to City Gas Station

- A few allied processes will be carried out at the CGS. Hence it becomes a critical area not only from the operational point of view but also from the fire risk point of view.
- The entire City Gas Station should be adequately fenced.
- 3) The upstream flow as well as downstream flow of the compressed gas should be regulated and controlled by such mechanism whereby any pressure differential should be noticed in the system of control room immediately and isolation valves should be closed by remote control from the control completed within seconds.
- 4) All the electrical fittings in the CGS should be of intrinsically safe/ flame proof type. A certificate to that effect should be obtained from the supplier.
- All hot work should be strictly prohibited and if absolutely necessary will be carried out under a work permit system.
- 6) Where the NG gas connection is given to an individual customer with a metering system, such meters should be located at ground level in a separate independent structure away from the existing electrical meter room of the buildings.
- 7) Inspection of the installations as mentioned below should be arranged with the city fire brigade where improvements in the fire safety could be suggested:
 - Laying of pipeline 1st stage
 - Installation of CGS, DRS 2nd stage
 - Prior to commencement of the pipeline 3rd stage
- 8) The pipeline alignment should be distinctly marked by pipeline markers and warning signs. Emergency contact numbers should be clearly displayed.

6.7.5 Telecom System

- There should be a computerized control room with VHF communication network between tap off point, CGS and other selected stations all over the city. These control rooms could be manned by a technical staff round the clock.
- There should be supervisory control and data acquisition system (SCADA) which on operation should trigger off alarm and shut down the system.

Fire Prevention and Fire fighting measures

- 25 kg capacity DCP type of fire extinguishers should be adequately provided all over the CGS station. A closed loop fire hydrant system should be provided at the CGS with fire fighting water supply for at least
- The electrical fittings and fixtures at all the gas stations should be of flame proof type. 2)
- The natural gas pipeline should not be laid above the ground unless safety distance of 100 meters is maintained between the pipeline and any inhabited areas.
- There should be adequate patrolling by pipeline walkers along the route of the pipeline for ensuring safety and avoiding sabotage misuse etc. The pipeline walkers should be provided with VHF sets for easy communication.
- In the event of any accident a mechanism should be provided to de-pressurize upstream and
- An emergency squad comprising of qualified Engineers and workers should be kept standby round the clock to meet any eventuality and assist the local fire services. This squad should be equipped with necessary tools required for operating valves, stopping gas leakages etc. The squad should also carry adequate quantity of water gel blankets which is useful for touching red hot objects as well as for
- Telecommunication hotline should be established between the CGS and the nearest fire station in order to reduce the response time to bare minimum.
- Disaster management plan should be in place where in probable emergencies and plan of action for

MDPE Pipelines for distribution of NG

- The guidelines are stipulated from the fire safety point of view only. The diameter of the pipeline should not be more than 125 mm and the operating pressure not exceeding 4 bars. The bursting pressure should not be less than five times the maximum operating pressure.
- The laying of the pipeline should confirm to the following stipulations:
 - The earth cover for the pipeline should not be less than 1 meter. In other words the pipeline should be laid at least 1 meter below the road or ground level when laid along the road/ street.
 - The horizontal distance of the pipelines from any building or structure should not be less than 3 meters. The same horizontal safety distance should be maintained when the pet pipeline is laid parallel to any other pipeline carrying flammable liquid/ gases.
 - If these safety distances cannot be maintained for any practical reasons, the matter should be referred to the fire brigade department for guidance in writing.
 - When laid across a road the earth cover should not be less than 1.5 m and the pet pipeline should
- Square pits should be provided on the pet pipeline as given below: 3)
 - At intervals of 750 meters in case of 125 mm diameter.
 - At intervals of 1 km in case of 90 mm diameter.
 - At intervals of 1.5 km in case of 63 mm diameter.
 - At intervals of 2 km in case of 32 mm diameter.
- In order to prevent external damage or attempt to pilfer the MDPE pipelines, the square pits should be provided with metal protection cover. The top cover of the pits should have markings of "Adani Gas Pipeline" for the purpose of identification.
- The route marker should be provided at intervals of at least 500 m.
- The MDPE pipeline should not be laid under any structure or temporary stalls or through slum areas. 6) 7)
- The following requirements should be complied with before filling the trenches:

- The pet pipelines should be tested to detect any leakages by injecting an inert gas or by any other suitable method and a certificate to the effect that the pipeline is free of leakages should be given by GAEL to the concerned Municipal Ward Officer.
- The pet pipelines should also be subjected to pressure test at at least twice the operating pressure and a certificate to the concerned Ward Officer for having carried out the test and that the pet pipelines is capable of withstanding twice the operating pressure mentioning therein the operating pressure at which the pipeline was tested should be provided.

6.7.8 General

- The route of the gas pipeline should not be altered without informing the authorities who had issued the NOC.
- 2) Clearance should be obtained from GPCB for project establishment and CCOE for CNG.
- 3) Within the city limits you may consider providing a rigid cover on top of the underground pipeline to prevent damage and subsequent fire in case of inadvertent drilling / tempering of the pipeline.
- Built in engineering safety measures should be incorporated in the CGS station.
- 5) Design parameters of the carbon steel & MDPE pipe should be indicated to the city Chief Fire Officer (CFO) which shall include hardness and max design temperature and pressure parameter.
- The date of commissioning of MDPE pipelines should be intimated to the concerned Municipal Ward Officer/ CFO.
- 7) On commissioning of any section of the gas pipeline, GAEL should ensure that all conditions stipulated and informed separately such as pipeline walkers, availability of emergency van, informing fire brigade control room on noticing/ detecting leakage, fire/ explosion or other accidents, periodical testing are complied.
- 8) Prior to commissioning of the pipeline system a Disaster Management plan will have to be prepared.

6.8 Natural Gas (odorized) MSDS

6.8.1 Synonym

Compressed Natural Gas (CNG): Methane, Dry Natural Gas, Sweet Natural Gas

6.8.2 Composition

A complex mixture of light gases separated from raw natural gas consisting of aliphatic hydrocarbons, having carbon numbers in the range of C_1 through C_4 ; predominantly methane (C_1) and ethane (C_2) may contain CO_2 , odorized with trace amounts of odorant.

6.8.3 Hazard Identification

6.8.3.1 Flammable Gas

Flammable gas may cause flash fire or explosion. High concentration may exclude oxygen and cause dizziness and suffocation. Contact with pressurized vapor may cause frost bite.

6.8.3.2 Eyes

Not irritating. However contact with pressurized vapor may cause frost bite and permanent eye damage.

6.8.3.3 Skin

Not irritating. Direct contact with skin or mucous membranes with pressurized vapor may cause frost bite. Signs of frost bite include a change in the color of the skin to gray or white, possibly followed by blistering. Skin may become inflamed and painful.

6.8.3.4 Ingestion

Risk of ingestion is extremely unlikely.

6.8.3.5 Inhalation

Product is considered to be non-toxic by inhalation. Inhalation of high concentrations may cause CNS depression such as dizziness, drowsiness, headache and similar narcotic symptoms, but no long term effects.

NG is a simple asphyxiant. In high concentration it will displace oxygen from the breathing atmosphere, particularly in confined places. Signs of asphyxiation will be noticed when oxygen is reduced to below 16%, and may occur in several stages. Symptoms may include rapid breathing and pulse rate, headache, dizziness, visual disturbances, mental confusion, in co-ordination, mood changes, muscular weakness, tremors, cyanosis, narcosis, and numbness of the extremities. Unconsciousness leading to CNS injury and possible death will occur when the atmospheric oxygen concentration is reduced to about 6%.

Warning:

The burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including CO, and inadequate oxygen levels, which may cause unconsciousness, suffocation and death.

Medical conditions aggravated by exposure:

Individuals with pre-existing conditions of the heart, lungs, and blood may have increased susceptibility to symptoms of asphyxia.

6.8.4 First Aid Measures

6.8.4.1 Eyes

In case of freeze burn cover eyes to protect from light. Flush eyes with water. Seek immediate medical attention.

6.8.4.2 Skin

In case of frost bite seek immediate medical attention.

6.8.4.3 Ingestion

Risk of ingestion is extremely unlikely. In case of frost bite due to oral exposure seek immediate medical attention.

6.8.4.4 Inhalation

Remove person to fresh air. If person is not breathing, give artificial respiration. If necessary administer medical oxygen, seek medical attention immediately.

6.8.5 Fire Fighting Measures

Flash Point	:	Flammable gas	
Auto ignition point	:	482°C – 632°C	
LEL	:	3.8-6.5	
UEL.	:	13 - 17	

6.8.5.1 Fire and Explosion Hazard

Dangerous fire and explosion hazard when exposed to heat, sparks or flame. NG is lighter than air and will travel long distances to a point of ignition and flash back.

6.8.5.2 Extinguishing media – DCP, CO₂, Water spray

Fire should not be extinguished unless flow of gas can be immediately stopped. If leak has not ignited, water spray may assist in dispersing gas or vapor to protect personnel attempting to stop leak.

6.8.5.3 Fire fighting instruction

Use water to cool equipment, surfaces and containers exposed to fire and excessive heat. For large fires use of monitor nozzles may be advantageous. 'Jse should be made of self contained breathing apparatus with full face piece and full protective clothing.

Accidental release measures 6.8.6

Evacuate non essential personnel and secure all ignition sources. No road flares, smoking or flames in hazard area. Consider wind direction, stay up wind, if possible.

Evacuate the direction of cloud travel. Cold vapor may be white, but color will dissipate as cloud disperses -

Stop source of the release, if safe to close. Consider the use of water spray to disperse vapors. Isolate the area until gas has dispersed. Ventilate and gas test area before entering.

6.8.7 Handling

Keep away from flame, sparks and excessive temperatures, bond and ground containers/ pipelines/

Exposure control and personal protection

Use explosion proof equipment and lighting in classified/ controlled areas.

Eyel face protection

Splash proof safety goggles and/ or face shield for protection from pressurized gas.

Skin protection

Wear apron, face shield, gloves.

Respiratory protection

Use positive pressure, supplied air respirator with self contained breathing apparatus for gas concentrations above occupational exposure limits; for potential for uncontrolled release, if exposure levels are not known.

6.8.9 Physical and chemical properties

Appearance

Colorless gas, cold vapor cloud may be white but lack of visible gas cloud does not indicate absence of gas.

NG has a distinctive, disagreeable "NG" type odor when treated with an odorizing agent (typically < 0.1%

Basic physical properties (for methane)

Boiling point	(10200)
Vaper pressure	40 ota ap nata
Vapor chandly (ale = t)	O O of 15 6%, and 1 alm
Sp gravity (water = 1)	0.4 @ 164°C
Solubility (water)	3.5%

6.8.10 Stability and Reactivity

Stability - Stable

Conditions to avoid - Keep away from strong oxidizers, ignition sources and heat

The Hazardous decomposition products are - CO, CO₂ and smoke.

6.8.11 Toxic properties

Acute toxicity

Methane and ethane, the main components of NG are considered practically inert in terms of physiological effects. At high concentrations, these materials act as simple asphyxiants and may cause deaths due to

Carcinogenicity

No.

6.8.12 Ecological information

The product is expected to exist entirely in the vapor phase in ambient air.

6.8.13 NFPA Classification

Health	And description to the state of			
	1	Slight		
Fire	4	Extreme		
Reactivity	0	Negligible		
The same of the sa				



7 DISASTER MANAGEMENT PLAN (DMP)

7.1 Introduction

Emergency planning is an integral part of the overall loss control program and is essential for any well run organization. This is important for effective management of an accident/incident to minimize losses to people and property, both in and around the facility. The important aspect in emergency management is to prevent by technical and organizational measures, the unintentional escape of hazardous materials out of the facility and minimize accidents and losses. Not only are unrecognized hazardous conditions which could aggravate an emergency situation be discovered, the emergency planning process also brings to light deficiencies such as lack of resources necessary for effective emergency response. Emergency planning also demonstrates the organization's commitment to the safety of employees and increases the organization's safety awareness.

The format and contents of the Emergency Response Plan (ERP)/ On-Site Disaster Management Plan (DMP) has been developed taking into consideration the regulatory guidelines, other applicable documents and accepted industry good practice principles formulated as a result of lessons learned in actual emergencies requiring extensive emergency response.

DMP can work smoothly and effectively only if the instructions are correctly and promptly followed and action taken at various levels is well co-coordinated.

The following information provides guidelines for preparing a working DMP for the project.

7.1.1 Objectives

The objectives of DMP is to describe and spell out the facility's emergency response organization, the resources available and response actions applicable to deal with various types of emergencies that could occur at the facility with the response organization structure being deployed in the shortest time possible during an emergency. Thus, the objectives of emergency response plan can be summarized as:

- 1) Rapid control and containment of the hazardous situation,
- 2) Minimizing the risk and impact of event/accident,
- 3) Effective rehabilitation of the affected persons and prevention of damage to property.

In order to effectively achieve the objectives of emergency planning, the critical elements that form the backbone of the DMP are:

- 1) Reliable and early detection of an emergency and careful planning.
- 2) The command, co-ordination, and response organization structure along with efficient trained personnel.
- 3) The availability of resources for handling emergencies.
- Appropriate emergency response actions.
- 5) Effective notification and communication facilities
- Regular review and updating of the DMP.
- 7) Proper training of the concerned personnel.

The plan should open up with a 'Foreword' duly signed by the MD of your organization, a copy of which is reproduced below:

7.1.2 Foreword

"The document On-site Disaster Management Plan is prepared with the objective of defining the functions and responsibilities of all concerned managerial, operational and supporting services department personnel with respect to detection and effective implementation of action plan. The ultimate goal is the effective containment of the situation by proper mitigative action at the place of occurrence, cautioning people in adjoining affected localities, prompt rescue and medical aid to affected persons and communication to civil authorities for rushing in help from outside. All concerned are hereby requested to carefully study and thoroughly familiarize themselves with it in order to ensure its effectiveness in times of emergency"

Date

7.1.3 Responsibility

Responsibility for establishing and maintaining a state of emergency preparedness belongs to the MD. He is responsible for maintaining distribution control of the plan, and for ensuring that the plan and applicable implementing procedures are reviewed and revised annually.

The Safety Officer is responsible for the training of personnel to ensure that adequate emergency response capabilities are maintained in accordance with the plan. He is also responsible for ensuring the adequacy of the conduct of drills, as outlined in the DMP. All employees of various departments are responsible for carrying out their responsibilities, as defined in this DMP.

7.2 Definitions

7.2.1 Disaster

An industrial disaster can be defined as an "occurrence of magnitude so as to create a situation in which normal pattern of life within a facility is suddenly disrupted, adversely affecting not only the personnel and property within the facility but also in its vicinity."

Such an occurrence may result in on-site/ off-site implications like:

- 1) Fire and/ or explosion,
- 2) Leakage of flammable material,

Incidents having off-site implications can be:

- 1) Natural calamity like earthquake, cyclone or any other natural calamity.
- 2) Air raids
- 3) Crashing of aircrafts or flying objects.

Incidents which could also lead to a disaster are:

- 1) Agitation/ forced entry by external group of people
- 2) Sabotage

An important aspect of the disaster is its unforeseen nature. Thus, by definition itself, a disaster is impossible to control completely. However, occurrence of events which lead to a disaster may be minimized through proper technology and engineering practices.

7.2.2 Alert

A situation wherein a gas/ fuel release may result in a fire or spillage with no expected off-site consequences necessitating an immediate response by shift personnel.

7.2.3 On-Site Emergency

A situation where a gas/ fuel release results in significant fire, spillage, explosion, or other incident affecting or potentially affecting the safe operation of the facility, for which actions are necessary to protect on-site personnel, but from which no off-site consequences are expected.

7.2.4 Off-Site Emergency

A situation where a gas/ fuel release will probably have an off-site impact, also defined as a major fire, spillage, explosion, or other incident affecting the safe operation of the plant, for which actions are necessary to protect on-site personnel and from which off-site impact is probable.

7.2.5 Emergency Response Organization (ERO)

All site personnel that have specified functions in response to an emergency situation.

7.2.6 Emergency Response Plan (ERP)

A document describing the response plan to handle an industrial emergency at the facility.

7.2.7 Emergency Operations Center (EOC)

The Central location (normally the Main Control Center) where emergency response activities are managed by the Emergency Response Organization (ERO).

7.2.8 Main Controller

That individual responsible for the implementation of the Emergency Response Plan during an emergency condition.

7.2.9 Operator

An employee or employees qualified and trained in, or being trained in, the operations of the unit.

7.2.10 Plant

The facilities, buildings, equipment, and contiguous areas.

7.2.11 Material Safety Data (MSDS)

A document that describes the chemical and physical properties, and the physical and health hazards, of a substance.

7.3 Probable Emergencies & critical targets on the proposed NG network

For the proposed NG distribution network, the probable emergencies that can occur are identified as follows:

Scenario I: Release of NG from a puncture of 50 mm underground pipeline after the CGS station

Scenario II: Release of NG from a puncture of 25 mm underground pipeline after DRS

Scenario III: Release of NG from a puncture of 25 mm underground pipeline

Scenario IV: Release of NG from a puncture of 25 mm above ground pipeline at Industrial MRS

Scenario V: Release of NG from a puncture of 10mm above ground pipeline at Domestic meter regulator, Galvanized Iron riser

Scenario VI: Release of NG from puncture hole of 10mm above ground pipeline at meter (copper pipeline)

Scenario VII: Release of NG above ground from a puncture of 25 mm from CNG compressor for filling Mother Cylinder Trolleys / vehicles.

The critical targets en-route the main distribution network are:

- Navrangpura area (near Mithakali circle)
- Kallupur area
- Mills area Asarva Mill, M.H. Mill, Arvind Mills, Ashima Textiles
- Sabarmati area

7.4 Concept of Operations

Concept of operations deals with the possible steps associated with an emergency response assuming the most severe emergency scenario (although this may not, and most likely, will not always be the case). This

- 1) Accident Initiation and Raising the Alarm.
- Accident Evaluation and Classification of on-site emergency declaration.
- Off-site and External Agency Notification.
- 4) Implementation of On-site Response Actions.
- 5) Implementation of Protective Actions and Evacuation.
- 6) Co-ordination of Response Actions with External agencies.
- 7) Management of Emergency Resources.
- 8) Recovery and Facility Re-entry procedures.

When an emergency occurs, the initial indication is via instrumentation or by raising of the alarm in the Main Control Centre or by the person who first notices a problem and informs their shift supervisors. The Shift Engineer is immediately notified who then assesses the severity of the condition, classifies it appropriately and directs the response actions of the Emergency personnel to mitigate the condition. Upon classifying the situation as On-Site (Site Emergency in CGS) or Off-Site (General Emergency beyond CGS) emergency situation, the Shift Engineer assumes the responsibility of the Main Controller and activates the DMP, pending the arrival of the Main Controller.

After classification of the emergency as a Site or General Emergency, the Main Controller provides for the immediate notification of the appropriate off-site governmental agencies, provides recommendations for protective actions, if necessary, and activates the full Emergency Response Organization. This organization, operating out of the Main Control Centre, functioning as Emergency Operations Centre (EOC), provides overall assessment, damage control, notifications and communications, and employee and public protective actions during emergency.

7.5 Emergency Classification

Emergencies are grouped into three classifications. These classifications adequately encompass those hazards that exist at the site, and provide for an effective response capability. Emergency Action Levels associated with these classifications are further defined in the Emergency Response Procedures, and are summarized in the following subsections.

7.5.1 Alert

This classification encompasses those events in which a potential hazard has reached a dangerous level that could affect the ability to safely operate the system. For gas leak, an Alert means that a gas release could be imminent and may occur. Off-site assistance may be necessary, in the form of fire fighting support, and a gas.

7.5.2 On-site Emergency (within CGS)

This classification encompasses those events in which the hazard exists or has increased, necessitating shutdown of a significant portion of the system, and immediate actions are necessary to protect on-site personnel. For accidents, a Site Emergency means that a gas release has occurred that probably will not have an off-site impact. Accountability to ensure the whereabouts of site personnel is required. Off-site assistance to mitigate the event, and full activation of the Emergency Response Organization, is required.

7.5.3 Off-site Emergency

This class fication encompasses those events in which the hazard exists or has increased, necessitating shut down of a significant portion of the site. Immediate action to protect the on-site personnel and recommendations to ensure the safety of the affected public in the vicinity of the plant, are appropriate. A General Off-site Emergency means that the accident/incident could have off-site impacts. Accountability to ensure whereabouts of site personnel is required. Off-site assistance to mitigate the events, the full activation of Emergency Response organization is required.

An emergency in the form of gas leak with or without fire/explosion anywhere in the city out of CGS also comes under the classification of Off-site emergency.

7.6 Emergency Actions

7.6.1 Initial Response Organization

Upon the initial classification by the Chief Engineer/ Shift Engineer of an Alert, On-site Emergency, or Off-site Emergency, the Main Control Centre in CGS is activated as the Emergency Operation Centre, and initial response team(s), based on the type and location of the emergency, are activated and respond to the scene under the direction of the Field Operation Coordinator. Initial notifications are made to appropriate off-site organization and government agencies by the Communication Coordinator, under the direction of the SEC. The Plant Manager is notified, and if the event is classified as an On-site or Off-site of General Emergency, the full Emergency Response Organization is activated.

The On-site Emergency Coordinator will monitor the emergency condition and mitigation efforts until escalation occurs, or until mitigation is successful and reentry and recovery can begin.

The Communication Coordinator, as directed by the Site Emergency Coordinator, will

- Notify the appropriate off-site agencies of the type of incident occurring
- Notify site support personnel, as needed
- Notify appropriate site management

Support personnel will report to their assigned locations and coordinate with or assist the response team(s) to promptly mitigate the accident, and begin reentry and recovery of the facility.

7.6.2 Full Emergency Response

Upon classification of an event as, of escalation from, an Alert, On-site or Off-site Emergency, the Main Controller provides immediate notification to off-site governmental agencies and, as necessary, recommends protective actions that should be taken by these agencies to protect the health and safety of the neighboring public. The Emergency Operations Centre is activated (if not already activated) and a full callout of the Emergency Response Organizations is initiated, as appropriate. Upon the arrival of support responders, their individual procedures. The designated Communications Coordinator will maintain communications with the Initial Response Team at the scene until relieved by the Response Operations Coordinator, as well as with onsite support groups and off-site agencies. The Field operations Coordinator will assume command and control of the Emergency Response Teams and will commence the immediate mitigation of the emergency condition. On-Site Security will be responsible for accounting for all personnel who were on - site just prior to the emergency condition. If you cannot account for all the people i.e. missing individual(s) then the Site Main Controller de-escalates the classification and begins directing the reentry and recovery efforts.

7.7 Emergency Capabilities

In order to maintain an emergency response capability, certain facilities must be kept in a state of readiness, and sufficient supplies and equipment must be available. Where the local police or private agencies may be called upon, such as volunteer fire companies and ambulance associations, agreements have to be developed ahead of time.

7.7.1 Facilities

Primary emergency response facilities consist of the following:

Main Control Centre - Upon classification of an emergency condition, the Main Control Centre is designated as the Emergency Operations Centre. Manned for around-the-clock operations, this facility houses instrumentation, controls, and alarms for the continuous monitoring of operations.

Alternate Emergency Operations Centre - If the emergency condition is such that evacuation of the Main Control Centre is necessary. The alternate emergency operations centre is activated which could be the Emergency van.

Administration Building - Upon classification of the emergency, or as designated by the Public Information Co-coordinator, the Administration Building conference room will be activated as the Media Centre.

7.7.2 Equipment

Equipment is available for use during emergency situations of all types. Most of this equipment is used during normal operations and is available for emergency use. Procedures are in place to ensure the periodic inventory and restocking of emergency equipment.

A detailed list of all equipment and the appropriate locations for same is maintained in the Main Control Centre, Alternate Emergency Control Centre (Emergency Van), and Administration Building.

7.7.3 Emergency Power and Lighting

The facility (CGS) is equipped with a diesel generator, which automatically starts on the loss of off-site power to the primary bus. The DG set is sized to provide emergency lighting throughout the site, and feeds key emergency equipment, in the Main Control Centre, all key instrumentation and all facility alarms. Portable DG set is available along with the Emergency Van.

7.7.4 Fire protection and fire-fighting

The following fire handling equipment should be provided for effective control of fires at the NG distribution network:

25 kg capacity DCP type of fire extinguishers should be adequately provided all over the CGS station. A closed loop fire hydrant system should be provided at the CGS with fire fighting water supply for at least 4 hours.

The electrical fittings and fixtures at all the gas stations should be of flame proof type.

The NG pipeline should not be laid above the ground unless safety distance of 100 m is maintained between the pipeline and any inhabited areas.

There should be adequate patrolling by pipeline walkers along the route of the pipeline for ensuring safety and avoiding sabotage misuse etc. The pipeline walkers should be provided with VHF sets for easy communication.

In the event of any accident a mechanism should be provided to de-pressurize upstream and downstream of the pipeline.

An emergency squad comprising of qualified Engineers and workers should be kept standby round the clock to meet any eventuality and assist the local fire services. This squad should be equipped with necessary tools required for operating valves, stopping gas leakages etc. The squad should also carry adequate quantity of water gel blankets which is useful for touching red hot objects as well as for treating burn injuries.

Telecommunication hotline should be established between the CGS and the nearest fire station in order to reduce the response time to bare minimum.

Disaster management plan should be in place where in probable emergencies and plan of action for handling them should be indicated.

7.7.5 Mutual Aid

Mutual Aid arrangement could be with industries such as:

Ahmedabad Electricity Company Ltd.

- City Fire Services
- City Police

GAEL should enter into a written agreement with these mutual aid members wherein it should be clarified what type of assistance the members would be providing.

7.8 **Notification and Communication**

The Notification and Communication element of emergency planning deals with the equipment, methods and procedures required for effective communication during the emergency. Communication is essential for the effective co-ordination of the response actions among the different response teams and functions during an emergency. Communication is vital for implementing protective measures, such as evacuation, that may affect the general public.

In particular, communication and notification procedures are necessary for:

- Raising the alarm
- Making the emergency known
- Notifying external agencies, where required
- Establishing and maintaining communication among the different functions within the response organization at the facility, including the Emergency Operations Centre.
- Establishing and maintaining communication between the on-site emergency response organization and external agencies and other response organizations.
- Making the emergency known outside the facility, if the general public may be affected.
- Informing the media

The initial communication procedures are especially important since they determine how soon the emergency plan can be activated and also the mobilization of outside resources, where necessary.

Communications equipment must be available to each function within the response organization, to avoid communication breakdowns which could severely cripple the effectiveness of the DMP. Detailed communication procedure should also be in place not only to co-ordinate emergency actions to bring the accident under control, but also to alert the facility personnel and the public, should this become necessary.

7.8.1 On-Site

Upon the discovery of an emergency condition by facility personnel, Production personnel, or security, notification is made to the Chief Engineer/ Shift Engineer. He classifies the emergency, assumes the role of Main Controller, ensures that off-site notifications and plant manager notifications are completed, and activates the emergency response organization.

Moreover, the non-essential facility personnel and on-site visitors and contractors are also advised about the protective actions to be taken (e.g., moving to safe assembly points, taking shelter, or evacuating the facility).

7.8.2 Off-Site (Notifying External Agencies)

Depending on the type and severity of emergency, the Main Controller, at the facility should notify the appropriate external agencies. The major emergencies should be notified are:

- Law enforcement departments Factory Inspectorate, Pollution Control Board, Police station.
- Fire departments and other response teams Fire Brigade.
- Hospital and emergency medical services.
- Ambulance services.
- Local government officials.
- Local environmental agencies.
- Utility companies, such as water, sewer, public works, telephone, and electricity.

- Contractors for heavy and special machinery (Agencies identified to be indicated here).
- Suppliers of emergency equipment (injutual aid companies to be identified here).
- The broadcasting media.

The notice shall include the following information:

- The name and address of the site where the release, has occurred.
- The name, position, and telephone number of the caller.
- The gas/ fuel name of the material release, and whether or not the material is classified as an extremely hazardous material.
- The location of the point of the release, a description of the source, cause, type of release; the quantity
 and concentration of the material released and whether the release is of a continuous nature.
- Any known or anticipated acute or chronic health risks associated with the emergency and, where appropriate, advice regarding medical attention necessary for exposed individuals.
- Proper precautions to be taken as a result of the release, including evacuation.
- The name(s) and telephone number(s) of the person(s) to be contacted for further information.
- Weather conditions, including wind direction and speed, and expected off-site effects, if any.
- The emergency classification

The list of the Mutual Aid companies, their contact personnel and their numbers should be kept in the EOC.

7.8.3 Making the Emergency Known to the General Public

In a situation where the general public can be affected by the accident, two possible courses of action can be taken - evacuation or sheltering inside buildings and houses. Whichever action is decided upon, the public must be informed of it. This can be quite a challenging task, to the point of becoming nearly impossible if an effective communication procedure is not already in place. Siren system can only be effective if the public is already aware of what actions to take if the alarm is sounded. The content of the messages should be as brief and clear as possible, and provide information on the action to be taken. In addition, the public should be asked to refrain from using the telephone (to minimize the potential for line overload), and to notify neighbors of the emergency (again, without using the phone). Should evacuation be recommended, the messages should inform the public of where the designated relocation areas are, and which evacuation routes to follow.

The authority to enforce these actions to protect the public, in general is assigned to local or state officials. However, the emergency response organization should be prepared for such a course of action, and :

- Be ready to advise local officials.
- Have developed guidelines as to when to recommend public evacuation versus sheltering.
- Any known or anticipated acute or chronic health risks associated with the emergency and, where appropriate, advice regarding medical attention necessary for exposed individuals.
- Proper precautions to be taken as a result of the release, including evacuation.
- The name(s) and telephone number(s) of the person(s) to be contacted for further information.
- Weather conditions, including wind direction and speed, and expected off-site effects, if any.
- The emergency classification

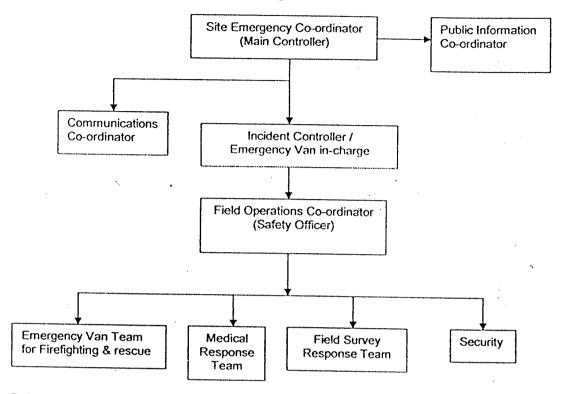
7.8.4 Press Release and Accident Reports

News of the emergency and any resulting injuries would be released to the press only by the Main Controller/ Administrative Manager.

The person responsible for this function should hold periodic press conferences, and provide accurate information, in order to avoid erroneous statements that could be made, which would have to be retracted later on. When information is not available, the person in this function should make it clear to the press as unfounded speculation or cover-up attempts are likely to become a source of embarrassment later on.

7.9 Roles and Responsibilities of key Personnel

The proposed emergency organization chart is given below:



Roles and Responsibilities for emergencies would differ depending on whether the incident has occurred On-site at the CGS or whether it has occurred Off-site in the city.

An Emergency occurring at site would be handled by the personnel on site. They are:

7.9.1 Main Controller (Chief Engineer / Site Engineer)

He shall:

- Relieve the Incident Controller of responsibility of the Main Controller.
- Analyze the emergency and decide on the emergency level (Alert, On-Site Emergency and Off-Site Emergency).
- Direct, co-ordinate and supervise the emergency response activities.
- Direct shutting down, evacuation and other operations at the facility.
- Ensure On-site and Off-site personnel protection, safety and accountability.
- Ensure that the casualties, if any, are given medical attention and that the relatives are informed if necessary.
- Arrange for relief of personnel when emergency is prolonged.
- Liaise with Off-site Emergency Response Personnel, Departments and Organizations such as Fire and Police officials and other statutory bodies and advise them of likely effects of the incident outside the facility.
- Issue authorized statement to the news media.
- Ensure preservation of evidence for inquiries to be conducted by Statutory Authorities.
- Authorize the termination of emergency situation.

7.9.2 Incident Controller (Shift Engineer)

He shall:

- Help the Main Controller organize and direct the emergency response activities, keeping in mind the safety of personnel and minimizing loss and damage to property.
- Formulate strategies and advise the Main Controller of the actions to be taken to mitigate the consequences of the accident.
- Co-ordinate the activities aimed at organizing, requesting and obtaining additional resources to support the emergency operations.
- Co-ordinate with the Security In-charge, Safety and Fire Officer.
- Check for casualties.
- Arrange for rescue of trapped workers and those in a state of shock.
- Pending arrival of Main Controller, assume his responsibilities.

7.9.3 Administrative Manager

The duties include:

- Work as a Liaison Officer during the emergency.
- Under the direction of Main Controller, handle police, press and other enquiries, receive report of roll
 call from assembly areas, and pass on the absenteeism information to the Incident Controller.
- Inform near by hospital and call for ambulance, if required.
- Maintain prior agreed inventory of emergency equipment in the Emergency Control Centre and make up for the shortages.

7.9.4 Security Function

The duties include:

- Raise the alarm.
- Inform Main Controller, Incident Controller and Administrative Manager.
- Place security guards in pre-determined posts for controlling the security.
- Ensure that media representatives are not directly admitted to Emergency Control Centre, in order to minimize unnecessary interference during emergency operations.
- Arrange for transport.
- Provide assistance in fire fighting and rescue operations.

7.9.5 Safety Officer

- He will advise the emergency staff on safety of members before implementing response actions.
- The function is responsible for minimizing the impact of an accident on the environment for which he
 would develop methodologies to control gas/ fuel leak.
- The function will also have the responsibility for determining the level of contamination of the site as a result of the accident; obtain appropriate supplies and equipment for this purpose.

In case of emergencies occurring Off-site in the city:

- The Safety Officer and/ or Emergency Van Engineer in-charge:
- Will proceed to the affected site along with the Emergency van and Emergency squad.
- Ensure that the Main Controller/ Incident Controller are informed and be in continuous contact with them.
- Inform the Fire Brigade, Police Station on the emergency telephone nos.

- Ensure that the affected gas pipeline is isolated by shutting off valves on either side of the gas leak.
- Evacuate the population within a range of 50 m all round the gas leakage area.
- Cool down the surrounding area to prevent combustibles from getting ignited.
- If necessary, allow the fire to burn under controlled conditions.
- After the fire is put off, ensure that the base is completely cool to prevent re-ignition.
- Immediately put the maintenance personnel to rectify the leak. Prior to any hot work, ensure with the help of an explosimeter that there is no flammable gas within flammable range.
- The Administrative Manger will move to the affected site and ensure that all legalities have been taken care of, all casualties have got medical attention, inform statutory bodies.
- Help the Safety Officer/ Emergency Van Engineer In-charge to prepare an Investigation Report.

7.9.6 Emergency Control Centre

Emergency Control Centre/ Van should be equipped with:

- Master plan of CGS/ City with gas pipe layout.
- Fire hydrant system layout/ location of fire stations with telephone nos.
- Layout of fire extinguishers/ DCP/ Pressurized water type of fire extinguishers.
- First-aid boxes.
- Hard back stretchers.
- Fire suits.

- SCBA (4 sets), Face shield, Safety belts, Leather gloves.
- List of Important Telephone Nos.
- Two mobile telephone sets.
- General stationery.
- PA systems.
- Emergency van should be equipped with implements for digging and carrying out repairs of gas pipeline.
- Explosimeter
- Oxygen meter
- Camera
- Fluorescent full suits and helmets.

7.10 Implementation of the Response Actions

If the fire can be attacked and is appropriate to do so, the action must begin as soon as possible. This decision should be modified during the attack, if new information leads to a new assessment of the emergency. The steps involved in the attack are:

- Evacuate the area downwind of the fire or possible vapor clouds.
- Isolate the area and remove all nonessential personnel.
- Approach the fire from upwind. The personnel involved should wear appropriate protective equipment.
- If remote isolation of the leakage is possible, provide for doing so, to avoid flammable vapor cloud formation.
- If remote isolation is not possible, and if an uninvited gas leak is present, disperse gas vapor with hose streams and attempt to shut off the flow using isolation valves.

- Do not extinguish the fire unless the leak is stopped. If remote isolation is not available, attempt to shut
- Determine whether the relief valve is operating. If it is not, withdraw personnel.
- If the relief valve is operating, listen for change in pitch level. This indicates that pressure is increasing,
- Attempt to extinguish the fire using the appropriate extinguishing agents and methods.
- Build trenches for fire water runoff, if necessary.
- Prevent spread of the fire.

Re-entry and Recovery Action Procedure

Re-entry Procedure

- 1) Verify with the Incident Controller/ Emergency Van in-charge (Field operations) that all mitigation
- Verify that personnel accountability is complete, and all personnel are accounted for.
- Determine the likely hazard for personnel re-entry by Incident Controller/ Emergency van in-charge 4)
- Determine personnel re-entry, protective clothing and equipment needs (e.g.: Fire suits).
- 5) Ensure their availability
- Brief the re-entry team on:
 - Conditions in the affected area
 - Expected actions
 - The use of protective clothing / equipment
 - Proper communication
- Ensure that re-entry actions are co-coordinated with the appropriate Off-site response agencies.
- Monitor re-entry team's communication.

Recovery Action

- Ensure emergency condition is stabilized.
- The Emergency (fire/ spill/ gas leak) is terminated.
- Fire out and fire watches are established.
- An Act of God hazard no longer exists.
- Electric power supply restored.
- All persons accounted for.
- All facility operations are under control and stable. 7)
- Develop a list of acceptable facility conditions to preclude re-initiation of an emergency condition.
- 10) For each acceptable condition not met, develop corrective action plan.
- 11) Determine resources (personnel & equipment) needed to implement the corrective action plan.
- 12) Determine non facility resources (personnel & equipment, off-site agency, mutual-aid, contract) needed
- 13) Ensure the preparation of any procedures necessary to implement this corrective action plan to include safe clean up of the facility and the removal of waste materials.

Some typical NG fire mitigation methods

NG fires are classified as 'Class C' fires.

First of all, the gas supply should be cut, the fire will extinguish automatically. If this is impossible the fires can be kept under control by use of DCP and CO2 type of fire extinguishers. It is dangerous to extinguish the gas fire as long as the gas supply is not cut, for, accumulation of gas may pose an explosion hazard.

Gas meter explosion

When handling gas meter fires, shut off the gas supply to the affected network. Gas fires should not be extinguished with a water hose stream. Gas fires should be allowed to burn and surrounding areas should be cooled until the gas can be shut off.

Gas Pipeline explosion at consumer end

The only way to extinguish a gas pipeline fire is to shut off the gas supply. After the fire is extinguished and before overhauling begins, ensure that gas and electric supplies are positively shut off.

During a serious fire, gas pipe joints may fail resulting in leakage of explosive gas. When overhauling the structure, walls and ceilings may have to be opened to examine for hidden fire spread.

Vehicle Gas Fuel tank explosion 7.12.3

When extinguishing a vehicle fire, fire-fighters should use the reach of the hose stream and stand away from the fuel gas tank. Keep the gas cylinder cool to prevent it from exploding.

Confined Areas Gas Fires / Explosions

Venting - In an industrial shed, venting a roof skylight over a burning area is one of the most effective methods of protecting fire-fighters from the blasts of an explosion. When roof conditions permit, the quick removal of a skylight by fire-fighters can vent a smoke filled shed and break up an explosion mixture, even if the smoke explosion occurs, the blast will be diverted upwards out of fire- fighters advancing hose line.

Quenching - Quenching the superheated confined fire can prevent explosion. Before fire-fighters enter a confined space/ shed where there is a suspected danger of an explosion a charged hose line should be positioned near the entrance. Fire-fighters in full protective gear should immediately discharge a hose stream into the fire area when it is opened up. This water may cool a potentially explosion atmosphere. Before air and fire-fighters can enter a burning, confined, potentially explosive fire area, the stream of a powerful water discharge might break up the explosive atmosphere. This is not as effective as roof venting, but some times it is the only alternative.

Fire on Gas Pipeline in open areas

Allow the gas to burn under controlled conditions keeping the surrounding area cool by means of water spray. Remove as much of combustible material lying in the immediate vicinity as possible. Cut off the gas supply to the pipe line before attempting to put off the fire.

If the pipe line is in a trench, do not enter the trench until it is confirmed that there is no flammable gas in the trench. This may be confirmed with the help of an explosimeter.

While repairing the pipeline, ensure that the trench and surrounding area is free of NG.