

PREPAREDNESS TO HANDLE EMERGENCY IN CITY GAS DISTRIBUTION NETWORKS

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Abstract

India today has a vast network of underground pipelines being used for transportation and distribution of natural gas. Big power plants, fertilizer plants & other industrial enterprises are the main consumers of natural gas as on today. However, with the increase in its popularity, it is now being used in the domestic sector as well as a fuel in the automotive sector in the big metropolitan cities. To take the gas to such end users who are located within the boundaries of a main city, there's need to build up city gas distribution pipeline networks. Such networks have already been developed in the cities of Delhi, Mumbai, Vadodara, Surat, Agra/Firozabad, Kanpur and many more such networks are being planned in the near future. Looking at the available infrastructure and layout in typical Indian cities, it becomes a difficult task to build up such a city gas distribution networks in the absence of separate corridors for the competing utilities. Depending upon the pressures, flow and economic criteria, these networks can either be constructed using steel pipelines, polyethylene (PE) pipes or a hybrid system of both PE & steel pipelines.

Unlike cross-country pipelines which runs straight for kilometers through open fields, city gas distribution network are more complex in nature. These are laid in densely populated areas and there are a large number of branches in the network catering to the need of users in different localities within a city. Though, these are much smaller in length and size than cross-country pipelines, the network in a city is much more distributed and varied. Increased number of branches means more number of joints, bends, reducers, fittings etc. in the network apart from more number of delivery points for the supply of natural gas. Coupled with all these factors, the pipelines have to pass through the congested areas within the city criss-crossing the various other underground utilities. Due to the various activities by third party/ other agencies within the city area, the risk of damages and accidents is all the more high as compared to cross-country pipelines. All these factors call for greater in-built safety systems in the network and the need of special preparedness to handle any emergency situation.

The paper presents detailed study and explanation of the various hazards and issues related to emergency preparedness to handle an unprecedented situation in City Gas Distribution Networks with the help of a case study prepared on one of incidences in City Gas Distribution Networks in India.

CITY GAS DISTRIBUTION NETWORK IN INDIA

Oil India Limited was first to start distribution of gas in Assam in 1960's. In Gujarat, Oil and Natural Gas Corporation (ONGC) started selling its associated gas to the neighboring

industries in 1970's. With the find of Oil / Gas at Mumbai high, supply of gas commenced to industrial consumers around Mumbai like MSEB, Tata and RCF. The gas pipeline networks were laid / owned by either ONGC or the customers.

With the gas discovery in south basin of Mumbai shores, the first cross country pipeline in India was conceptualized with Hazira as the landfall point in Gujarat. Gas Authority of India (GAIL) was formed in 1984, to act as a nodal agency for natural gas in India. GAIL constructed and operated this pipeline, which ran from Hazira to Jagdishpur via Bijaipur. This pipeline supplied gas to the fertilizer and power sector. Thereafter, entire existing assets of ONGC and development of new networks were transferred to GAIL.

As a pilot project first city gas distribution project was taken up with the help of ONGC at Vadodara city in 1972. Historically due to scarcity of natural gas vis a vis demand, the supply of gas to other cities like Mumbai and Delhi, projects did not take off in absence of adequate gas allocation.

Gujarat Gas Company Ltd. (GGCL) was the first commercial city gas distribution company in India. GGCL in association with British Gas developed distribution network in Bharuch and Ankleshwar cities. Subsequently, they expanded their network to Surat.

Mahanagar Gas Limited (MGL) started city gas distribution to domestic, commercial and industrial customers in Mumbai in 1995. The focus of the company was to supply gas to domestic households and to transport sector and in an event of surplus cater to the industrial demand.

Indraprastha Gas Limited (IGL) started city gas distribution to domestic, commercial and transport sector customers in Delhi in 1998. The focus of the company was to supply gas to transport sector.

As on date, gas is available in 41 cities in India and in another 14 cities establishment of gas pipeline network is in project stage.

With the availability natural gas in various cities in India, it has become the most sought after fuel in the country. There are about 0.60 million vehicles running on CNG and over 0.85 million households are connected with piped natural gas in India.

Internationally as well as domestically, the use of natural gas has been increasing steadily for several reasons viz. price advantage, environmental concerns, fuel diversification and/or energy security issues, market deregulation (for both gas and electricity).

With the improvement in availability of gas and related pipeline infrastructure, several city gas distribution projects are going to come up in near future. As per the available estimates, as many as 150 cities are going to be connected with the gas pipeline network in India in next five years to come which will further expand to 250 cities in the next ten years. Total length of natural gas pipeline network including the trunk lines and city distribution networks is about 8000 kms and there are 20 different companies involved in the operations and development of City Gas Distribution Network in India

The four major sectors identified for the city gas distribution in India are:

1. Transport Sector
2. Domestic Sector
3. Commercial Sector
4. Industrial Sector

Domestic, Commercial and Industrial Sectors use Piped Natural Gas (PNG) where as the Transport Sector use Compressed Natural Gas.

INFRASTRUCTURE: CITY GAS DISTRIBUTION NETWORK

The primary network of steel pipelines provides the core backbone connecting CGS to various DRS. The pressure levels for primary network are between 26 bar(g) to 19 bar(g). While most of the industrial customers are not required to be supplied at this pressure level, only a select few units have specific requirement for medium pressure delivery would be connected to through this network. The design of the primary network is based on the demand forecast to be catered.

Secondary network system consisting of MDPE pipelines operates at pressure level between 4 bar(g) to 1 bar(g). MDPE pipeline network is planned for cluster of industrial, commercial or domestic units at low pressure. The secondary network is normally developed with MDPE pipes.

Using the domestic / small commercial quantity and large commercial quantity values, and additional information, including location of customers, pressure requirements at major customers, availability of existing supply, and geographic features, optimum method of supply is determined and the network is designed and constructed accordingly.

The supply facilities include the following:-

- High pressure Steel pipeline main
- Medium pressure Steel pipelines
- Low pressure MDPE mains
- Low pressure MDPE services
- CGS/ DRS / Hot Taps
- Service Connections
- Odorisation Facilities

VARIOUS STATIONS INVOLVED IN THE NETWORK

The various stations involved in the network are:

- City Gate Station (CGS)
- Pressure Reduction Station (PRS)

- District Regulating Station (DRS)

City Gate Station (CGS):

CGS for the network is normally located at Tap off point of the main transmission line or else connected by a spurline to the main transmission line. The CGS has an inlet supply mains from the transmission pipeline, a pressure reduction system, a filtering unit, gas chromatograph and metering, odorant injection system and associated piping alongwith various monitoring and control systems.

The gas transported at city gate station is at a high pressure. The pressure reduction facility comprises pressure regulator runs with standby units, each having an active /monitor regulator, each fitted with 'slam-shut' protection facilities. In addition, provision can be made for natural gas pre-heaters, as per the design requirements.

It is recommended that a CGS be located in a fenced off secure area. To supply the remainder of the distribution system from the 26 bar maximum transmission pressure system, 'DRS' is required. The DRS will be similar in design to the City Gate with different capacity, except no allowance is normally required for gas heating.

Industrial Pressure Reduction Station (IPRS):

IPRS for the network is located in major Industries. It has a pressure reduction system, a filtering unit, Turbine metering system, valves etc. Based on the consumption profile of the user, customized arrangements are designed with metering arrangement. The IPRS has slam shut valves, pressure regulating valves, creep relief valve and vent, isolation valves, non-return valves and pressure gauges.

District Regulating Station (DRS):

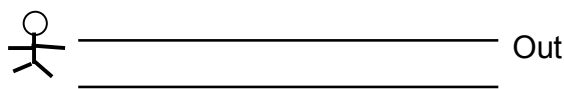
DRS for the network is located at strategic locations which are sometimes also known as field regulating stations to meet various demand centers for Domestic/ Industrial segment. It too has a pressure reduction system, a filtering unit, Turbine metering system, valves etc. Based on the consumption profile of cluster of users, customized arrangements are designed with online metering arrangement. The DRS too has a slam shut valves, pressure regulating valves, creep relief valve and vent, isolation valves and no-return valves.

Basically there are three sections that describe the purpose and different component of stations located at a pressure levels interface

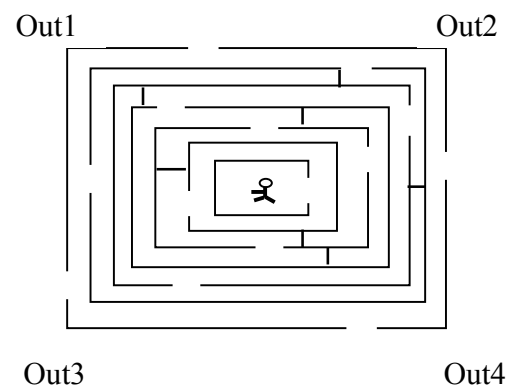
- The City Gate : interface between High Pressure and Medium Pressure;
- The Pressure Reducing Station : interface between Medium Pressure and Low Pressure
- The Service Connection: interface between network and end-user pressure.

CHALLENGES IN CITY GAS DISTRIBUTION NETWORK

The challenges in City Gas Distribution Network can be compared with the simple puzzle” to find the way out”. Wherein a person stuck up inside a maze has to find his way out. In contrast, the cross country pipeline the person has to follow practically straight line path to come out.



Cross Country Pipeline



City Gas Pipeline Network

Similar to the puzzle, city gas distribution network has different routes of varying lengths and sizes crossing various hurdles and catering to different end users. The challenges start from the very beginning of the project when the network is to be laid and continues when the network comes into operation. As more and more number of branches and consumers are added to the network, the complexity goes on increasing.

The various challenges in city gas distribution network can be categorized under two broad heads as below –

- (a) Setting up the Network
- (b) Operation & Maintenance of the Network

SETTING UP THE NETWORK

No separate corridors or ROW is available in the city area for laying of gas pipelines. The pipeline is to be laid along the road side or under the pathways in whatever space is available alongwith the other utilities like telecom cables, water pipes etc. Due to city congestion and traffic not enough working space is available for pipeline construction activities. Large number of metalled and unmetalled road crossings along with drains etc are to be made to take pipeline to the various end users. Each end user means a separate branch line for the user. As the pipeline is laid in the limited space available in parallel or

crossing the other utilities, additional precautions and care is required so that the other utilities do not get damaged. Where steel pipelines are used, providing effective cathodic protection for the city pipeline network is also a challenging task. As safety cannot be compromised, all the standard codes in design and construction have to followed and compliance has to be strictly ensured.

The dynamic nature of city gas distribution, with frequent addition of new consumers also requires continuous up gradation and expansion of pipeline network.

OPERATION AND MAINTENANCE

Once the network has been set up and gas is charged in the pipeline network, it is not only required ensure continuous availability of gas to the consumers but also to maintain the health of the pipeline system. The safety of the system and the surrounding areas is of paramount importance in city area. A small leakage or an accident / fire in gas pipeline may result into a big catastrophe. A quick vigil is required to be maintained by the O&M personnel to face the following challenges in the city gas distribution.

1. Safety and Emergency preparedness.
2. Customer related operations like
 - (a) Proper metering and billing.
 - (b) Changing pressure and flow requirements of consumers.
 - (c) Shutdown, overdrawl, non-payment by the consumers.
 - (d) Consumer education and training.
3. Liasoning with District Authorities and other utility departments.

The paper focuses on aspects related to Safety and Emergency preparedness in a City Gas Distribution Network and an example of City Gas Distribution network established by GAIL(India) Ltd. in the cities of Agra and Firozabad in India has been taken to discuss the issues involved.

SAFETY AND EMERGENCY PREPAREDNESS

Genesis of Hazard

- a) The major hazard in gas supply is a leak or rupture of pipeline, resulting in uncontrolled gas release. The gas leaks can prove hazardous if mishandled or not properly disposed off. The situation can assume disastrous proportions if adequate, safe and timely actions are not taken. It is, therefore, essential to have an organized plan of action.
- b) Possible causes of gas leaks-
 1. Pipeline damage due to construction/material failure, corrosion or mechanical damage etc.
 2. Flange leak due to material failure, wrong gasket. (Inside customer's premises only)

3. Valve leak due to stem seal failure, assembly failure etc. Valve seal leak can occur as a result of ageing, filthiness, damage, wrong gasket used or assembly failure.
 4. Enemy Action / Sabotage / Natural calamities like earthquake, flood etc.
- c) In a typical City Gas Distribution network the other main underground utilities are OFC, telephones cables, power cables, sewer and water lines. Historical data available from world over indicate that the main risk to the pipeline integrity is from damage created by third parties e.g. a crew repairing telecom cable or water mains may inadvertently damage the gas pipeline in the process of excavation.

In total there are about 21 threats to the gas pipeline networks as identified under the code ASME B31.8S which if not taken care of at the appropriate stage and time, may cause a serious damage in the pipeline network. However, all of these threats may or may not be applicable for a particular network at a given time. The network needs to be examined against each of the possible threats to identify the possible and potential hazards to the pipeline network. Accordingly, steps have to be taken to appropriately handle these threats right from the design and construction stage to operations and maintenance stage for the entire life “Through Life” of the pipeline network. Various steps and issues related to Safety and Emergency Preparedness at different stages in the life cycle of a city gas distribution network are described in the forthcoming paragraphs.

A. BUILT IN DESIGN FEATURES

The pipeline distribution networks installed for transportation and distribution of gas to the various consumers must have the required built in safety systems to ensure safe operation of the system. These built in features for Agra & Firozabad distribution networks in consideration are described below-

In Main Bajhera - Agra – Firozabad Spurline

GAIL has laid a 53 kms. of 10” dia pipeline from 36” mainline (GREP Pipeline) at Bajhera (near Bharatpur) up to Agra and then 35 kms. Of 10” and 8” dia pipeline from Agra to Firozabad. This 10”/8” cross-country pipeline is known as Bajhera – Agra – Firozabad Spurline. This underground pipeline has been provided with three-layer polyethylene coating over it for protection against external corrosion. Apart from PE coating, the cathodic protection has also been given to the pipeline. In between Bajhera & Agra, as also between Agra and Firozabad, a sectionalising valve has been provided. In case of heavy leakage of gas or fire, we can isolate the gas supply in the affected section by closing the related isolation valves. The inlet valves at Bajhera , Agra and Firozabad stations can be operated both locally and from Master control room at Vijaipur through SCADA. Also the pressure profile of the network at both the tap off point and at City Gate Station is continuously monitored in the master control room through SCADA. This spurline is a piggable line.

At City Gate Station

City Gate Station (CGS) is a terminal from where the gas supply to the city is made & monitored. All process parameters like pressure, temperature, flow & gas composition etc. are monitored in the control building.

The natural gas as received at C.G.S. at a high pressure of 50 – 65 kg/cm² (g) is filtered and passed through PCV/SDV streams to reduce the pressure to 15 Kg/Cm². PCV maintains the down stream pressure in the City Distribution Network irrespective of the upstream pressure. Before PCV, a Shutdown Valve (SDV) has been installed which senses the City Distribution pressure and in case of any malfunctioning of PCV, it will stop the gas supply in the City Distribution Network at a pre-set pressure which is usually kept slightly higher than the PCV set pressure. Two Pressure Safety Valves (PSV) have also been installed in the line downstream of PCV/SDV. These acts as a third line of defense against uncontrolled pressure rise in the city gas distribution network. In case, both PCV & SDV malfunctions and the city distribution network pressure starts increasing then at a set pressure of 19.5 Kg/Cm², the PSV's will come into operation and will release the excess pressure. Finally, the gas is passed through the flow meters where the flow of gas is measured before it goes in the city network. All the critical process parameters are continuously available in the local as well as Master Control Room.

Other available safety devices/equipment at city gate stations are,

- a) LEL detectors installed around process area
- b) Fire water network
- c) Break Glass units
- d) Fire extinguishers of various types.
- e) A dedicated communication system for communication with all pipeline installations on the network and with Master Control Room.

In City Gas Distribution Network

8" dia main with 3" / 2" dia branch lines, network has been laid in the city at a depth of 1.0 mtr. and the new distribution lines have been laid at a depth of 1.5 mtr. from ground level and operating at a pressure of 15 Kg/cm². Pipeline has been extended to the premises of individual consumers from this network. The total length of pipeline network in each city is a little over 50 kms. Major portion of the network has been laid with steel pipe and some of it has been constructed using PE pipes.. Primary protection to the pipeline against external corrosion has been given by PE / Coal Tar coating / cold tapes. Cathodic Protection has also been given in the network apart from coating of pipeline. Sectionalizing valves have been provided in the network at regular intervals. A separate valve has also been provided in each of the branch lines and again at the inlet to each consumer point. In case of emergency, gas supply in the affected section can be stopped by closing the upstream and downstream valves. Pipeline markers at every 50 mtrs. distance and warning signs at approx. 500 mtrs. distance have also been installed for easy identification of pipeline. A continuous warning tape has been provided at the top of the entire pipeline in the city. Gas Venting facility has been provided at the City Gate Stations and also at each customer end for venting out the entire gas from the respective city gas networks in about 15 minutes in case of any emergency.

At Consumer End Terminals

As on date there are over 150 small industrial customers in Agra alongwith CNG stations for supply of gas to the transport sector. Similarly, there are over 185 small industrial customers in the city of Firozabad. Customers in Agra are mostly foundary units and that in Firozabad are Glass manufacturing units. Pressure reduction and Metering skids have been provided at each consumer end where gas is filtered, pressure is reduced to 2-3 Kg/Cm² and gas flow is metered before its delivery to the consumer. The skids have the filter element, PCV SDV, PSV, Flow meter and Electronic Volume Corrector (EVC) for proper regulation, flow measurement and safety of the system. In case of any emergency, inlet valve in our pipeline before the metering skid can be closed for stoppage of gas supply. These skids are installed in open environment and fenced with barbed wire/ wire mesh.

B. OPERATIONAL PREPAREDNESS

Any system no matter how well designed, cannot serve the purpose unless it is closely monitored and maintained to perform. GAIL for its networks in Agra & Firozabad has developed such system to support and make best use of the above mentioned built in facilities to ensure safety of the public and the property and to prevent any untoward incident. Some such steps taken by GAIL are described below.

1. Daily line walk by security Guards over the entire city pipelines to monitor activities of other external agencies in the vicinity of our pipeline route. This ensures that no other utility department or agency starts digging over the pipeline without GAIL's knowledge.
2. Station-In-Charge maintains close contact with other utility departments like BSNL, NHAI, PWD, Water works, municipal corporation etc. so that any digging activity of theirs can be pre-planned by taking care of our pipeline.
3. All the consumers have been issued safety pamphlets and recommendations regarding safety arrangements to be taken care at their end while designing their gas use systems.
4. Ready inventory of emergency equipment, spares and tools.
5. Preventive maintenance activities are being carried out in a planned manner as per ISO schedules to ensure proper working of systems.
6. Safety Mock drills are carried out every month.
7. Internal safety audits by a team of qualified engineers and annual external safety audits from reputed agencies like OISD, Germinsher Lloyd, MGL etc. are carried out.
8. A toll free number has been provided on all the pipeline markers which is connected to the National and Regional Gas Management Centre.
9. Local control rooms are manned round the clock.
10. Regular trainings are provided not only to the employees and staff of the company but also to the contractors, customers, officials from the district authorities and other utility departments and general public in the vicinity of the pipeline network.

C. EMERGENCY PREPAREDNESS

The unprecedented situations where the accidents happen inspite of all the built in safety features and actions, have to be handled effectively and efficiently so as to minimize its effect and losses to the public and the property. Any organization has to be very well prepared to handle such emergency situations, as any let out may result into a major disaster affecting the life and property of many in the congested city areas.

Emergency Response and Disaster Management Plan

Particular care must be taken when handling natural gas. Prompt action must be taken to stop leaks, and very small fires nearby must be extinguished immediately to prevent a difficult or uncontrolled situation from developing.

Once a significant fire has developed, personnel will almost certainly not be able to approach the point of leakage, or to attack the fire itself, because of the pressure of the gas escaping and the intense heat radiated by the fire. In fact, even if it was possible, immediate extinguishing of the flames may be dangerous because almost certainly there would be a “flash-back” as the leaking gas may catch fire from surfaces heated by the fire. The procedure for tackling such incidents is ;

1. Ensure whereabouts and safety of all personnel.
2. Inform the fire brigade/Safety Department.
3. Isolate the section of the pipeline from which gas is leaking.
4. Protect the section of the pipeline from which gas is leaking.
5. Only where the fire has been greatly reduced by loss of pressure and is under control, should it be extinguished by power appliances. Water hoses and monitors must continue to cool surrounding equipment until gas leakage has been stopped. If gas leakage cannot be shut-off completely, it would be safe to leave the fire burning in a contained manner, until positive shut-off has been established. Such action would prevent danger of “flash-back”.

GAIL (India) Ltd. has a well defined and documented Emergency Response and Disaster Management Plan. The plan is prepared in consultation with all the agencies and departments involved in handing of an emergency situation arising out of a gas leakage or a fire and the same is approved by the District level head i.e. the District Magistrate. Copies of this plan are made available along with the city gas network maps to all the concerned authorities and executives. Key features of the plan include-

- Description & details of the city gas pipeline network
- Identification and definition of Roles, Responsibilities and Authorities
- Procedures for Emergency Handling, Shutdowns and Evacuations
- Emergency contact numbers
- Mutual aid agencies and their roles

- Important Do's and Don'ts
- List and location of Emergency tools and spares
- Training requirements and plans

Effective Liasoning With District Authorities & Other Utility Departments

According to the historical data available on incidents and accidents on gas pipeline networks world over, the biggest threat to the gas pipeline networks is from third party damages. Therefore, City Gas Distribution Network, whether it is only for industrial supply as in Agra – Firozabad or including CNG and domestic supplies, requires a close coordination and liasoning with the District Authorities, other oil and gas companies and utility departments like Telecom, City Municipal Department, Water Works, Public Works Department (PWD), Electricity Authorities etc. Any development activity by a department in the vicinity of pipeline network may result in an accidental damage to the pipeline and vice-versa while laying of pipeline care is to be taken for other utilities coming close to the pipeline route. Therefore, a close coordination is required with all these agencies and departments. As on today, in India there is no system like “One Call System” which can bring all the utility departments on one platform. This necessitates greater level of coordination to be maintained at local level between different utility departments by the concerned officials. The coordination is also essential to ensure that the development plan of the gas pipeline network remain in tune with the development plans of the city.

One of the incidences that took place in the city network is presented below:

Incidence : Gas leakage & Fire in the 3” branch line valve.

Place : 3” tap off line near National Highway.

Date & Time : 8.20 PM, 6.4.2002 (Saturday)

After a shutdown of 7 days (from 30.3.2002 to 6.4.2002) for the City Gas Network Expansion works, the gas supply to Firozabad consumers was resumed on 7.30 PM on 6.4.2002. Soon after the resumption of gas supply at 8.20 PM a phone call was received from one of the consumer informing that there's a fire on the Gas pipeline near his factory in 3” tap off line connecting. Executive who was available at City Gate Station at that time, responded immediately by shutting off the gas supply to city network and started the venting off the gas from CGS. In about 20 minutes time the entire network was depressurized and the fire was extinguished at site. There was a quick response from the fire department and local administration. Fire tender reached the site quickly and along with police they cordoned off the entire area and kept the surrounding area cool to prevent the fire from spreading. Fire was extinguished once the gas supply had been stopped from the CGS and network was depressurized.

Thereafter, the excavation was done and further action was taken to rectify the problem and restore the supplies.

Total system was restored and gas supply resumed was to consumers by 12.30 hrs. on 7.4.2002

Loss / Damages :

No casualty has occurred due to the leakage / fire. Also no significant damages have occurred except for damage to the belongings (line clothes, bed, food grains, utensils etc.) of a guard living in the adjacent premises.

Reason / Causes :

The 3" valve was installed in the underground branch line during the present shutdown and after installation it was covered with sand bags and loose soil so that no body falls in the valve pit till the valve chamber is completed. It was suspected that some heavy vehicle crossed over the pit which resulted in rupturing of the valve body. Rupture in the HAZ portion of welding in valve body resulted in the leakage as soon as the gas pressure was increased in the network after resumption of shutdown. A spark from the overhead electrical lines provided the source of ignition.

Learning's from the Incidence:

The case though a very small one which didn't result in any loss of life or property provides a deep insight into the preparedness of any organization in responding to a emergency situation. It is always not necessary to wait for a casualty to happen before we take corrective actions to strengthen the safety systems. The case highlights the importance of the key elements of an emergency reponse and Dissater management plan and why proper coordination between all these elements is essential in effectively handling any kind of an emergency situation in the network. Timely action from all the agencies involved and their knowledge and skills helped in preventing any major loss and casualty in the present case.

CHALLENGES AHEAD

One of *Murphy's famous law* states that "*left to themselves, things will always go from bad to worse.*" This humorous prediction is, in a way, echoed in the second law of thermodynamics which states that "entropy (i.e. a measure of the disorder of a system) must always increase in the universe and in any hypothetical isolated system within it ." Practical application of this law says that to offset the effects of entropy, energy must be injected into any system. Without adding energy, the system becomes increasingly disordered. The same concept can very well be applied to the pipeline system. The networks have been designed and are operated to take care of any emergency in the city area as described above. However, ensuring safety at all times calls for continuous monitoring, review and improvement in the system. These are the means of injecting energy into the system to offset the effects of entropy. Monitoring, review and improvement are tools that not only help to enhance the effectiveness and safety of the present system but also help to design and implement the future system in a better way.

Time has come when Natural Gas as an industrial, domestic and automotive fuel is gaining popularity in India. This is reflected in the fact that India today operates the largest fleet of CNG buses in the world. With recent gas finds and import of gas, the gas shall be available in abundance in the years to come. Keeping in tune, the City Gas network in the existing cities are expanding and also City Gas Pipeline Networks are being set up to cover more cities not only for industrial supply but also for the domestic as well as automotive sector. More and more consumers are being added on to the existing network and the length of the network is growing swiftly. GAIL is all set to expand its existing pipeline network and establish CGD networks in many more cities in the country.

This possess greater challenges for the personnel involved in setting up, operating and maintaining the City Gas Distribution Pipeline Networks. With the vast experience gained in this field, GAIL is all set to take these challenges and remain committed to un-interrupted supply of Natural Gas to its existing and future customers

References :

1. System Design documents of Agra & Firozabad City Gas Distribution Networks.
2. Emergency Action Plan For Agra and Firozabad City Gas Distribution Networks.
3. W. Kent Muhlbauer, “ Pipeline Risk Management Manual “, Gulf Publishing Company, Houston, Texas, 1996.

