"CONSTRUCTION OF CNG STATION FOR CITY GAS PIPE LINE SYSTEM"

Submitted By

Master of Pipeline Engineering

(2007-09)

UPES, Dehradun

College of Engineering

University of Petroleum & Energy Studies

Dehradun

April, 2009

"CONSTRUCTION OF CNG STATION FOR CITY GAS PIPE LINE SYSTEM"

A thesis submitted in partial fulfilment of the requirements for the Degree of
Master of Technology
(Pipeline Engineering)

By

C.PRABHAKAR CHAKRAVARTHY

Roll: R160207010

Under the guidance of

Mr.....

College of Engineering

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Mr. R V SUBRAMANAIN

General Manager

MNGL, PUNE.

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UNIVERSITY OF PETROLEUM & ENERGY STUDIES

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CERTIFICATE

UPES Guide has ascertained quality of the project – II, Anti Plag certification etc for asserting this high quality academic activity.

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Name .....P.K. BAHL.....

Pipeline Engineering

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CERTIFICATE

This is to certify that the dissertation report titled **"CONSTRUCTION OF CNG STATION FOR CITY GAS PIPE LINE SYSTEM "** is being submitted by **Mr. C.PRABHAKAR CHAKRAVARTHY**, in partial fulfillment of the requirements for the award of the degree of MASTER OF TECHNOLOGY (Pipeline Engineering) of U.P.E.S. Dehradun. This is a bonafide record of the work carried out by him under our guidance and supervision. Further certified that this work has not been submitted for the award of any other degree or diploma.

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Date

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(Round seal of the Department)

This dissertation is accepted

External Examiner **Internal Examiner**

Date:

CERTIFICATE

This is to certify that **Mr.C.Prabhakar Chakravarthy**,student of **M.tech,University of Petroleum And Energy Studies,Dehradun**, has completed his project work on " **Construction of CNG Station For City Gas Pipeline"** during **21-March-2009 to 21-April-2009** in **MNGL,Pune**.He has completed his project work and duly submitted the report.

He is Sincere, Flexible, Competitive and also performing satisfactory. I wish him all success in his life.

Maharashtra Natural Gas Ltd
Shivajinagar
Pune-411005.

R.V. Subram
15/04/09

R V Subramanian
(GENERAL MANAGER)

DECLARATION

I hereby declare that the entire work presented in this dissertation was carried out by me under the guidance of **Mr. R V SUBRAMANAIN** and no part of this report has been submitted for any degree or diploma in any institution previously.

In keeping with the general practice of reporting scientific observations, due acknowledgement have been made wherever the work described is based on the findings of other investigators. Any omissions, which might have occurred by oversight or errors in judgement, are regretted.

Date **Signature**

C.PRABHAKAR CHAKRAVARTHY
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ACKNOWLEDGEMENT

I am greatly indebted to my guide **Mr. R V SUBRAMANAIN,** General Manger (E&P), ***MAHARASTRA NATURAL GAS LIMITED,*** PUNE, for providing me an opportunity to work under his guidance. His unflinching support, suggestions and directions have helped in smooth progress of the project work. He has been a constant source of inspiration in all possible ways for successful completion of my project work.

I acknowledge my sincere gratitude to **Mr.R.J.Ram, Sr Manager (Projects) and Mr.C.Shanthi Sagar, Sr Manager (Planning)**, *MAHARASTRA NATURAL GAS LIMITED,* PUNE, for providing information and guidance to complete this dissertation work successfully.

I also acknowledge my sincere gratitude to employees of the ***MAHARASTRA NATURAL GAS LIMITED,*** for their support and cooperation throughout my project work.

I also acknowledge the support given by **MANAGING DIRECTOR, MR. SHAMA SUNDARA** and **DIRECTOR (COMMERCIAL), MR. K L THUSSU** of ***MAHARASTRA NATURAL GAS LIMITED.***

Finally, I would like to thank my family for their constant support. It would have been impossible for me to accomplish this study without their support.

C.PRABHAKAR CHAKRAVARTHY.

ABSTRACT

If gas has to be supplied or transfer through pipelines, the supply of gas can be done with help of compressors. In city gas pipeline system compressors are used to compress the gas from 19kg/cm2 to 250 kg/cm2 for supplying sufficient compressed gas supply for vehicles and industries.

The compressor stations are the heart and soul of city gas distribution system.CNG supply to vehicles, industries and other stations are to be done from compressor station itself.CNG compressor station activities mainly consist of two types one is construction of station according to civil design and the second one is arrangement of equipment which are required for CNG Production and Distribution.

INDEX

INTRODUCTION TO MNGL

- MNGL is a joint venture company of GAIL (India)Ltd. & BPCL
- Main objective of MNGL is to set-up CGD infrastructure and provide eco-friendly fuel and service in the state of Maharashtra
- This will include:
  - CNG for automotive sector
  - Supply of PNG to domestic and commercial sector
  - Provide eco-friendly and clean fuel for industrial sector.

ABOUT MNGL

- **Maharashtra Natural Gas Ltd.,** is a company incorporated in January 2006

Areas Covered: Maharashtra other than Mumbai/Navy Mumbai/Thane districts.

MNGL is engaged in city gas distribution (PNG & CNG) in Pune including Pimpri and Chinchwad.

Our Stations

- **Mother Station** (Chinchwad)
- **Daughter Booster Stations**
  - Ishwar Service Station (Lulanagar near Kodhwa)
  - Vardhman Petrol Depot(Warje)
  - Om Sai Ram (Pimple Saudagar)
  - Sai Express (Thathewadi)
  - Samarth (Hinjewadi)
  - Sheetal (kondhwa)
- **Online Station**

Gas (CNG) Supply is done to PMPML mainly to areas such as Natawadi, ,Kothrud, Hadapsar, Katraj, Sant Tukaramnagar(Pimpri-Chinchwad)

Maharashtra Natural Gas Limited

Maharashtra Natural Gas Limited (MNGL), is incorporated in January 2006 as per the directives of Ministry of Petroleum and Natural Gas, Govt. of India to implement City Gas Distribution Project in Pune including Pimpri-Chinchwad for supply of Compressed Natural Gas (CNG) to Automobiles and Piped Natural Gas (PNG) to Domestic, Commercial and Industrial consumers.

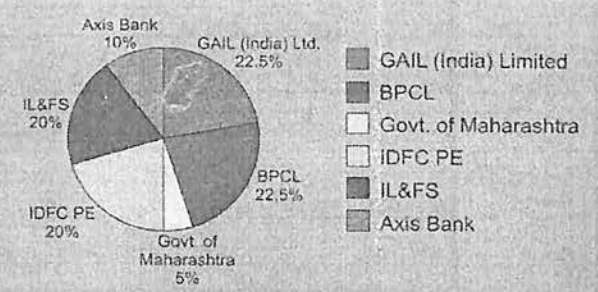
MNGL is a joint venture Company of two navratna PSUs viz. GAIL (India) Limited (GAIL) and Bharat Petroleum Corporation Limited (BPCL) with the mission to supply clean and green (eco-friendly) fuel to the cities of Pune and Pimpri-Chinchwad.

Objective

- To provide clean, environment friendly green fuel as an alternative to the conventional auto fuels like Petrol and Diesel;
- To provide safe, convenient and reliable piped natural gas to its customers in the domestic, commercial and industrial sectors.

Equity Structure

GAIL (India) Limited	22.5%
BPCL	22.5%
Govt. of Maharashtra	5%
IDFC PE	20%
IL&FS	20%
Axis Bank	10%



MNGL STACK HOLDERS:

- GAIL : 22.5 %

BPCL: 22.5 %

Govt of Maharashtra: 5%

IL & FS: 20% - in process

IDFC: 20% - in process

Axis Bank: 10% - in process

- <u>Pricing</u>

Rs 28/Kg - Pimpri-Chinchwad

Rs 28.25/Kg –Pune

KNOWLEDGE OF NG/CNG/PNG:

- NG – is mainly methane (85%-91%)
- CNG – is natural gas compressed to 200-250 bar
- PNG – piped natural is a fuel supplied through pipeline for the use of domestic commercial and industrial sector

TYPICAL COMPOSITIONS OF CNG:

Methane	70-90%
Ethane	0-20%
Propane	
Butane	
Carbon dioxide	0-8%
Oxygen	0-0.2%
Nitrogen	0-5%
Hydrogen sulphide	0-5%
Rare gases	Trace

CITY GAS DITRIBUTION INFRASTRUCTURE:

Major Constituents of CGD are

- City Gate station
- Pipelines
  - Steel Pipelines
  - Poly Ethylene Pipelines
  - GI / Cu Pipes
- Regulating Stations
- CNG Stations

CNG AS AUTOMOTIVE FUEL:

- Environmental Friendly Fuel
- Safe for vehicles
- Low operating cost
- Increases components / consumables life
- Improves country economy
- No adulteration possible

COST SAVING WITH CNG:

	Conversion cost (Rs.)	Distance Covered (Km/day)	Savings (Rs/km)	Payback Period (Months)
r (petrol)	30000	80	2.53	5
xi	30000	150	2.53	2.64
ito (Petrol)	22000	200	1.09	3.36
is (Diesel)	300000	250	6.33	1.5

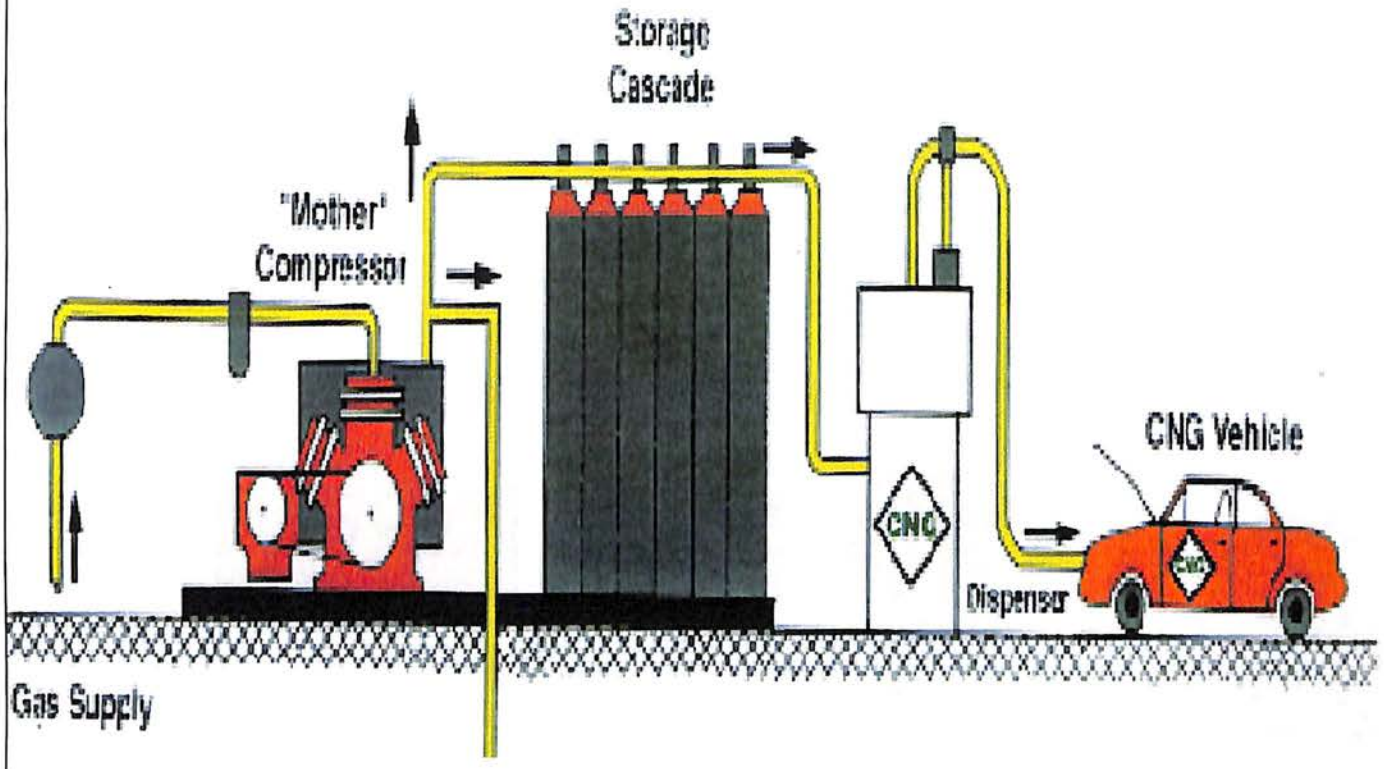
Fuel Prices:	
CNG	28 Rs/kg
Petrol	55 Rs/ltr
Diesel	40 Rs/ltr

	HSD	PETROL	CNG
Bus Mileage	2.5km/ltr		4km/kg
Car Mileage		14km/ltr	20km/kg
Auto Mileage		30km/ltr	38km/kg
Taxi Mileage		14km/ltr	20km/kg

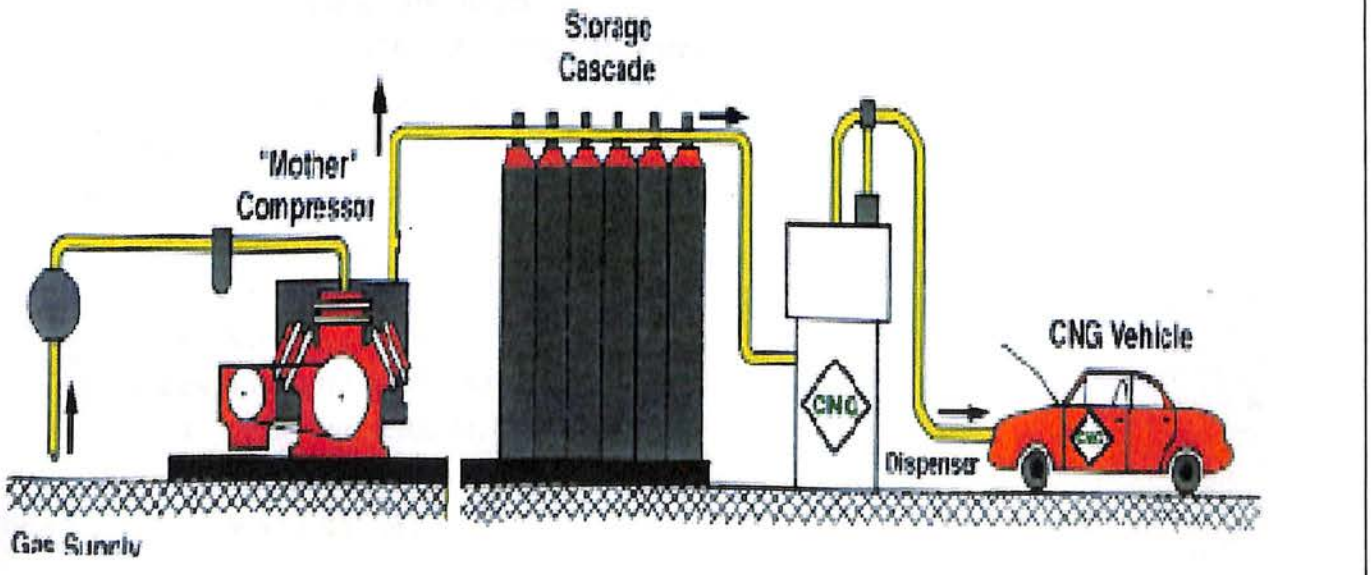
CNG STATION TYPES:

1) MOTHER STATION
2) ON LINE STATION
3) DAUGHTER BOOSTER STATION

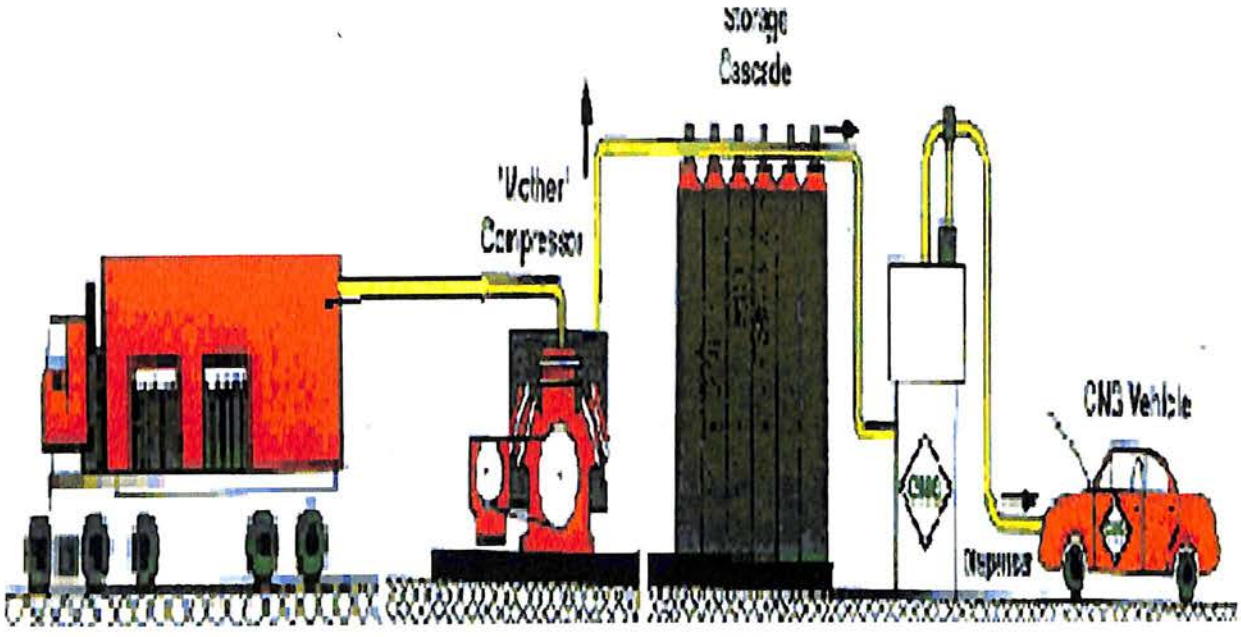
- **MOTHER STATION**



- **ON LINE STATION :**



- **DAUGHTER BOOSTER STATION**

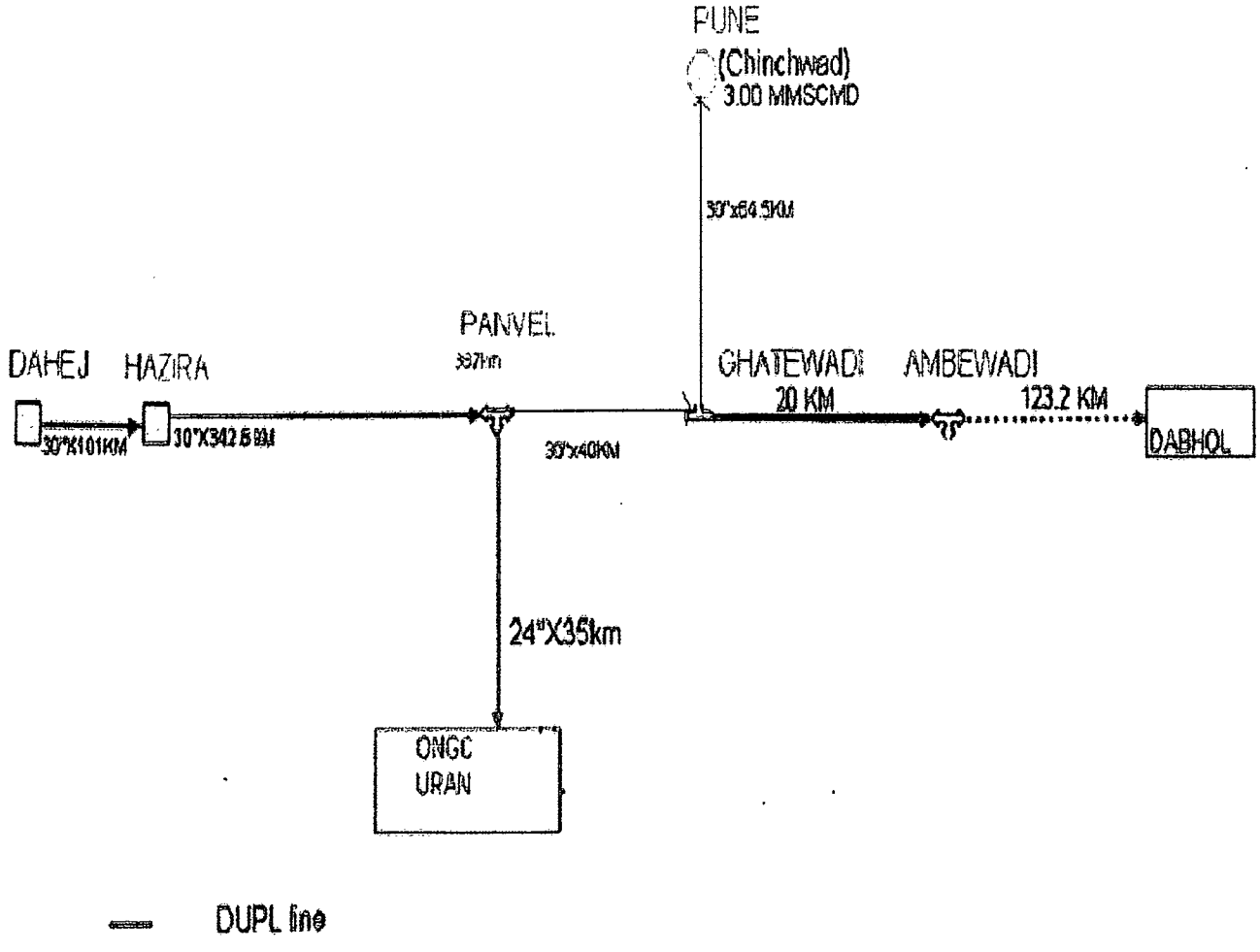


FINANCIAL ANALYSIS OF MNGL

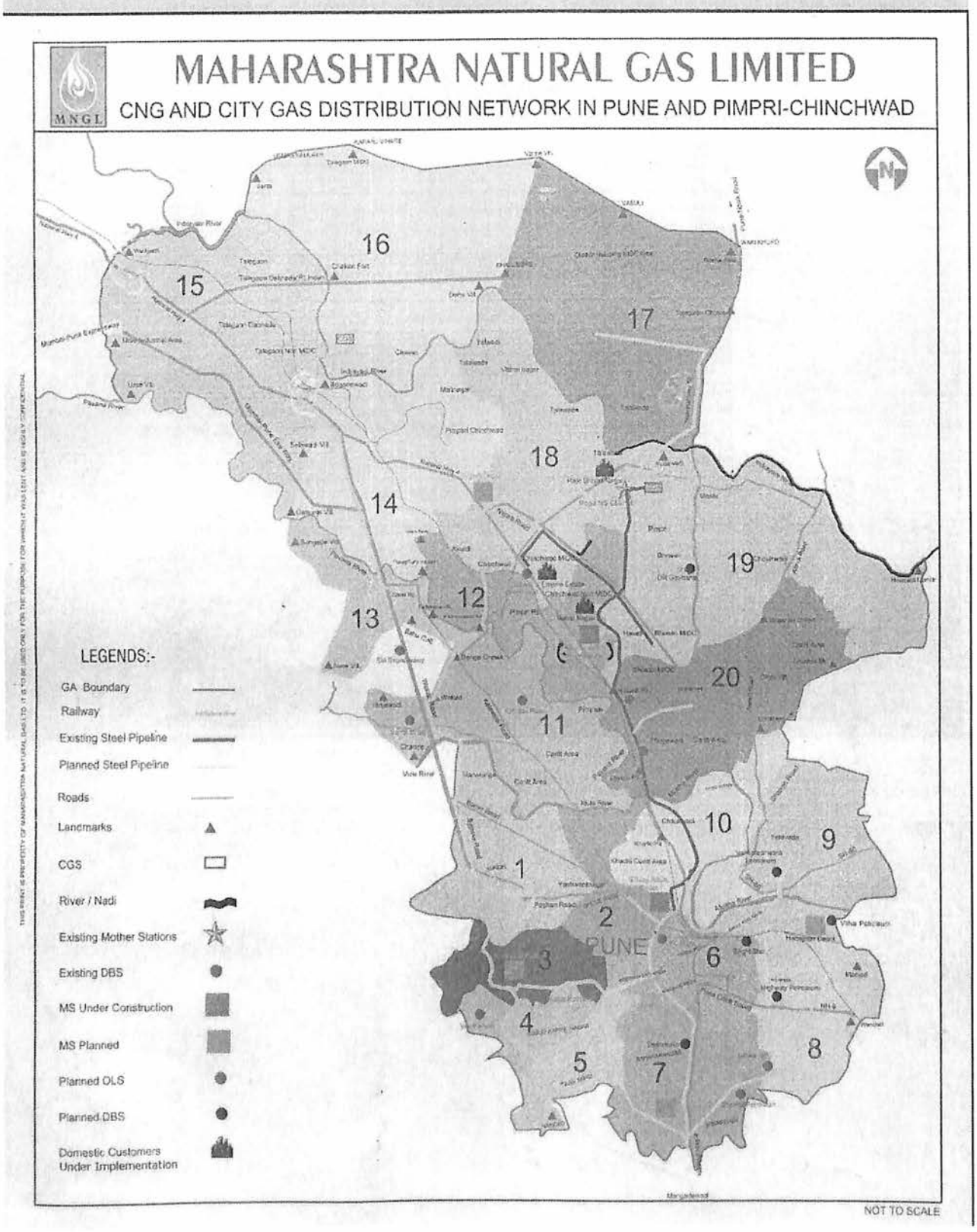
- Authorized Capital : 100 crores
- Equity Capital by GAIL & BPCL : 45 crores
- Maharashtra Govt. : 5 crores
- Pvt. Investors : 50 crores
- Price of CNG in Pune : Rs. 28.25
    - Basic Price : Rs. 21.95
    - Excise Duty : Rs. 3.16
    - VAT : Rs. 3.14
- Prices in Pimpri-Chinchwad:Rs. 28.00
    - Basic Price : Rs. 21.75
    - Excise Duty : Rs. 3.14
    - VAT : Rs. 3.11

PIPE LINES OF MAHARASTRA NATURAL GAS LIMITED:

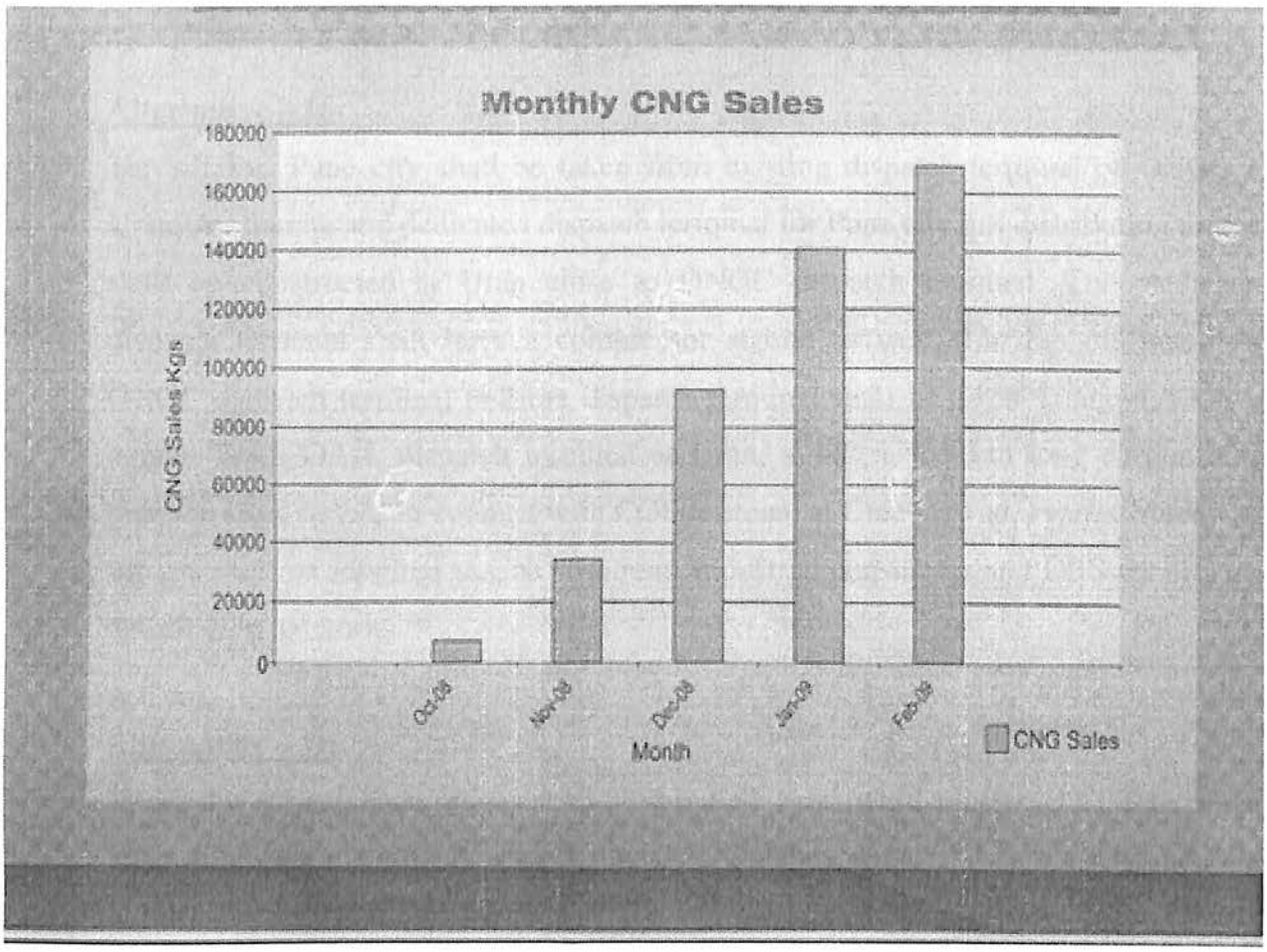
1) BELOW FIG SHOES THE GAS PIPE LINE OF GAIL SUPPLYING GAS TO MNGL PUNE.(PIPE LINE IS COMING FROM DAHEJ TO PUNE)



MNGL PIPELINE ROUTE MAP FOR THE CITY GAS DISTRIBUTION IN PUNE:



MONTHLY CNG SALES AT PRESENT FOR MNGL:



1. SYSTEM DESCRIPTION

To meet the projected gas demand for Pune City Gas Distribution for Automobile, Industrial, Commercial and Domestic sector consumption, following alternative are studied as desired by GAIL.

Alternative – I:

Tap off for: Pune city shall be taken from existing dispatch terminal of ONGC at Uran. A separate and dedicated dispatch terminal for Pune city gas distribution project shall be constructed at Uran close to ONGC dispatch terminal. This dedicated dispatch terminal shall have a compressor station as well. The tap off line from ONGC dispatch terminal to Uran dispatch terminal shall be 14" OD and 1.5 km in length. From GAIL dispatch terminal at Uran, a 14" x 135 km long carbon steel pipeline shall be laid to connect with CGS terminal at Chinchawad. From Chinchwad, the gas shall be supplied to CNG Stations, industrial consumers and DRS for city gas distribution network.

Alternative – II:

Under this scheme, natural gas shall be supplied directly at Chinchwad CGS terminal. From CGS, the gas shall be supplied to CGS Stations, Industrial consumers and DRS for city gas distribution network.

2. Feeder Line (Only Under Alternative – I)

3. Feeder Line (From ONGC terminal to dispatch terminal at Uran)

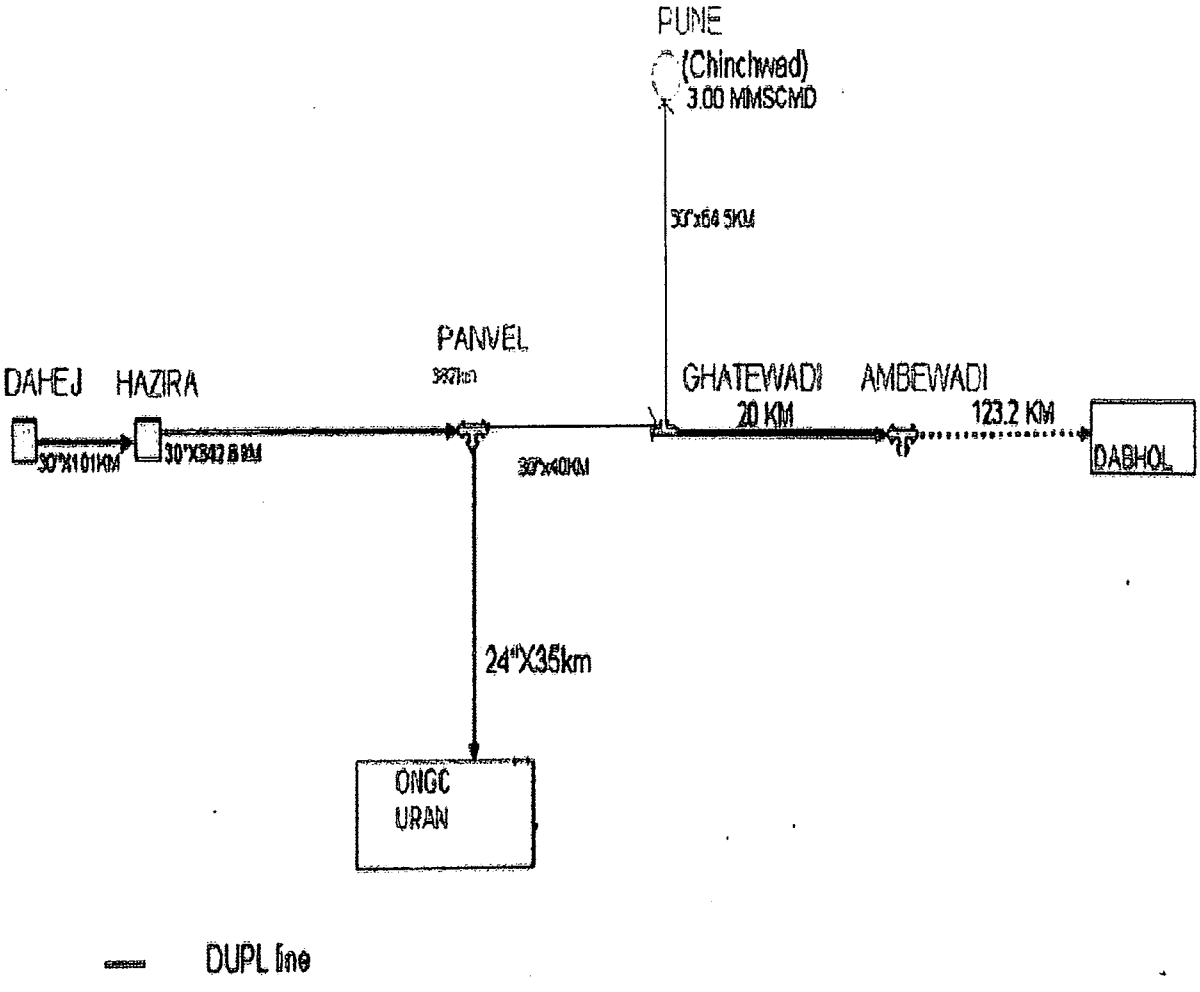
The proposed steel pipe line from ONGC terminal to dispatch terminal at Uran shall be of 14" ϕ and 1.5 km long. This pipeline will deliver the gas to the compressor station a pressure of 25kg/cm^2 (g).

Feeder line (from dispatch terminal at Uran to CGS Chinchwad)

The proposed steel pipeline from dispatch terminal cum compressor station at Uran to CGS Chinchwad shall be 14" ϕ and 135 km long. The pipeline route shall have provision for 1 no. Intermediate Pigging Station (IP station) and 3 Nos. SV Stations. The IP Station shall be located at distance of 90 kms from dispatch terminal and shall

have facility for launching/receiving pigs through scrapper launcher and receivers. Besides, these stations shall also have facility for cold venting and to control gas actuated vales for isolation of the line. The SV Stations SV 1 and SV 2 shall be located at distance of 30 kms and 60 kms from dispatch terminal at Uran. The third SV Station SV-3 shall be located at distance of 24 kms from IP Stations. All the IP and SV Stations shall have SCADA provisions.

DIAGRAM BELOW SHOWS THE GAS SUPPLY TO MNGL BY GAIL FROM DAHEJ TO PUNE PIPE LINE:



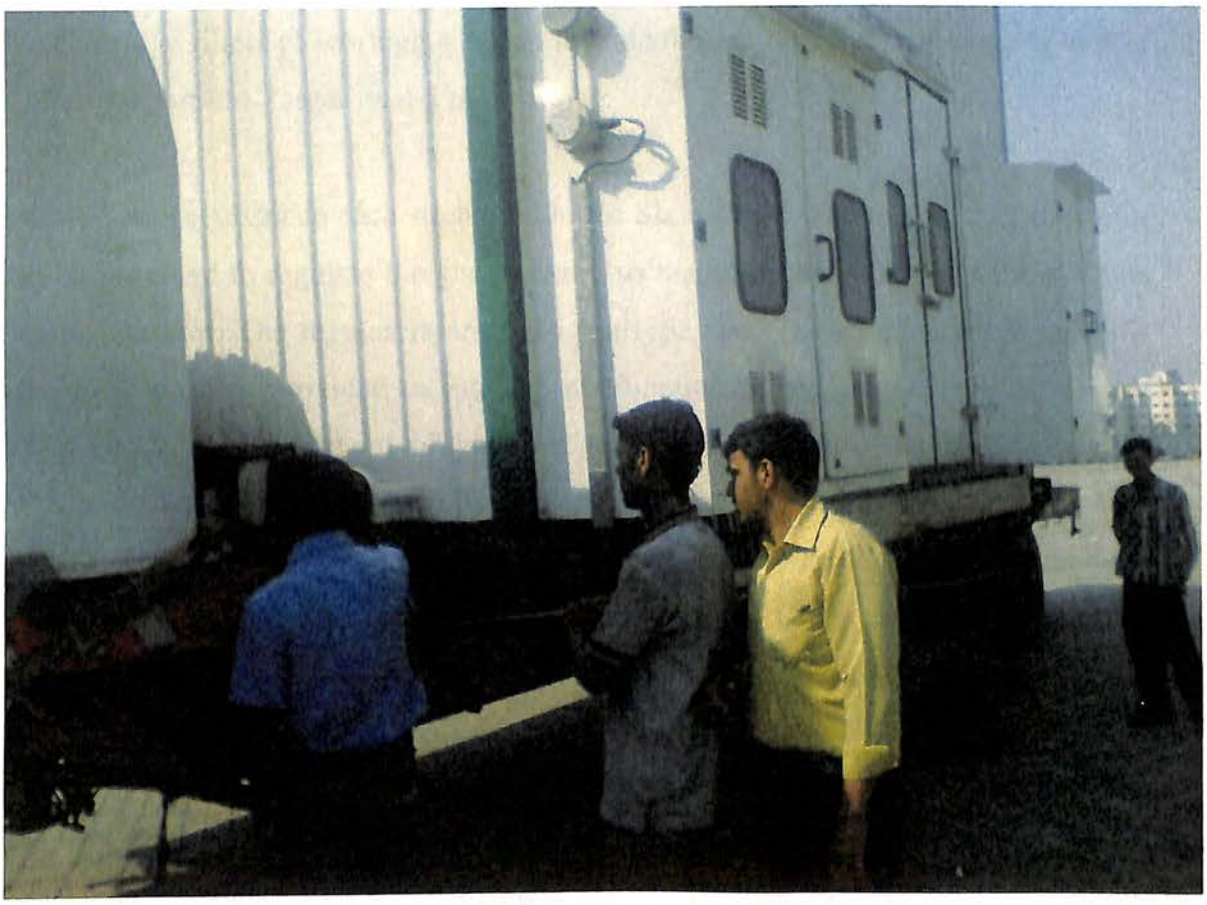
Compressor Station and Dispatch Terminal

A compressor station cum dispatch terminal is proposed to be installed at a new plot in Uran. The dispatch terminal shall have a designed capacity of 2.5 MMSCMD and on deliver on outlet pressure of 80 kg/cm^2 (g). The dispatch terminal shall have the following major facilities.

- Compressor Station
- Gas Actuated Ball Valve
- Ball Valves
- Plug Valves
- Flow Tee
- Insulating Joint, Pig Signaller & QOEC

Compressor Station

3 Nos. of centrifugal compressors each of capacity 1.50 MMSCMD have been envisaged i.e. in Ph-I and 1 No. in Ph-II. During Ph-I one No. compressor will be working and 2nd Compressor will be standby. The centrifugal compressor will be driven by gas turbine and would compress the natural gas from present pressure of 25 $kg/ck^2(g)$ to 80 $kg/cm^2(g)$. A set of gas conditioning cascade will also be provided along with other auxiliary system such as water, compressed air, electrical power, interconnecting piping and cabling, electrical and instrumentation. The gas compressor station will include compressors, control room, handling facilities and other infrastructure.



City Gate Station (CGS)

- Gas actuated Isolation Valve
- Cartridge Filters
- Pressure regulators
- Stam Shut Valve
- Mass Flow Meter
- Flow Control Valve with by-pass valve
- Cold Venting Facility
- Pressure Safety Valve
- 2 Nos. of Tap-offs.
- Control Room with UPS, Battery Bank, Control Panel and SCADA provision.

Two Cartridge filters (1 working + 1 standby) shall be provided to remove all the dust and foreign particles larger than 5 micron size.

One pressure regulator in each stream with one Slam shut valve upstream of regulator shall be provided to regulate the gas pressure so that the gas supply to main grid line remains constant. The regulators are fall open type and Gas actuated. High and low indications are also provided to indicate malfunction of regulators. In the event of high pressure at downstream of pressure regulator, the upstream slam shut valve closes with an alarm for closure. The set pressure of slam shut valve shall be kept slightly higher than set pressure of Pressure control valve. The set pressure of standby Regulator shall be kept slightly higher than set pressure of the operating Regulator. The stand by Regulator is closed under normal operation and becomes operative automatically in the event of failure of the operating Regulator.

Mass flow meter of Turbine type will be provided to measure mass flow rate. Flow, temperature, pressure and density shall be telemeter through SCADA.

One number **Flow control valve** with bypass arrangement shall be provided. The function of flow control valve is to regulate gas flow requirement of the main grid line.

Main Grid Line

Phase – I consists of the following steel pipelines

- 12" ϕ x 15 km - From CGS Chinchwad to Ring Main in Pune City
- 10" ϕ x 20 km - Ring main within Pune City
- 6" ϕx 20 km - Spur lines from main grid/ring main to CNG Stations and DRS

Phase – II consists of the following pipelines

- 6: ϕ x 6.0 km - Spur lines from main grid/ring main to CNG Stations and DRS

Sectionalizing Valve Station (SV Station)

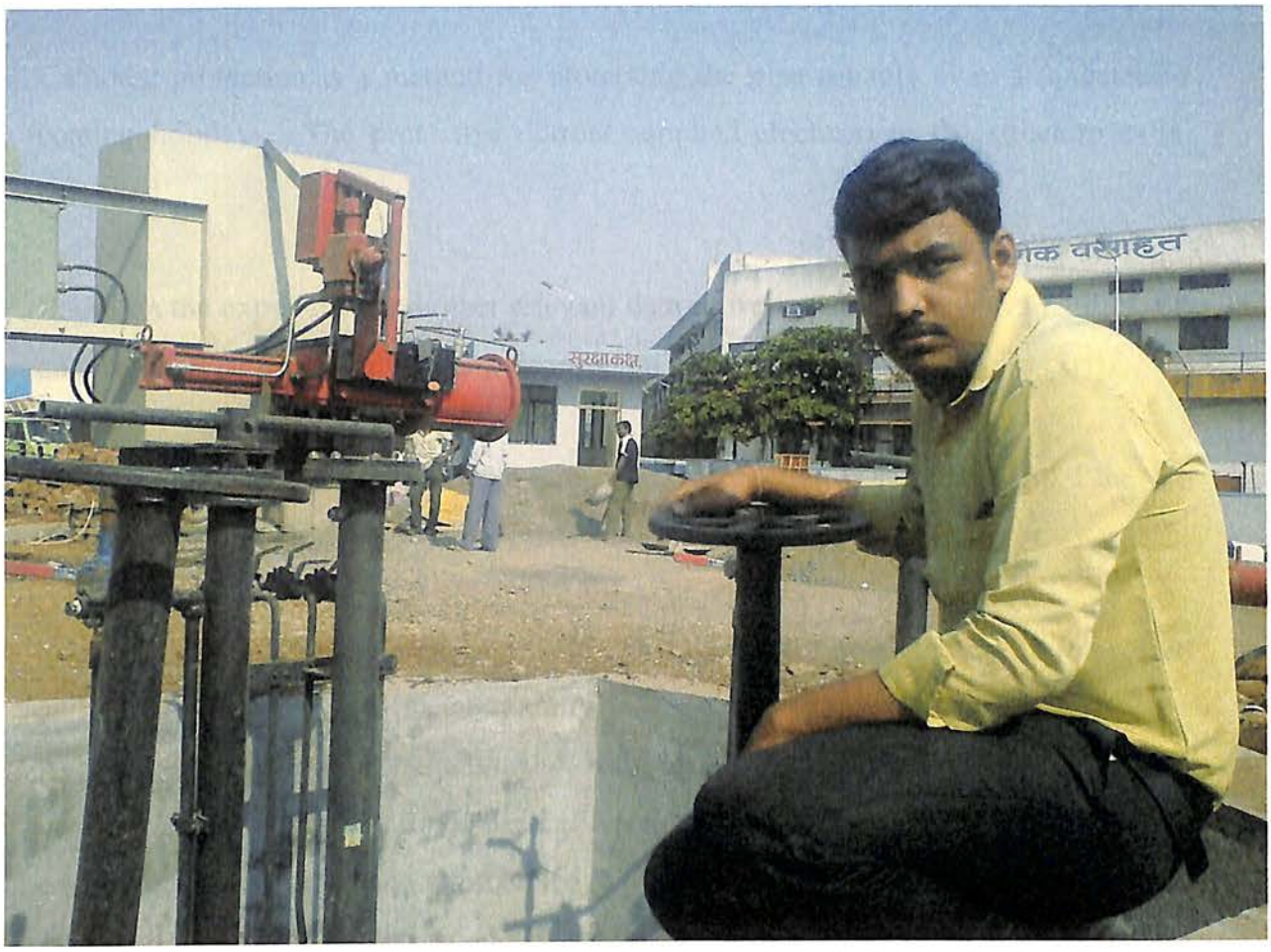
The Sectionalizing Valve station shall have following features:

- Sectionalizing valve
- Tap-Off on upstream (future provision
- Cold Venting facility

SV shall be reduced bore ball valve with extended stem.

4" tap-off for 12"/10" ϕlines and 2" tap-off for 6" ϕshall be provided for future use. Provision shall be made for safe flow down of gas in to the atmosphere through QOEC. A vent pipe of minimum 3 m height above ground and located at a suitable safe distance from the valve assembly shall be provided.

To install the facilities a plot size of 5m x 5m shall be required.



Cathodic Protection (CP) System

For efficient and satisfactory functioning of the main grid line system, both from safety and economic point of view, the pipeline must be protected against corrosion.

External protection shall be provided for prevention of pipeline corrosion. This external protection shall be a combination of corrosion coating and cathodic protection techniques. Conventional coating of pipelines by 3 layer Polyethylene (PE) coating shall be used as "passive" protection.

Complete corrosion protection cannot be achieved practically by coating, as it is impossible to fully avoid minor defects such as pores or cracks in the coating. Welded pipelines are particularly subject to corrosion at coating holidays because of their low longitudinal resistance, i.e., they practically do not resist the flow of current through the pipeline. At these holidays, dangerous pitting corrosion is initiated. Because of the high corrosion current density, this phenomenon often causes rapid corrosion failure.

Cathodic protection is a method for protecting the pipe reliably even at undetected coating holidays. The protective current supplied electrons to the structure to be protected.

Based on the experience and other relevant data as well as indigenous availability, PE coating shall be provided as external corrosion coating for the pipeline.

Salient features of the CP system proposed for Feeder Line/Main Grid Line are described as follows:

i) The proposed main grid line shall be catholically protected by an impressed current CP system as a permanent facility.

ii) Necessary measures shall be adopted to mitigate stray current interference due to the nearby electrified railway track and the interference along the proposed line and the existing lines (protected and unprotected that may exist in and around the ROW).

iii) Temporary Cathodic Protection (TCP) shall be provided during construction phase of the proposed line by suitable means.

iv) All the cased road crossings shall be provided with proper insulating separators, end seals and vent pipes. The casings shall be coated. Carrier portions inside the casings shall be independently protected by sacrificial anodes, wherever necessary.

v) Minor crossings need not be insulated but extra care in their protection shall be exercised.

vi) For monitoring purposes, test stations shall be installed at approximately 1 km interval. In addition, test points shall be provided at all crossings and near insulating joints. Central monitoring station shall be located at the CGS through a Remote Terminal Unit (RTU).

vii) Interference effects, wherever suspected or observed shall be duly investigated and remedial measures provided, wherever necessary.

viii) Insulating joints shall be provided on the proposed line at all necessary locations where electrical insulation is desirable such as at CGS and DRS. The grounding cells will also be installed at each location.

SCADA System

SCADA System shall be provided to ensure effective and reliable control, management and supervision of the pipeline from a centralized location using remote terminal units (RTUs) located along the pipeline at suitable locations.

The pipeline shall be monitored and controlled from central SCADA System Control centre located at the CGS.

The SCADA System Control Centre shall be inter-locked through fibre optics cable with remote terminal units (RTUs) located along pipeline. RTUs will be used for scanning and telemetering of pipeline parameters such gas flow, temperature, pressure, valves status, CP parameters, etc., to update the computer data.

CNG Distribution Network

Natural Gas shall be transported from CGS to Compressed Natural Gas (CNG) Stations through main grid pipeline described above.

CNG Stations

The following CNG stations are planned in Pune city for catering to the demand of automobile sector: (for details refer Drawing No. MEC/23A4/05/62/M/005/0002).

In Phase – I

- Six Nos. Mother Stations (2 compressors of 1200 SCMH each) each on own plot.
- Two Nos. Mother Stations (3 compressors of 1200 SCMH each) each at existing city bus depot.
- Six nos. On-line Stations (6 compressor of 1200 SCMH each) each on own plot.
- Six nos. On-line stations (6 compressors of 500 SCMH each at existing petrol/diesel retail outlets.
- One No. On line Station (1 compressor of 1200 SCMH) on existing city bus terminal.
- Eight Nos. Daughter Booster Stations (8 booster compressors of 150 SCMH each) at existing petrol/diesel retail outlets.

In Phase - II

- Augmentation of 6 Nos. existing Mother Stations (1 compressor of 1200 SCMH each) of Ph-I on own plot.
- One No. Mother Station (3 compressors of 1200 SCMH each) at existing city Bus depot.
- One no. On line Stations (1 compressor of 1200 SCMH) on own plot.
- Ten Nos. of Daughter Booster Stations (10 booster compressors of 150 SCMH each) at existing petrol/diesel retail outlets.

Mother Station

The following units have been envisaged in each Mother Station:

A. Main Equipment

i) Mother Compressor along with auxiliaries

ii) Dispensers for buses

iii) Dispensers for cars and three-wheelers (autos)

iv) Loading facility for Mobile Cascades

v) Stationary Cascades

vi) DG Set, UPS & Battery Bank, AVR, Electrical Control Panel

vii) Instrument Air and Water Facilities

viii) Metering skid

ix) Fire Fighting equipment and safety sign

B. Other Facilities

i) Office cum Control Room

ii) RCC forecourt, canopy over dispenser island and signages

iii) Stainless steel tube connecting compressor, dispenser & cascades laid in U/G trenches

iv) U/G drainage and sewerage network

v) Approach/exit road, boundary wall etc.

Note: In case of Mother Station at bus terminal only required equipment and facilities are planned.

On line Station

The following units have been envisaged in each On-line station:

A. Main Equipment

i) On line Compressor along with auxiliaries

ii) Dispensers for cars and three wheelers (autos)

iii) Stationary Cascades

iv) DG Set, UPS & Battery Bank, AVR Electrical Control Panel

v) Instrument Air and Water Facilities

vi) Metering skid

vii) Fire Fighting equipment and safety sign

B. Other Facilities

i) Office –cum-Control Room

ii) RCC Forecourt, canopy over dispenser island and signages

iii) Stainless steel tube connecting compressor, dispenser & cascades laid in U/G. trenches

iv) U/G drainage and sewerage network

v) Approach/exit road, boundary wall etc.

Note 1. Depending on development of the On-line Station at green field location or at Retail Outlets of Oil Company, the facilities as listed above shall be considered.

2. In case of On-line Station in bus terminal only required equipment and facilities are planned.

Daughter Booster Station

The following units have been envisaged in each Daughter Booster Station:

A Main Equipment

i) Booster Compressor along with auxiliaries

ii) Dispensers for cars and three wheelers (autos)

iii) Stationary Cascades

iv) DG Set, UPS & Battery Bank, AVR, Electrical Control Panel

v) Instrument Air and Water Facilities

vi) Fire Fighting equipment and safety sign

vii) Unloading facility from mobile cascades

C. Other Facilities

i) Office cum Control Room

ii) RCC Forecourt, canopy over dispenser island and signage's

iii) Stainless steel tube connecting compressor, dispenser and cascades laid in U/G. trenches

iv) U/G drainage and sewerage network

v) Approach/exit road, boundary wall etc.

Note Daughter Booster Station will be developed at Retail Outlets of Oil Company, the facilities as listed above shall be considered.

Equipment Description

A) Mother Compressor :

Reciprocating type compressors, each of capacity 1200 SM^3 /hr at suction pressure 19 Kg/cm^2 shall be installed at mother station. Approximate gas consumption of gas engine will be 55 SM^3 /hr. The compressor will start automatically in case cascade pressure falls less than 210 Kg/cm^2 and will unload at pressure 255 Kg/cm^2.

Main Specification/Features

- 3 stage reciprocating type compressor with console type air cooling and safety relief valve at each stage, after cooler at final discharge along with all services lines, tubing, valves, instrument and auxiliaries.
- Gas engine with air and coolant/water based cooling system; gas flow meter with electronic volume corrector, totalize and associated equipment.
- Control system will ensure unattended safe operation in automatic mode. The priority fill system will ensure maximum flow rate by filling of vehicle, storage cascade and mobile cascade in assigned order.
- Entire compressor equipment shall be mounted on one skid and packaged in an acoustically insulated housing.
- The engine and the compressor will be housed in the same package unit with a partition wall. The housing will provide a degree of protection equipment to IP 44 as per AS1939. The housing will be flame and fire proof and provided with forced ventilation, flame arrestor, infrared flame detection and alarm system, automatic shutoff, automatic CO_2 flooding and other fire retardant features.
- The compressor will be provided with the required control system using PLC; air compressor for start up and pneumatic control; instrumentation and controls; emergency shutdown device and electric supply system.
- The entire compressor system shall be earthed.

B) On-line Compressor

Reciprocating type compressors each of capacity 500 SM^3 /hr at suction pressure 19 Kg/cm^2 shall be installed at On-line station. Approximate gas consumption of gas

engine will be 30 SM^3/hr. The compressor will start automatically in case cascade pressure falls less than 210 Kg/cm^2 and will unload at pressure 255 Kg/cm^2.

Air receiver and air compressor of suitable capacity shall be provided to meet the compressed air demand for gas engine starting and pneumatic control.

One priority fill system will be provided in the compressor to priorities the dispensing to car dispenser, stationary cascade (of capacity 3000 litres of water).

The packaging and safety features shall be in line with Mother Compressor.

C) **Booster Compressor**

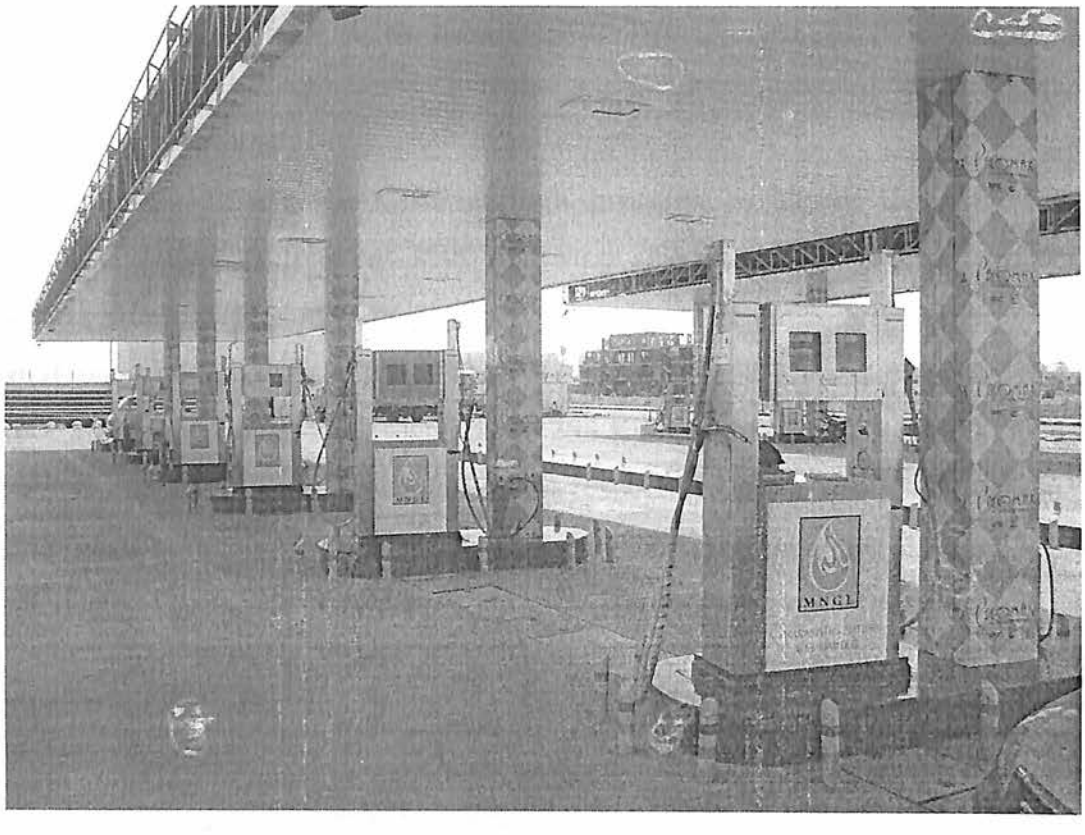
To increase the dispensing speed and reduce waiting time for filling at daughter station and better utilization of cascade capacity, one hydraulic/reciprocating type electric motor driven compressor of capacity 150 SM^3/hr at suction pressure of 30 Kg/cm^2 has been envisaged at daughter station. This booster compressor shall operate at mobile cascade pressure/suction pressure from 30 to 200 Kg/cm^2 with discharge pressure of about 255 Kg/cm^2.

D) **Dispensers**

Compressed natural gas from compressor/cascade shall be dispensed to NGVs (natural gas vehicles) such as cars, three wheelers, buses, etc. through dispensers. Following two types of dispensers have been envisaged.

Bus Dispenser

To meet the requirement of bus filling at mother stations, single arm bus dispenser, each of capacity 80 Kg/min has been envisaged. The system shall be designed in such a way that when compressors are in operation, the bus dispenser will take about 65 Kg/min gas from the compressor.



Car Dispenser

To meet the requirement of car and three wheeler filling at mother; on-line and daughter stations, double arm type car/auto dispensers, each with a capacity of 15 Kg/Min have been envisaged. At the Daughter Booster Station, provision shall be kept to install one car dispenser in future.

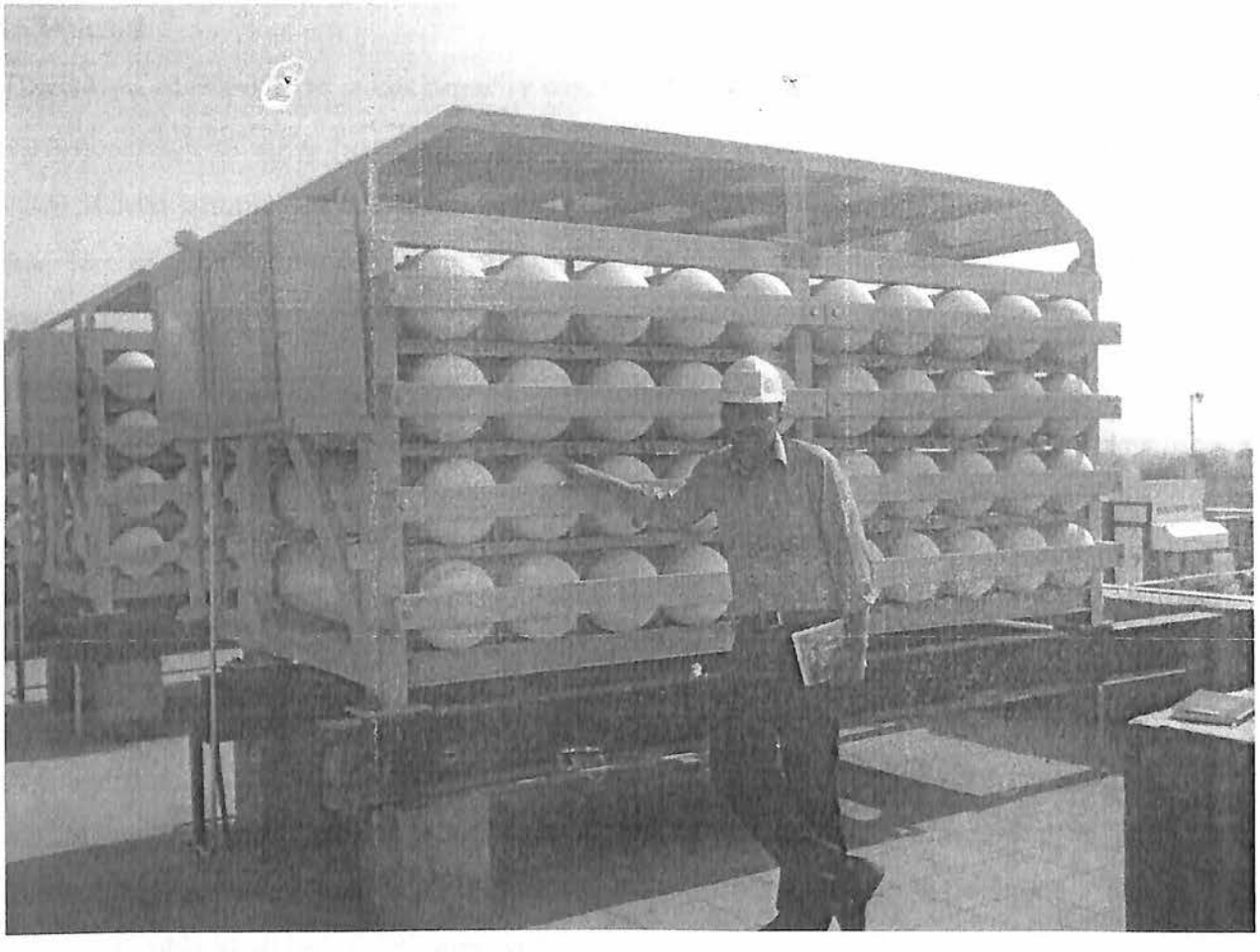
Main Specification/Features

- The car dispenser shall have two arms and bus dispenser shall have one arm for dispensing the gas.
- 'Coriolis' true mass flow metering system or equivalent with necessary sensor and electronics shall be provided with provision of liquid crystal backlit display for night viewing which will show unit price of CNG in Rs=NP/Kg, quantity of gas sold in Kg and total sale in Rs=Np. A tamper proof totalize shall be provided.
- PLC based sequencing software and controller including hardware along with ball valves associated with pneumatic actuation for dispensing of gas shall be provided.
- Two CNG flexible electricity conductive twins fill and vent hoses with two NGV-1 types -2, Class – A fill nozzle with captive vent including 3 ways vent shall be provided.

- All dispensers shall be earthed.

E) Stationary Cascade

Cascades are used to store the CNG at high pressure, to absorb the surge of reciprocating compressor, frequent start and stop of compressor and to supply additional gas when dispensing rate is more than compressor capacity. Compressor will start if pressure in cascade falls below 210 Kg/cm^2 and stop at pressure 255 Kg/cm^2.For a pressure range of 220 Kg/cm^2 to 255 Kg/cm^2, in cascades of 3000 litre and 2200 litre capacity, about 90 kg and 65 kg respectively, of useful CNG can be stored. The maximum storage capacity of these cascades is approx. 600 kg. And 350 kg respectively. The cascade shall supply gas to bus as well as car/auto dispensers.



Main Specification/Features

- Cascade shall be made of group of cylinders fixed with structural steel frame having facility of lifting and placement.

- The cylinder and their neck threading shall be designed as per IS: 7285-1988 & IS: 3224-1979, respectively, and approved by Chief Controller of Explosives (CCOE), government of India.
- The cylinder shutoff valve shall be with fusible disc confirming to requirement of IS: 3224 or CCOE approved.
- All end connections for quick release couplings, PG, valves and fitting of cascade shall be within tamper proof enclosure. These shall be on one side of cascade for ease of operation.

Following capacities of cascades have been envisaged for different types of stations.

In Phase-I

- Three Nos. of 3000 litres water capacity cascades for each Mother Stations.
- Two nos. each of 3000 litres water capacity cascade for one no. On-line Station of 1200 SCMH compressor capacity.
- One No. of 2000 litres water capacity cascade each on line Stations of 500 SCMH compressor capacity.
- One no. of 2200 litre water capacity for each Daughter Booster Station.

F) **Mobile cascade**

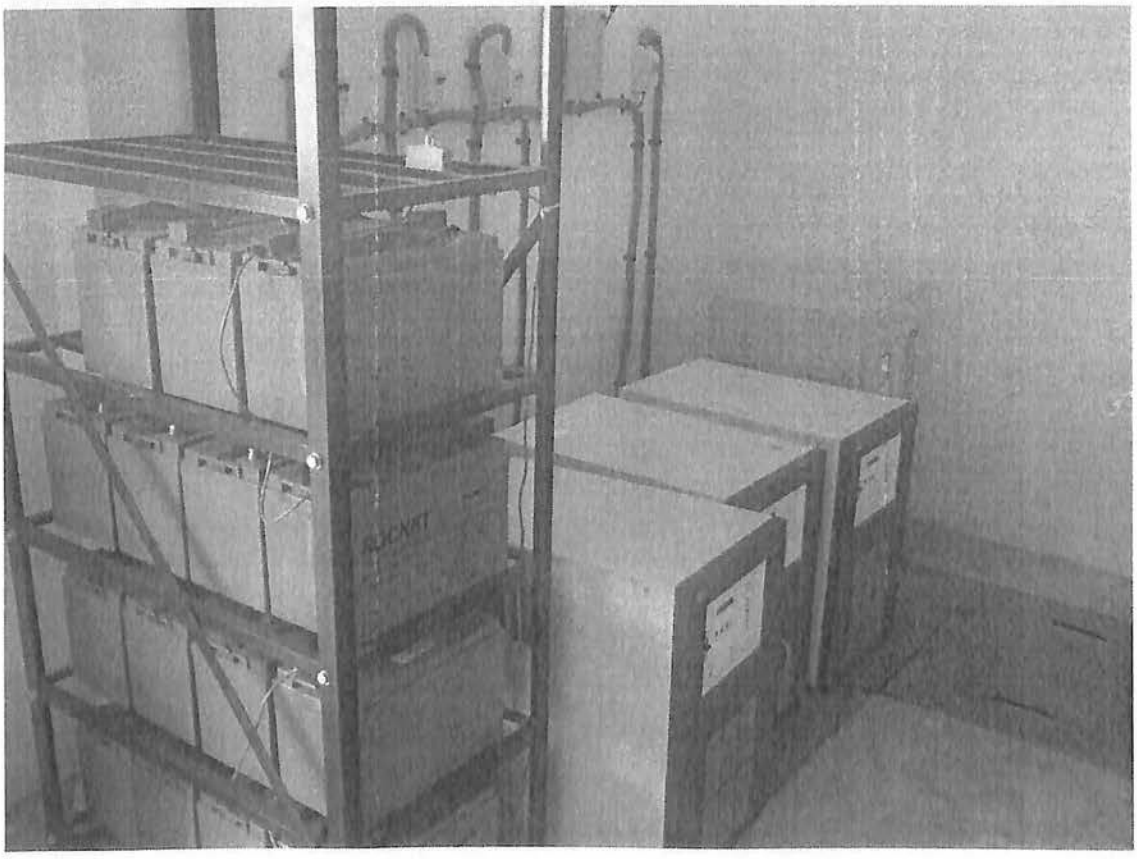
This cascade of 2200 litre water capacity shall be fitted in, light commercial vehicle (LCV). Three nos. mobile cascades with LCV have been envisaged for each Daughter Booster Station. The mobile cascades will be fitted at Mother Station up to 255 Kg/cm^2 (g) pressure. Mobile cascade at this pressure will be sent to Daughter Booster Station for gas dispensing up to a pressure of 30 kg/cm^2(g). Empty mobile cascade at pressure lower than 30 Kg/cm^2 (g) shall return to Mother Station for refilling. Approximately 335 Kg of gas can be transported from this cascade. The entire assembly shall be CCOE approved.

Suitable loading facility at Mother Station and unloading facility at protection shed.

G) DG Set, UPS & Battery Back-up & AVR

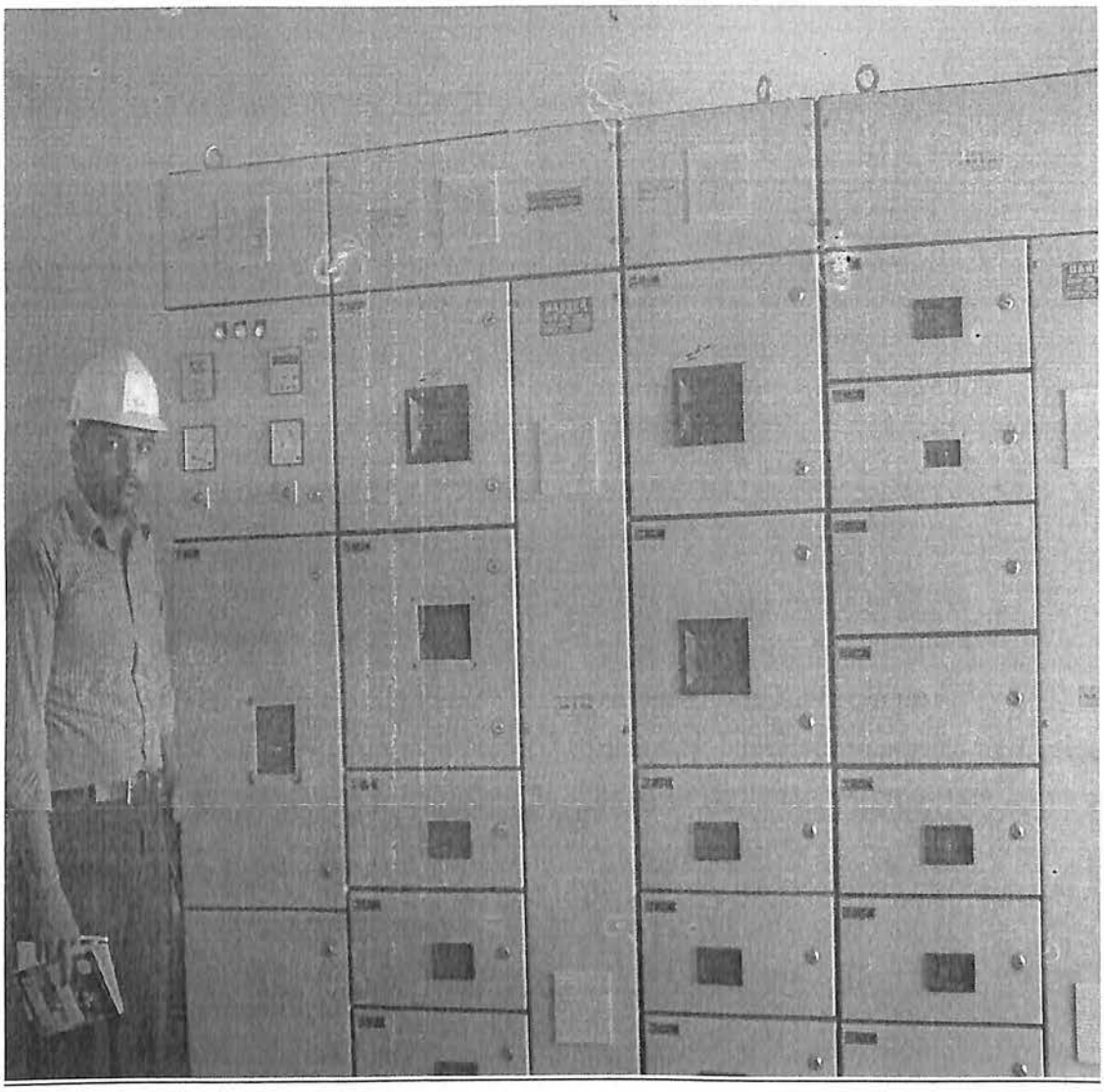
DG Set - To meet the requirement of emergency of emergency power in case of grid power failure, one DG set of capacity 7.5 kW has been envisaged at each station. The DG set shall start automatically in case of grid power failure. Emergency loads shall be connected to DG set.

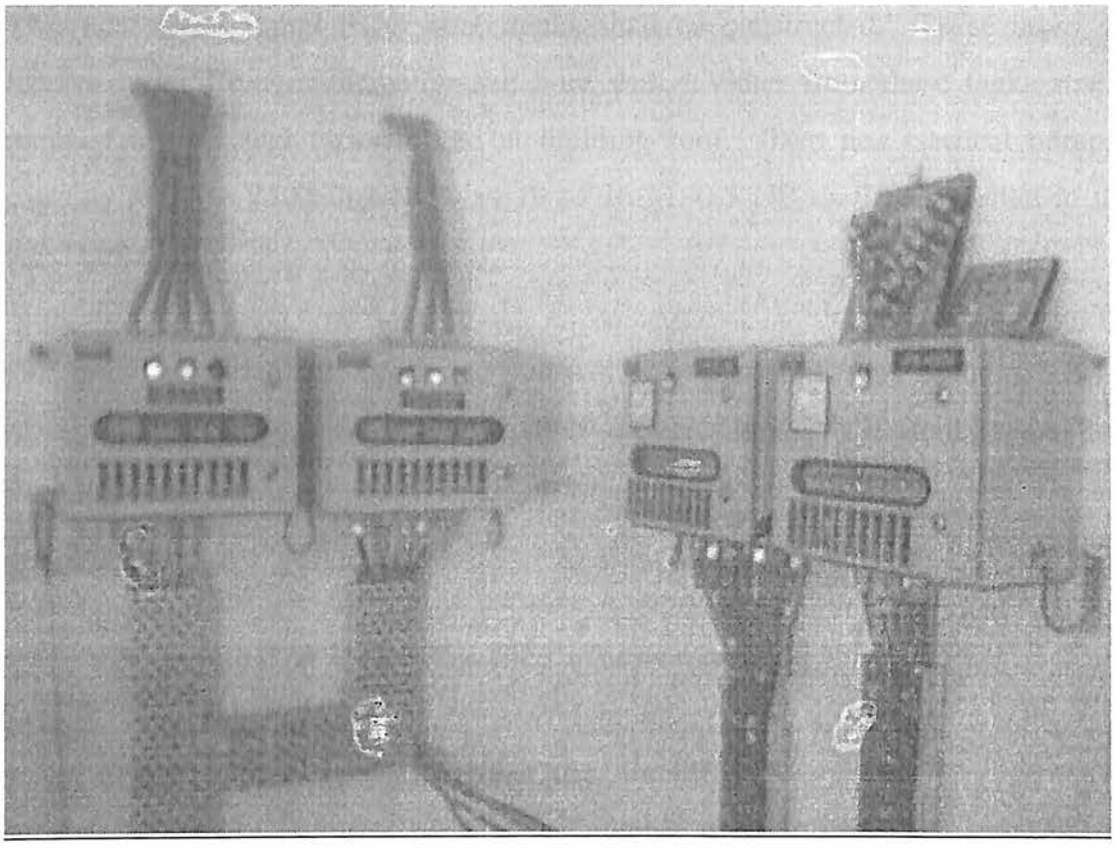
UPS & Battery Back-up – a one hour UPS and battery back-up system shall be provided at each station.



AVR - A suitable automatic voltage stabilizer based on local supply has been envisaged.

Electrical System (Refer 06.08.06) - The electrical system shall comprise of conduit work including junction boxes, wiring for lighting and power; fittings and accessories, cables, mains and sub-mains; LT panel, main & sub-distribution panels, capacitor panels; cable trays, GI conduits; earthling system, area lighting, canopy lighting, signage lighting & control room illumination etc.





G) SS Tubing

SS Tubing shall run in underground concrete/masonry trenches for conveying compressed natural gas from compressor to priority panel to dispenser and priority panel to stationary cascade to dispenser. Generally these shall be ¼", ¾" or 1" size tubes of SS 316 grade

H) Water supply & Underground Services

To meet the water requirement at mother stations, water supply network consisting of bore well, vertical pumps, submersible pumps and interconnecting piping has been envisaged.

Two nos. underground RCC water tanks shall be constructed. These tanks shall receive water from municipality and bore well. Water from these tanks shall be pumped to overhead tanks placed at building roof. Two nos. vertical pumps of capacity 2000 to 2500 litre/hr, head 19 to 26 M, 0.5 HP shall be installed in these RCC tanks.

One bore well of suitable depth and size will be constructed. One submersible pump of capacity 3,000 – 5,000 ltr/hr, head 50-60 meter, approx 2 H.P. shall be installed in the bore well.

Underground drainage, sewerage network comprising of drain pits, drainage pipe, septic tank and soak pit shall be installed apart from municipal connections.

I) **Control Room-cum-Office & Other Facilities**

This shall be an RCC framed structure of suitable size to house office, control room, electrical room, cash box and toilet. The front side shall have glazed partition for viewing dispensing operation. The floor will have ceramic tiled finish and synthetic emulsion paint on walls and ceiling has been considered.

- The station shall be enclosed with 2.1 m high boundary wall on three sides.
- The forecourt shall be made of high riding quality RCC pavement with wearing resistant surface.
- The SS tube trenches and drainage shall be covered with heavy duty precast SFRC covers of suitable design and manufacture.
- GI conduits shall be laid for cabling work.
- Properly designed dispenser island with safety guards shall be provided.
- Structural steel canopy shall be provided over the dispensing area for providing sum and rain protection. The canopy shall have provision of roof drainage, illumination and signage's.
- The station shall be provided with approach roads, entry and exit ways, parking bay, operation area fence, safety barbs, road signs, station drainage system etc.
- The station shall be provided with corporate traffic and safety signage's using state of art techniques and landscaping.

- The station shall be provided with safety and fire fighting equipment, earthling pits and safety instructions.

Industrial Supply System

There are a large number of small and medium size industrial consumers in Pune. These consumers shall be supplied gas through steel feeder line tapped from the nearest steel grid line.

One feeder line may be dedicated to one or more than one industry depending on the geographical location and actual allocation. However, for the purpose of techno-economic analysis, following facilities have been assumed for one industry.

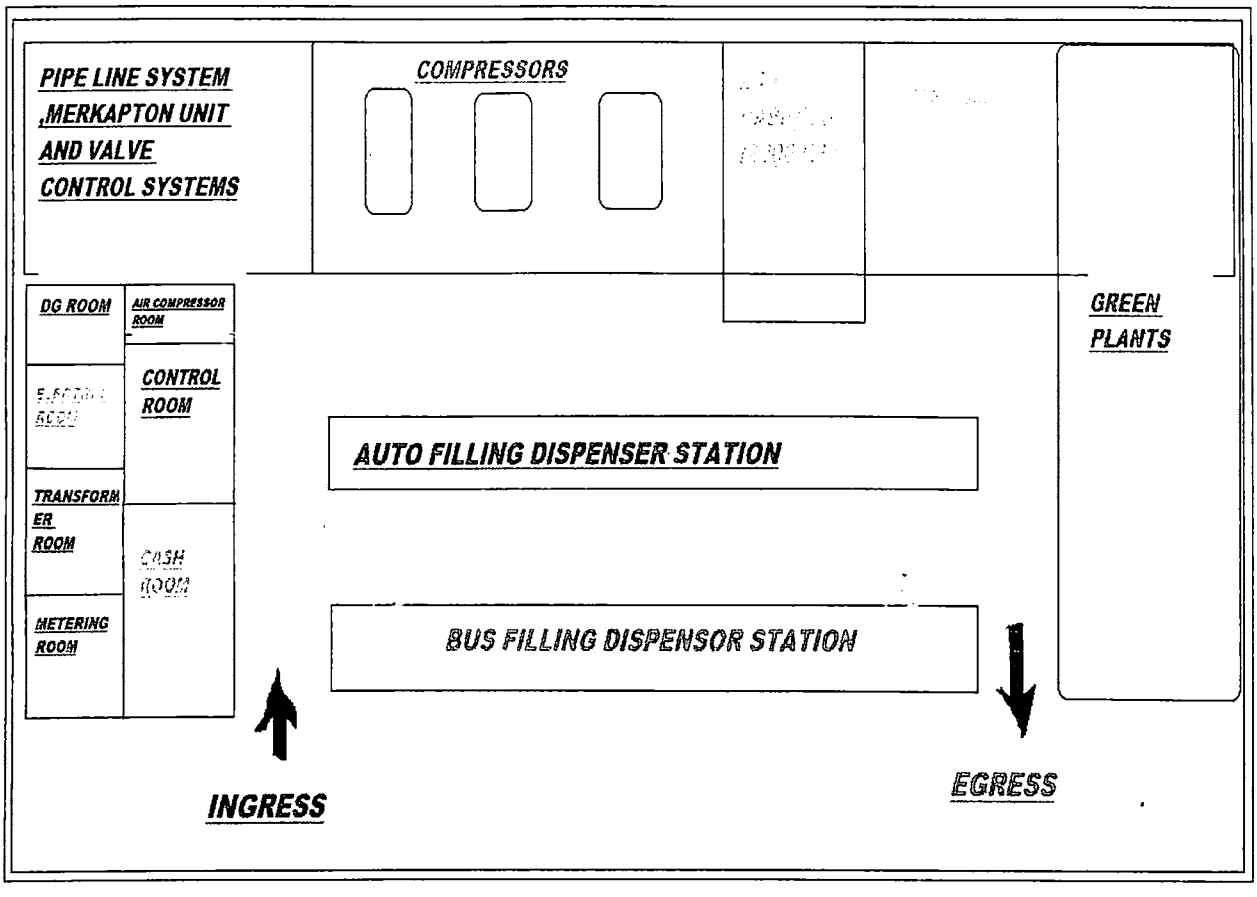
- Steel Feeder line – 4" 3" x 200 meter approx. of API SL Gr. B WT 6.4 mm, PE coated.
- Skid mounted Meter Regulating Station (MRS) – 1 No., consisting of
- Cartridge Filter
- Pressure Control Valve (PCV)
- Slam Shut Valve (SSV)
- Pressure Safety Valve (PSV)
- Flow Control Valve (FCV)
- Turbine Meter with Electronic Volume Corrector
- Valves, & Fittings

City Gas Distribution System

The city gas distribution network shall receive gas from DRS at a pressure of 4 bars for onward distribution to domestic and commercial consumers. The distribution system shall comprise of:

- District Regulating Station
- MDPE pipe network
- GI pipe network
- Office-cum-Control Room for operation and maintenance.

THE CIVIL PLAN OF CNG STATION AS A TOP VIEW:



UN LOADING OF COMPRESSOR EQUIPMENTS AT CNG STATION FROM TRUCKER:

COMPRESSED NATURAL GAS PIPE LINE SYSTEM IN MAHARASTRA NATURAL GAS LIMITED.

CNG Infrastructure

Considering the availability of land for CNG stations at Pune, MNGL has asked MECON to decide the nos. of Mother, On-line and Daughter Booster stations against those indicated in scope of work (as well as in DFR) based on survey and techno-commercial feasibility. After carrying out techno commercial feasibility based on survey and the following considerations, MECON has proposed the nos. /combination of MS, OLS & DBS as presented in table- I.

- Non-availability of suitable land in close proximity to the steel pipeline grid for construction of Mother and on-line stations on green field due to which most of the CNG stations have been considered in the existing bus depot and the existing Retail outlets (ROs) of Oil marketing companies (OMCs).

- Availability of ROs of OMCs at strategic locations from the point of view of maximising the sale.

- Availability of ROs having space for installation of minimum 2- CNG dispensers and associated CNG equipment as per CCOE norms.

- Spreading the CNG distribution network within the city keeping the inter distance between two CNG stations as 4-6 km.

- To cater the buses of PMT and PCMT, exclusive CNG filling stations have been planned within four PMT and two PCMT bus depots. Further, facilities for LCV filling have also been envisaged from six nos. Mother station so as to evenly feed the DBS and optimise running of LCVs with mobile cascades.

- The inter-state private / Govt. buses shall be catered from the Mega CNG station on green field at Chinch wad for which the land is available.

- Total compression capacity of this nos. of MS & OLS is sufficient to cater the total vehicular load under Phase-I as envisaged in the DFR.

- Total dispensing capacity of this nos. of MS, OLS & DBS is sufficient to cater the total vehicular load under Phase-I as envisaged in the DFR.

- Total mobile cascades filling capacity of six nos. MS proposed, is sufficient to feed 12 nos. Daughter Booster stations proposed.

TABLE –I

Type of Station	Nos. as per Scope	Nos. revised and finalised by MECON/MNGL under Ph-I	Locations
Mother stations	8	6	Chinch wad Mega, PMT Bus Depot at Shivajinagar, Katraj, Kothrud, Hadapsar and PCMT bus depot at Nigadi.
On line stations	13	11	OLS at Dapodi(BPC), Kasarwadi(BPC), Famous Auto(BPC), Jai Hind(BPC), Select Auto(BPC), Highway SS (HPC), Sant Tukaram Nagar (PCMT) , COCO RTO (BPC), Kasat Petroleum(BPC), Market Yard(IOC) & Deshmukh Petroleum (BPC).
Daughter Booster stns.	8	12	DBS Out of Ishwar SS(BPC), Om Sairam Fuel(BPC), Vardhaman Auto (BPC), Samarth SS (HPC), Highway Petroleum (HPC), Maa Shitaladevi(HPC), Bright star (BPC), Sheetal Petroleum (HPC), Aadarsh Automobiles (BPC), DR Gavhane(BPC), Mauli Petroleum (BPC), NRO Fursungi(BPC), Kawade Petroleum(BPC), Siddhivinayak SS(BPC), Tekawade SS(BPC).
Total	29	29	

Pune City Grid line (Steel Ring Main) under phase- I

- Commissioning of 12" NB Steel Pipeline from GAIL's CGS at Chinchwad upto PMT Bus Depot, Shivaji Nagar (20 kms approx.)
- Commissioning of 10" NB Steel Pipeline from K. Bajaj Chowk to PMT Bus Depot, Hadapsar. (15.7 Km approx.)
- Commissioning of 10" NB Steel Pipeline from PMT Bus Depot, Shivajinagar to Swargate (5.7 Km approx.)
- Commissioning of 6" NB steel spur line from Gavali Nagar Chowk to Landewadi Chowk (2.5 Km approx.)
- Commissioning of 6" NB steel spur line from Gavali Nagar Chowk to Empire Estate (5.3 Km approx.)
- Commissioning of 6" NB steel spur line from PMT Bus Depot Hadapsar to Serum Institute in Hadapsar area (3.0 Km approx.)
- Commissioning of 6" NB steel spur line from Deccan Gymkhana upto Kothrud (6 Km approx.)
- Commissioning of 6" NB steel spur line from Swargate upto Katraj (5.2 Km approx.)
- Commissioning of 4" NB steel spur line from Tap-off on 12"/10"/6" main line / spur line to connect 6 nos. Mother Station, 11 nos. Online Station, 6 nos. Industrial consumers and 3 nos. DRS (10.75 Km approx.)

City Gas (PNG) under phase- I

- **Industrial Connections-** To connect 10 nos. Industrial Consumers in Pune/Pimpri/Chinchwad area.
- **Commercial Connections-** To connect 20 nos. Commercial Consumers (including two large commercials) at Bund Garden Road area.
- **Domestic Connections-** To connect 1000 nos. Domestic Consumers at Empire Estate in Pimpri area.

FACILITIES PLANED UNDER PHASE - I A

Considering the availability of land for CNG stations, MNGL has asked MECON to set up the following infrastructure under Phase-IA. Procurement of material for Phase-IA has already been taken up accordingly (refer Table –VIII). However, the length of the steel pipelines under Phase -IA has been finalized after simulation and design of the network based on the complete facilities under Phase-I. The simulation report is attached in this document (as Simulation-I, Simulation – II, Simulation – III & Simulation – IV).

Procurement of materials for Phase-IB has been planned under the present revision (R8) of the document (refer Table –IX).

Pune City Grid line (Steel Ring Main)

- Commissioning of 12" NB Steel Pipeline from GAIL's CGS at Chinchwad upto PMT Bus Depot, Shivaji Nagar (20 Km approx.).
- Commissioning of 6" NB steel spur line from Gavali Nagar Chowk to Landewadi Chowk (2.5 Km approx.)
- Commissioning of 6" NB steel spur line from Gavali Nagar Chowk to Empire Estate (5.3 Km approx.)
- Commissioning of 4" NB steel spur line from Tap-off on 12" main line to connect 3 nos. OLS and 1 no. DRS near Thermax (2.5 Km approx.).

CNG STATIONS UNDER PHASE-IA

The following CNG Stations are planned in Phase-IA in Pune City for catering to the demand of Automobile Sector :-

Mother Stations - 2 Nos.

1. Mega station at Chinchwad
2. PMT bus depot in Shivaji Nagar

Online Stations-3 Nos.

1. COCO Kasarwadi(BPC)
2. COCO Dapodi(BPC)
3. Jai Hind Auto (BPC)

Daughter Booster Stations-8 Nos.

1. Om Sai Ram Fuel(BPC).
2. Ishwar Service Station(BPC)
3. Samarth Service Station (HPC)
4. Vardhman Service Station(BPC)
5. Highway Petroleum (HPC)
6. Tekawade SS (BPC).
7. Bright Star (BPC).
8. Sheetal Petroleum (HPC).

FACILITIES PLANED UNDER PHASE - I B

Pune City Grid line (Steel Ring Main)

- Commissioning of 10" dia Steel Pipeline from K. Bajaj Chowk upto PMT Bus Depot, Hadapsar. (15.7 Km approx.)
- Commissioning of 10" dia Steel Pipeline from PMT Bus Depot, Shivajinagar upto Swargate (5.7 Km approx.)
- Commissioning of 6" dia steel spur line from Deccan Gymkhana upto Kothrud (6 Km approx.)
- Commissioning of 6"dia steel spur line from Swargate upto Katraj (5.2 Km approx.)
- Commissioning of 6" dia steel spur line from Chinchwad Chowk to PCMT bus depot. at Nigadi (3.0 Km approx.)
- Commissioning of 4" dia steel spur line from Tap-off of 12"/10"/6" main line / spur line to connect 8 nos. OLS, 6 nos. Industrial consumers and 2 nos. DRS (8.25 Km approx.)

A. CNG STATIONS UNDER PHASE – I B

Mother Stations - 4 Nos

1. PMT bus depot in Katraj.
2. PMT bus depot in Kothrud.
3. PMT bus depot in Hadapsar.
4. PCMT bus depot in Nigadi.

(Cumulative – 6 Nos.)

Online Stations - 8Nos.

1. Famous Auto (BPC)
2. Select Auto (BPC)
3. Highway Service Station (HPC).
4. Sant Tukaram Nagar(PCMT).
5. COCO RTO (BPC).
6. Kasat Petroleum (BPC)
7. Market Yard (IOC)
8. Deshmukh Petroleum (BPC)

(Cumulative – 11 Nos.)

Daughter Booster Stations-4 Nos(Out of the following).

1. Adarsh Automobiles (BPC).
2. DR Gavhane SS (BPC).
3. Mouli Petroleum (BPC).
4. Kawade Petroleum (BPC).
5. Siddhivinayak SS(BPC).

6. Maa Shitala Devi(HPC).
(Cumulative – 12 Nos.)

C. Industrial Connections

- Commissioning of first 5000 SCMH DRS at Pimpri (near Thermax) and 10 Nos. MRS along with required steel and MDPE Network to connect 10 Nos. Industrial Consumers progressively.

D. Commercial Connections

- Commissioning of second 2000 SCMH DRS (near Ruby hall at Bund Garden Road) and 2 Nos. MRS (for large commercials) with required MDPE Network to connect 20 Nos. Commercial Consumers (including two large commercials) progressively.

E. Domestic Connections

- Commissioning of third 500 SCMH DRS (at Empire Estate in Pimpri area) with required MDPE Network to connect 1000 Nos. Domestic Consumers progressively.

Gas Network System Design (for Phase – I)

This document describes the design basis for the facilities downstream of CGS including CNG Distribution Steel Network. It has been considered that NG at an outlet pressure of 19 kg/cm^2 (g) shall be made available at the GAIL's CGS for the CNG & city gas distribution in Pune. The grid line has been checked for a load of 1.1 MMSCMD under Phase-I as per following table -II without the loop having completed.

TABLE –II

Sectors	Consumers/Day	Peak Load
Automobile Sector	Buses – 850 nos. Cars – 3900 nos Auto – 40000 nos Total – 44,750 vehicles	19,450 SCMH

Sectors	Consumers/Day	Peak Load
Domestic Sector		10,000 SCMH
Commercial Sector		1,000 SCMH
Industrial Sector		15,000 SCMH
Total		45,450 SCMH (= **1.1 MMSCMD**)

The above grid line can also cater for an increased capacity of 33% i.e. 1.45 MMSCMD. The simulation reports for both the cases are attached in the report (as Simulation-I & Simulation-II).

However the system can be upgraded under Phase-II with a closed loop to cater to the load of 2.54 MMSCMD as per the DFR (with 33% excess capacity) with NG to be equally fed from two sources at a pressure of 19 kg/cm^2 (g) at the battery limit of GAIL & MNGL. A re-simulation for this load has also been conducted and reports attached with the document (as Simulation – III & Simulation – IV).

GAIL's Proposed Facility

GAIL will provide a 12" NB tap-off at City Gate Station at pressure of 19 kg/cm^{2}g with facilities for custody transfer at the battery limit for further distribution in the city of Pune by MNGL.

Design of the Main Grid System

In Phase-I, the main objective is to develop a grid supply system, which shall carry the bulk gas supplies to the areas of potential demand from GAIL's City Gate Station (CGS) at Chinchwad to the City of Pune.
The pressure regimes followed for the system design is as below:-

Distribution Network	Pressure Regime	Service pipe
Main Grid Line (High Pressure System)	19 kg/cm^2(g)	Steel
Distribution/ Service Line (Medium Pressure System)	4 - 1.5bar	MDPE

Large commercial connection	2 bar	MDPE
Medium & Small commercial Connection	300 mbar	MDPE
Domestic Connection (Low Pressure System)	21 mbar	MDPE / GI

Steel Pipeline Design Parameters

Max. Op. Pressure, kg/cm^2(g):		19 kg/cm^2 (g)
Op. Temperature, °C	:	5-50
Design Temperature	:	Buried – 45°C Above Ground – 65°C
Population Density Factor	:	Class IV
Design Life	:	30 Years
Corrosion Allowance	:	0.5 mm
Pipeline Efficiency/ Roughness	:	0.9 / 45 micron.

The schematic layout of City Gas steel pipeline grid & CNG facilities (under Phase-I) for Pune City is detailed in drawing no. MEC/23K8/05/25/M/001/000/0001A, R-4 (2 sheets) is enclosed herewith.

Steel Pipeline Network under Phase - I A

The following line pipes (refer Table – III) have already been finalised by MECON for procurement under Phase- IA after carrying out simulation study of the entire network under Phase-I. (refer simulation report attached as Simulation – I and pipeline route drg. nos. MEC/23K8/05/11/C/00/RS/006AR4 & 006BR1).

TABLE – III

Sl. No.	Inch (NB)	Th. (mm) (f=0.4, CA=0.5 mm)	Material (API 5L) Grade	Estimated Length (with 5% extra) for procurement (Coated) (m)	Estimated Length (with 5% extra) for procurement (Bare) (m)	Actually procured (m)
1.	12"	9.5	B	4500 # Refer note No.1	-	4500
2.	12"	6.4	B	14500	-	14500
3.	10"	6.4	B	14000	-	10800
4.	6"	6.4	B	16000	-	16000
		6.4	B	7500	500 *Refer Note No.2	Coated -7500 Bare-500

Note :

1) For river crossing & DC traction.
2) Inside MS and OLS for above ground piping only.
3) For detailed pipeline routing, tap-off points and corresponding lengths please refer enclosed "Schematic Layout of City Gas Steel Pipeline Grid & CNG Facilities for Pune City" Drawing No. MEC/23K8/05/25/M/000/0001A, R-4 (2 Sheets)

Steel Pipeline Network under Phase - I B

In view of addition of 2 Nos. Mother station viz. Kothrud and Hadapsar, the line pipes already procured under Phase- IA (as per Table – III) have been reviewed after simulation & sizing calculation. (revised simulation report has been attached as Simulation –V and revised pipeline route drg. nos. MEC/23K8/05/11/C/00/RS/006AR4

& 006BR1 attached in Annexure). The additional quantities of line pipes are presented in table- IV.

TABLE – IV

Sl. No.	Inch (NB)	Th. (mm) (f=0.4, CA=0.5 mm)	Material (API 5L) Grade	Estimated Length (with 5% extra) for total procurement under Ph-I (Coated) (m)	Quantity already procured under Ph-IA (m)	Quantity to be procured under Ph-IB (m)
1	12"	9.5	B	4500	4500	**Nil**
2	12"	6.4	B	16500	14500	**2000**
3	10"	6.4	B	23000	10800	**12200**
4	6"	6.4	B	24500	16000	**8500**
5	4"	6.4	B	Coated-11500 Bare-500	Coated-7500 Bare-500	**Coated-4000 Bare-Nil**

SCADA & TELECOM

No SCADA and Telecom facility have been envisaged for laying the pipeline as per scope of work. However, Provision shall be kept to hook-up parameters such as pressure, temperature indication, status of actuated ball valves and remote operations of gas actuated ball vales, all metering parameters such as flow, pressure & temperature from CNG station, and data from MRS & DRS. All instruments shall be SCADA compatible. Operating platforms for SCADA shall be Modbus.

At present only 24 fibber OFC through HDPE duct shall be laid in the same pipeline trench.

Instrumentation And Control

Instrumentation and control system has been envisaged for smooth, efficient and trouble-free transportation of natural gas from CGS to Pune city distribution network.

This will be achieved through measurement of inlet/outlet gas pressure and temperature, metering at CGS and control of gas flow through pipeline at CGS/ DRS/ City gas network.

All the instruments shall be microprocessor based electronic type with 4-20mA DC isolated output. Final control element shall be gas-actuated type. Instrument power supply shall be based on 230V, 50Hz AC through UPS. For SV stations, the line pressure and temperature indications shall be local only.

ODOURSING FACILITY

An Odorizing unit has been planned at the Mega Station at Chinchwad for which an approximate area 6.0 m x 9.0 m been envisaged. The odorant to be used shall be Ethyl Mercaptane.

GAS COMPOSITION/ PARAMETER

Composition of Gas considered as below.

Component	Range mole %		Design case mole %
Methane	84.50	98.77	89.00
Ethane	0.69	9.00	5.00
Propane	0.03	4.00	1.50
Butane	0.00	2.00	0.50
Pentane	0.00	0.35	0.35
Hexane	0.00	0.15	0.15
Heptane	0.00	-	0.00
Carbon Dioxide	0.00	4.50	3.00
Nitrogen	0.05	1.25	0.50
Total	100	100	100

NOTES:

•O2 not more than 0.5 % mole •Total non hydrocarbon –Not more than 2.0 %
•Total S including H2S Not more than 10 PPM by weight •H2S not more than 4 PPM by volume •Moisture content in the range 112 to 144 Kg/ MMSCM •Density 0.779 kg/Sm^3 (design case)
•Temp of gas shall be 20 to 40 °C

CNG NETWORK

Summary of compression and dispensing capacities

Type of Station	Compression capacity					Dispensing Capacity	Mobile Cascade Filling Capacity	Number of Vehicles under Ph – I			
	SCMH	No. of Stations	Total SCMH	Total SCMD	Total Kg/day	Kg/ day	Kg/ day	Bus (Nos)	Car (Nos)	Auto (Nos)	Grand Total
Mega Station	3150	1	3150	56700	45360	19500	10500	200	500	500	
Mother Stations at PMT Depot	2400	4	9600	172800	138240	48000	42000	600	-	- -	
Mother Station at PCMT Depot	1200	1	1200	21600	17280	4000	7000	50	-	-	
Online Stations	750	11	6750	108000	86400	56250	-	-	4050	18000	
Daughter Booster Stations		12				42000	-	-	-	21000	
Grand Total		29	19700	359100	287280	169750	59500	850	4550	39500	44900

Selection criteria of Mother & Online Compressors

Based on a study made at Pune about the availability of power, it was found that uninterrupted power is available throughout the day except 6 hrs. On a particular day in a week. Subsequently, a comparative study of the gas engine driven vis-à-vis electric motor driven compressors has been made based on the price of electricity unit and selling price of gas (per kg) in the city of Pune. The comparative study is enclosed as Annexure – II. As per comparison, the Electric Motor driven compressor is found cheaper than Gas Engine Driven Compressor taking into account the cost of setting up of Transformer Room for HT line.

Further, to cater for running of compressor during power cut a gas engine driven compressor of capacity 1200 SCMH has been proposed in all Mother stations to be constructed on green field and on PMT bus depot only. For online stations to be constructed on ROs, the DG set has not been envisaged since these online stations are designed for car and auto (3 wheeler) filling only and it will be possible to cater the load (dispensing) from the stationary cascade (of 4500 WL capacity) during the power cut.

Selection of Booster Compressors

During the presentation a deliberation was made by MNGL to put daughter booster station on wet lease. However, MECON presented a comparison for procurement of booster compressor vis-à-vis wet leasing of booster compressor for a guaranteed sale of 1000 kg and 3000 kg and wet leasing of Booster compressor was found to be uneconomic in both the cases. This comparative statement has been enclosed (as Annexure – III) in earlier revision R-5 of this document. Accordingly, it has been decided to procure Booster compressors for the daughter Booster stations through purchase.

As per MOM dated 30.11.06 & 25.01.07 between MNGL & MECON, MNGL has decided to set up 8 nos. daughter booster stations under Phase- 1A. The list of these 8 DBS has been presented in 3.1B as well as in table -VIII. Accordingly, procurement action for 8 nos. of booster compressors has already been completed.

Selection criteria of Cascades

All the stationary cascades in Mother Stations shall be of 3000 WL capacity as envisaged in DFR. All Mother stations and On-line stations shall have as many nos. of stationary cascades as the nos. of compressors. However the stationary cascades in on-line stations shall be of 4500 WL capacity (for large buffer stock) to cater for dispensing during power cut. Further, the priority system in the stationary cascades have been designed and defined for car / auto and bus filling from cascades so as to match the priority system in the Mother / Online compressor.

All mobile cascades shall be of 2200WL capacity as envisaged in DFR. M/S MNGL requested MECON to make a comparative analysis for both 2200WL and 3000WL cascades taking into consideration the reduced no. of trips for LCVs. As per comparative analysis (placed in annexure-III) 3000WL mobile cascade works out to be cost effective w.r.t. 2200 WL. However, because of comparatively smaller size of LCVs, ease of transportation and space constraints in the existing ROs proposed for DBS, mobile cascades of capacity 2200 WL have been chosen for feeding DBS. Consequently, the stationary cascades in Daughter Booster Stations shall also be of capacity 2200 WL.

ELECTRICAL EQUIPMENTS

The electrical load shall comprise of mainly electrical motors, lighting load, instrumentation power requirements at all locations and air conditioning, UPS, SCADA, etc. The total Electrical loads required at various types of CNG stations depending upon the facilities are presented in below

SL. NO.	Type of stations with equipment & facilities	Load in KW
A)	**Mega Station in Green Field at Chinchwad**	
i)	I no.-1200 SCMH Electric Motor Driven Compressor with auxiliaries	180
ii)	1 no.- 750 SCMH Electric Motor Driven Compressor with auxiliaries	120
iii)	1 no.- 1200 SCMH Gas Engine Driven Compressor with Auxiliaries	20
iv)	Area Lighting	10
v)	Canopy Lighting	10
vi)	Building load including LT transformer room	20
vii)	Signage's including Signage Tower	20
viii)	Other utilities (like Bore well pump, air compressors, Dispensers etc.)	10
	Total Load	**390**
	To be considered for applying to MSEB	**400**
	Mother Station in PMT Bus Depot at Shivajinagar	
i)	I no.-1200 SCMH Electric Motor Driven Compressor with auxiliaries	180
ii)	1 no.- 1200 SCMH Gas Engine Driven Compressor with Auxiliaries	20
iii)	Area Lighting	10
iv)	Building load including LT transformer room	10
	Total Load	**220**
	To be considered for applying to MSEB	**250**

SL. NO.	Type of stations with equipment & facilities	Load in KW
C)	**Mother Stations in other PMT Bus Depot at Katraj, Kothrud & Hadapsar**	
i)	I no.-1200 SCMH Electric Motor Driven Compressor with auxiliaries	180
ii)	1 no.- 1200 SCMH Gas Engine Driven Compressor with Auxiliaries	20
iii)	Area Lighting	10
iv)	Building load including LT transformer room	10
v)	Other utilities (like air compressors, Dispensers etc.)	5
	Total Load	**225**
	To be considered for applying to MSEB	**250**
D)	**Mother Station in PCMT Bus Depot at Nigadi**	
i)	1 no.- 750 SCMH Electric Motor Driven Compressor with Auxiliaries	120
ii)	Area Lighting	10
iii)	Building load including LT transformer room	10
iv)	Other utilities (like air compressors, Dispensers etc.)	5
	Total Load	**145**
	To be considered for applying to MSEB	**150**
E)	**On line Stations in Ros**	
i)	1 no.- 750 SCMH Electric Motor Driven Compressor with auxiliaries	120
ii)	Area Lighting in CNG equipment area and other auxiliaries including air compressors & dispensers.	10
	Total Load	**130**
	To be considered for applying to MSEB	**150**
F)	**Daughter Booster Stations in Ros**	
i)	1 no.- 250 SCMH Electric Motor Driven Hydraulic Booster Compressor with auxiliaries	30
ii)	Area Lighting and other auxiliaries including, air compressors and dispensers.	10
	Total Load	**40**
	To be considered for applying to MSEB	**50**

List of CNG Equipment (Station Wise) Planned

The total list of CNG equipment (station wise) planned under Phase-IA (as approved by MNGL) are presented in Table VIII (refer earlier Table-VI in Design Basis R-5).
The total list of CNG equipment (station wise) planned under Phase-IB is presented in Table IX.

List of Equipments (Station Wise) Planned Under Phase IA

TABLE – VIII

Type of Station	Station Location	Equipment Details											
		Mother Compressor (1200 SCMH) Electric Motor Driven	Mother Compressor (1200 SCMH) Gas Engine Driven	Online Compressor (750 SCMH) Electric Motor Driven	Booster Compressor (250 SCMH) Electric Motor Driven	Cascade (4500WL) (Stationary)	Cascade (3000WL) (Stationary)	Cascade (2200WL) (Stationary)	Cascade (2200WL) (Mobile)	Dispenser (bus)	Dispenser (Car/ auto)	LCVs	DG set 20 kw)
MS	Chinchwad	1	1	1	-	-	3	-	-	3	3	-	1
MS	Shivajinagar	1	1	1	-	-	3	-	-	2	-	-	1
MS	Katraj	1	1	1	-	-	3	-	-	2	-	-	1
OLS	Coco Dapodi	-	-	1	-	1	-	-	-	-	2	-	-
OLS	Coco Kasarwadi	-	-	1	-	1	-	-	-	-	2	-	-
OLS	Famous Auto,Fc Rd.	-	-	1	-	1	-	-	-	-	2	-	-
OLS	Jai Hind Service Station	-	-	1	-	-	1	-	-	-	2	-	-
DBS	Om Sai Ram	-	-	-	1	-	-	1	1	-	2	1	-

DBS	Samarth Service Station	-	-	-	1	-	-	1	1	-	2	1	-
DBS	Ishwar Service station	-	-	-	1	-	-	1	1	-	2	1	-
DBS	Vardhaman Service Station	-	-	-	1	-	-	1	1	-	2	1	-
DBS	Highway Petroleum	-	-	-	1	-	-	1	1	-	2	1	-
DBS	COCO WRD	-	-	-	1	-	-	1	1	-	2	1	-
DBS	Shree Balaji Service Station	-	-	-	1	-	-	1	1	-	2	1	-
DBS	Ma Shitala Devi Service Station	-	-	-	1	-	-	1	1	-	2	1	-
TOTAL		**3**	**3**	**7**	**8**	**3**	**10**	**8**	**8x1.5=12**	**7**	**27**	**8x1.5=12**	**3**

List of Equipments (Station Wise) Planned Under Phase IB

TABLE – IX

Sl. No.	Type of Station	Station Location	Phase	Compressor				Cascade				Dispenser		LCV
				1200 SCMH Gas Engine	1200 SCMH Motor	750 SCMH Motor	250 SCMH Hydraulic Booster	4500 WL(Stationary)	3000 WL(Stationary)	2200 WL(Stationary)	2200 WL (Mobile)	Bus	Car/Auto	
1.	MS	Chinchwad	IA	1	1	1	-	-	3	-	-	2 + 1***	3 + 1***	-
2.	MS	Shivajinagar	IA	1	1	-	-	-	2	-	-	2	-	-
3.	MS	Katraj	IA	1	1	-	-	-	2	-	-	1 + 1*	-	-
4.	MS	Kothrud	IB	1	0 + 1*	-	-	-	1 + 1*	-	-	1 + 1*	-	-
5.	MS	Hadapsar	IB	1	0 + 1*	-	-	-	1 + 1*	-	-	1 + 1*	-	-
6.	MS	Nigadi	IB	-	-	1	-	-	1	-	-	1	-	-
7.	OLS	COCO Dapodi	IA	-	-	1	-	1	-	-	-	-	2	-
8	OLS	COCO Kasarwadi	IA	-	-	1	-	1	-	-	-	-	2	-
9	OLS	Jai hind Auto	IA	-	-	1	-	1	-	-	-	-	2	-
10	OLS	Select Auto	IB	-	-	1	-	1	-	-	-	-	2	-
11	OLS	Famous Auto	IB	-	-	1	-	1	-	-	-	-	2	-
12	OLS	Highway SS	IB	-	-	1	-	1	-	-	-	-	2	-
13	OLS	PCMT Sant Tukaram Nagar	IB	-	-	1	-	1	-	-	-	1	-	-
14	OLS	COCO RTO	IB	-	-	1	-	1	-	-	-	-	2	-

15	OLS	Kasat Petroleum	IB	-	-	1	-	1	-	-	-	-	2	-
16	OLS	Market Yard SS	IB	-	-	1	-	1	-	-	-	-	2	-
17	OLS	Deshmukh Petroleum	IB	-	-	1	-	1	-	-	-	-	2	-
Sl. No.	**Type of Station**	**Station Location**	**Phase**	**Compressor**				**Cascade**				**Dispenser**		**LCV**
				1200 SCMH Gas Engine	**1200 SCMH Motor**	**750 SCMH Motor**	**250 SCMH Hydraulic Booster**	**4500 WL(Stationary)**	**3000 WL(Stationary)**	**2200 WL(Stationary)**	**2200 WL (Mobile)**	**Bus**	**Car/Auto**	
18	DBS	Om Sai Ram	IA	-	-	-	1	-	-	1	2	-	1 + 1**	2
19	DBS	Vardhman Auto	IA	-	-	-	1	-	-	1	2	-	1 + 1**	2
20	DBS	Ishwar SS	IA	-	-	-	1	-	-	1	2	-	1 + 1**	2
21	DBS	Shital Petroleum	IA	-	-	-	1	-	-	1	2	-	1 + 1**	2
22	DBS	Samarth SS	IA	-	-	-	1	-	-	1	2	-	1 + 1**	2
23	DBS	Bright star	IA	-	-	-	1	-	-	1	2	-	1 + 1**	2
24	DBS	Highway Petroleum	IA	-	-	-	1	-	-	1	2	-	1 + 1**	2
25	DBS	Tekawade SS	IA	-	-	-	1	-	-	1	2	-	1 + 1**	2

26	DBS	Adarsh Auto	IB	-	-	-	1	-	-	1	2	-	1 + 1**	2
27	DBS	D.R. Gavhane SS	IB	-	-	-	1	-	-	1	2	-	1 + 1**	2
28	DBS	Mauli Petroleum	IB	-	-	-	1	-	-	1	2	-	1 + 1**	2
29	DBS	Maa Shitala Devi	IB	-	-	-	1	-	-	1	2	-	1 + 1**	2
TOTAL				**5**	**3 + 2***	**13**	**12**	**11**	**10 + 2***	**12**	**24**	**9 + 4***	**35 + 13***	**24**
Order placed as on 31.08.2007 for phase-IA				3	3	7	8	3	10	8	12	7	27	12
Balance to be procured for phase-IB				2	0 + 2*	6	4	8	0 + 2*	4	12	2 + 4*	8 + 13*	12

*MS at Kothrud and Hadapsar shall have provisions of 2 compressors and 2 dispensers for future when the demand goes more than the present installed capacity. However, presently only one gas compressor and one bus dispenser shall be installed and procurement shall be accordingly effected. Since the station is dependent on a single compressor at present hence gas engine driven compressor recommended for procurement to have continuous supply of CNG without any interruption due to power. Further MS at Katraj shall have only one bus dispenser at present although the station is designed for 2 bus dispensers.

** Each DBS shall have provisions of minimum 2 dispensers, however presently only one dispenser shall be installed and procurement shall be accordingly effected.

***Mega MS at Chinchwad shall have provisions of 3 bus and 2 car dispensers for future when the demand goes more than the present installed capacity. However, presently only 2 bus, 1 car and 2 auto dispensers shall be installed and procurement shall be accordingly effected.

Facilities Planned In Mega Station at Chinchwad

- No. of compressors : 1 – 1200 SCMH Gas Engine Driven,
  1 – 1200 SCMH Electric Motor Driven &
  1 – 750 SCMH Electric Motor Driven.

Suction pressure : 16-19 kg/cm2 (g) [guaranteed 17.5 kg / cm^2 (g)]
Priority fill system in comp. : 9 bank for 1200 SCMH Gas Engine Driven Compressor,
3 bank for 1200 SCMH Electric Motor Driven Compressor
7 bank for 750 SCMH Electric Motor Driven Compressor

- No. of dispensers : 3 Bus(Single Arm), 4 Car / auto(Twin arm)
- No. of LCV filling point : 2 (two)
- No. of stationary cascade : 3 – 3000 WL
- Dispensing capacity : 19500 kg / day
- Mobile cascade filling capacity : 10500 kg / day
- Compression capacity : 45360 kg / day
- HT to LT Transf. Room (for 400 kW): 5.0 m x 9.0 m
- Facilities in Utility building : Electrical Room, Air Compressor Room, DG Room, Cash counter and Toilet for customers

Facilities Planned In Mother Stations at PMT Bus Depot, Shivaji Nagar

- No. of compressors : 1 – 1200 SCMH Gas Engine Driven,
  1 – 1200 SCMH Electric Motor Driven

Suction pressure : 16-19 kg/cm2 (g) [guaranteed 17.5 kg / cm^2 (g)]

- Priority fill system in comp. : 3 bank
- No. of dispensers : 2 – Bus (Single Arm)
- No. of LCV filling point : 2 (two)
- No. of stationary cascade : 2 – 3000 WL
- Dispensing capacity : 12000 kg / day
- Mobile cascade filling capacity : 10500 kg / day
- Compression capacity : 34560 kg / day
- HT to LT Transformer Room (for 250 kW): 5.0 m x 9.0 m

Facilities in Utility Building : Electrical room and Air Compressor Room

ilities Planned In MS at PMT Bus Depot - Katraj, Kothrud & Hadapsar

- No. of compressors : 1 – 1200 SCMH Gas Engine Driven,
  1 – 1200 SCMH Electric Motor Driven &

Suction pressure : 16-19 kg/cm2 (g) [guaranteed 17.5 kg / cm^2 (g)]

- Priority fill system in comp. : 3 bank
- No. of dispensers : 2 – Bus (Single Arm)
- No. of LCV filling point : 2 (two)
- No. of stationary cascade : 2 – 3000 WL

- Dispensing capacity : 12000 kg / day
- Mobile cascade filling capacity : 10500 kg / day
- Compression capacity : 34560 kg / day
- HT to LT Transf. Room (for 250 kW): 5.0 m x 9.0 m

Facilities in Utility Building : Electrical room and Air Compressor Room

Facilities Planned In MS at PCMT Bus Depot – Nigadi

- No. of compressors : 1 – 750 SCMH Electric Motor driven

Suction pressure : 16-19 kg/cm2 (g) [guaranteed 17.5 kg / cm^2 (g)]

- Priority fill system in comp. : 3 bank
- No. of dispensers : 1 – Bus (Single Arm)
- No. of LCV filling point : 1(one)
- No. of stationary cascade : 1 – 3000 WL
- Dispensing capacity : 4000 kg / day
- Mobile cascade filling capacity : 3000 kg / day
- Compression capacity : 10800 kg / day
- HT to LT Transf. Room (for 150 kW): 5.0 m x 9.0 m

Facilities in Utility Building : Electrical room and Air Compressor Room

Facilities Planned In On-Line Stations (11 Nos. in Ros)

- No. of on-line compressor : 1 – 750 SCMH
- Type of driver : Electric Motor

Suction pressure : 16-19 kg/cm2 (g) (guaranteed 17.5 kg/cm2 (g))

- Priority fill system in comp. : 6 bank
- No. of dispensers (twin arm): 2 – Car (at present)
- No. of stationary cascade : 1 – 4500 WL
- Dispensing capacity : 6250 kg / day
- Compression capacity : 9600 kg / day
- Utility room (3.0 m x 4.0 m) : Electrical cum Air Compressor room

Facilities Planned In Daughter Booster Stations (12 Nos.)

- No. of Booster compressor : 1 – 250 SCMH
- Type of driver : Electric Motor
- Priority fill system in comp. : 3 bank
- No. of dispensers(twin arm) : 1Car (at present) + 1Car (in future)
- No. of stationary cascade : 1 – 2200 WL

No. of Mobile cascade : 2 – 2200 WL (at present)

Dispensing capacity : 3000 kg/day

- Utility room : Electrical cum Air compressor room (3.0 m x 3.0 m)

Supply PNG to small industrials, commercials and domestic consumers has been tabulated in Table- XVII.

LIST OF STANDARDS & ENCLOSURES

PIPELINE CODES AND STANDARDS

a) American Society of Mechanical Engineers (ASME)

ASME B31.8	:	Gas Transmission and Distribution Piping System
ASME B16.25	:	Flanges & Fittings with Butt Welded Ends
ASME B16.9	:	Factory – Made Wrought Iron Steel Butt-Welding Fits
ASME B31.3	:	Process Piping

b) American Petroleum Institute (API)

API Spec 5L	:	Specification for Line Pipe
API RP 1102	:	Recommended Practice for Liquid Petroleum Pipelines Crossing Railroads and Highways
API STD 1104	:	Standard for Welding Pipeline and Related Facilities
API RP 1110	:	Recommended Practice for the Pressure Testing of Liquid Petroleum Pipelines

c) Bueareu of Indian standards.

IS 14885	:	Specification for manufacture of Polyethylene pipes
IS 1239 (Part-I)	:	Specification for manufacture of Carbon Steel Pipe.
IS 1239 (Part-II)	:	Specification for manufacture of Carbon Steel Fittings.

CONCLUSION

This deals with construction of CNG stations for the pipe line system of citygas.For any city gas pipeline distribution you need to fallow all the safety and standards from the beginning to the end of project.

Safety is the most important thing which needs to be kept in mind for every engineer who is working in city gas system.

The city gas stations and its functions and working condition requirements all these have been understood and covered in the report. The safety that needs to fallow also been covered. Equipment required for compressor station also been understood in the report.

Clear understandings of CITY GAS PIPELINE SYSTEM and CITY GAS STATION will be understood by the report.

REFERENCE

1) OIL INDUSTRY SAFETY DIRECTORY 179,220.

2) CITY GAS PIELINES MANULS(MNGL)

3) CITY GAS BASICS AND NETWORK ANALYASIS BY R.J.RAM

4) CNG BY SHANTHISAGAR

5) ASME B 31.8