Report SGC 088

TECHNICAL DESCRIPTION OF THE SWEDISH NATURAL GAS DISTRIBUTION SYSTEM

Ronny Nilsson
KM MILJÖTEKNIK AB

Report SGC 088 ISSN 1102-7371 ISRN SGC-R--088-SE

SGC Svenskt Gastekniskt Center AB

FOREWORD

RD&D-projects performed by the Swedish Gas Centre, are usually presented in reports, available to each and everyone who wants to share the results of a project.

SGC prints and publishes the reports but the authors of each report are responsible for the accuracy of the content. Everyone making use of any description, results etc, will do this on his own responsibility. Excerpts from a report may be used if the source is indicated

Swedish Gas Centre (SGC) is a joint venture of energy gas business organisations. SGC's primary mission is to co-ordinate the joint Research, Development and Demonstration (RD&D) efforts that are performed within the Swedish gas industry. The shareholders of SGC are: The Swedish Gas Association, Sydgas AB, Sydkraft AB, Gothenburg Energy, Lund Energy and Helsingborg Energy.

This project has been funded by:

- Sydgas
- Vattenfall Naturgas
- Gothenburg Energy
- Helsingborg Energy
- Lund Energy
- Stockholm Energy Gas Company

SWEDISH GAS CENTRE

Johan Rietz
President

CONTENT

page

Technical description of the Swedish distribution network for natural gas

1 INTRODUCTION

Natural gas has been used in Sweden since 1985. The development of the Swedish network for natural gas has taken place gradually. At present the network covers the western part of Sk ne, parts of central Sk ne as well as the west coast up to and including G teborg, including a high pressure line to Hyltebruk. Thus the introduction of natural gas in Sweden has occurred relatively late as compared with other countries in Europe, which means, among other things, that the technical design of the network could to a considerable extent be based on experience from the development of the European networks for natural gas.

This description of the Swedish distribution network has been produced to provide information for distribution companies, trade organisations, etc., who have an interest in getting a clear understanding of the technical design and standards, technical directives, etc., which have served as guidance in the development. The technical description covers the piping system from a measuring and regulating station (MR station) up to the consumer s substation, however, only sections with a maximum operating pressure of 4 bar. By way of introduction, the description contains introductory information on supply channels, consumption patterns and the principal design of the high-pressure network in Sweden.

The description has been prepared by direction of the Swedish Gas Centre (SGC) and is being published in a Swedish and an English version.

2 NATURAL GAS IN SWEDEN

2.1 Background

Deliveries of natural gas to Sweden take place via a supply pipe under resund, from Amager in Denmark to Klagshamn south of Malm . Import to the Swedish natural gas network is exclusively made from the Danish natural gas fields in the North Sea. The Swedish natural gas network is connected with the European natural gas network via Denmark and Germany. The possibility of further expansion of the current network northward and eastward as well as the import from other countries is under investigation. To date this has not been implemented. The extension of the natural gas network is illustrated in figure 1.

Figure 1 The Swedish natural gas network in 1996

The import of natural gas has increased from 85 millions m^3 (0,9 TWh) in 1985 to 865 millions m^3 (9,3 TWh) in 1996, corresponding to 20 % of the energy supply within the developed area.

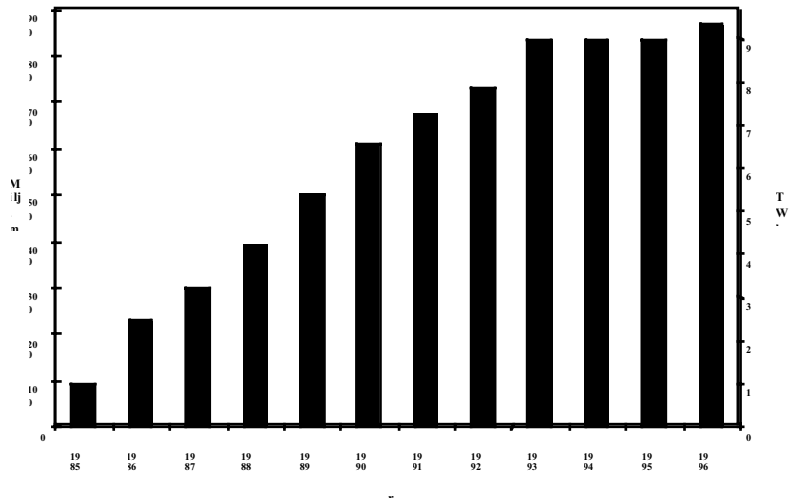


Figure 2 Import of natural gas. Development during the period 1985-1996.

Out of the imported quantity of natural gas approximately 50 % is supplied to the combined power and district heating sectors, whereas supplies to industry constitute approximately 35 %. The remaining 15 % are consumed by the private heating sector /1/, /2/.

2.2 Design of the natural gas network

Principally the natural gas network is divided into different parts with respect to pressure level and function as follows:

- High-pressure network, with an operating pressure ranging between 4 bar and 80 bar, with main pipe, branch pipes and measuring and regulating stations (MR stations)
- Distribution networks, with an operating pressure of maximum 4 bar, with regulating stations and service piping
- Customer installations, with a design operating pressure of either maximum 4 bar or maximum 100 mbar

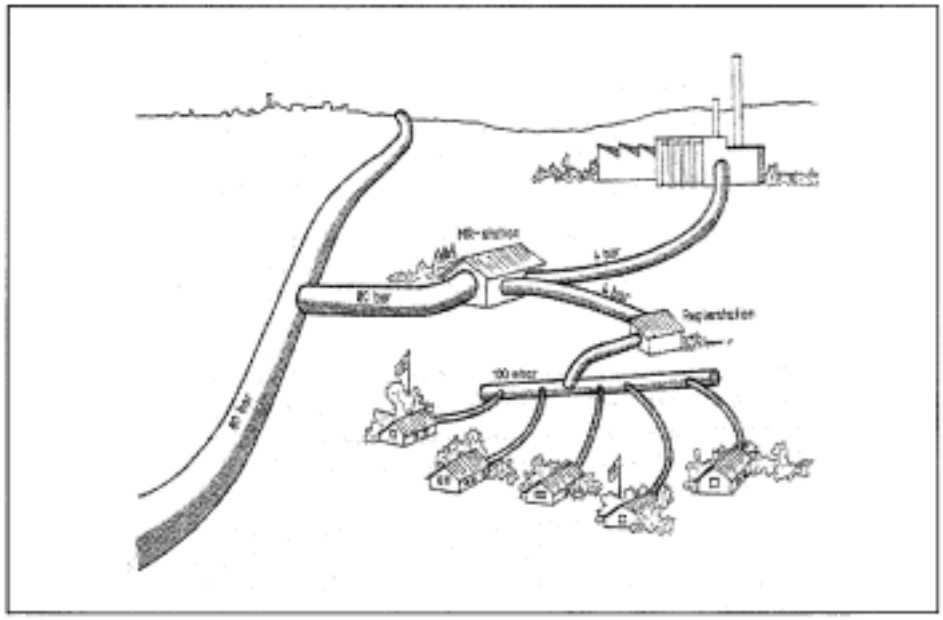


Figure 3 Principal construction of the natural gas network

2.2.1 The high-pressure network

The high-pressure network handles transportation of gas over long distances. The main pipe in the Swedish high-pressure network is 320 km long, with a yearly transport capacity amounting to a maximum of 3 billion m^3 or just under 35 TWh. The pipeline is made of steel and designed for a maximum pressure of 80 bar.

The high-pressure network also contains a number of pipes designed for 30, 24 and 16 bar respectively. High consumer categories or consumers requiring high gas pressure, for instance power stations, gas turbines or larger industries are supplied through these pipes. In the Swedish high pressure network for natural gas there are pipes for a maximum operating pressure of 16 bar in Malm , Lund, Helsingborg, Halmstad and G teborg, as well as on the route Bjuv-Billesholm. Pipes for maximum operating pressures higher than 16 bar are available for supplies to gas turbine power stations in Lund (24 bar), ngelholm (30 bar) and to Kemira Kemi AB in Helsingborg (30 bar).

The connection between the high-pressure system and the distribution network is through MR stations. In the MR station the gas pressure is reduced and the gas flow is measured. Maximum distribution pressure after a MR station is in most cases 4 bar.

2.2.2 The distribution network

In the distribution network the gas is distributed from the MR station to the consumers. The distribution pipes are mainly made of plastic (polyethylene, PE). Pipes of steel are only used to a limited extent and then only for large pipe sizes. In the distribution system the consumers are connected either to the 4 bar network or, after a regulation station, to a 100 mbar network. Normally the distribution network extends as far as to the consumer s plant, which means that it also includes the service pipe from the distribution pipe to the main cut-off valve in the customer s substation.

At present the Swedish distribution system is comprised of a total pipe length of approximately 2000 km. The extension of the distribution system for natural gas in Sweden started already in 1981 as a prephase connection of smaller distribution areas being supplied from temporary LPG stations. The LPG was mixed with air the station to obtain the same Wobbe index as the future natural gas fuel, in order that the installations within the supply area could be constructed for natural gas operation.

The main extension phase extended principally from 1981 up to and including 1990, and in the following years the extension of the natural gas network has entered a phase of reduced expansion, with only minor construction of new distribution networks.

2.3 The organisation

The conditions for import of natural gas for the Swedish natural gas network are regulated in a contract with the Danish supplier Dangas. Vattenfall Naturgas AB is the importer of natural gas and owner of the main pipeline, including MR stations north of Falkenberg. South of this boundary at Falkenberg the branch pipes and MR stations are owned by the regional gas company Sydgas AB.

The distribution networks after the MR stations are owned and operated by a number of distribution companies. The biggest distributor is Sydgas AB with a distribution area comprising approximately 20 districts ranging from Trelleborg in the south to Falkenberg in the north. Thus Sydgas AB plays a part both as a regional gas company with activities within the high-pressure network and as distributor in a number of distribution networks.

In Helsingborg, Lund, Varberg and G teborg the distribution networks for natural gas are owned and operated by the local energy companies. Helsingborg Energi AB and Lunds Energi AB are also minority owners of Sydgas AB. There is also a minor distribution network owned by ngelholm Energi AB.

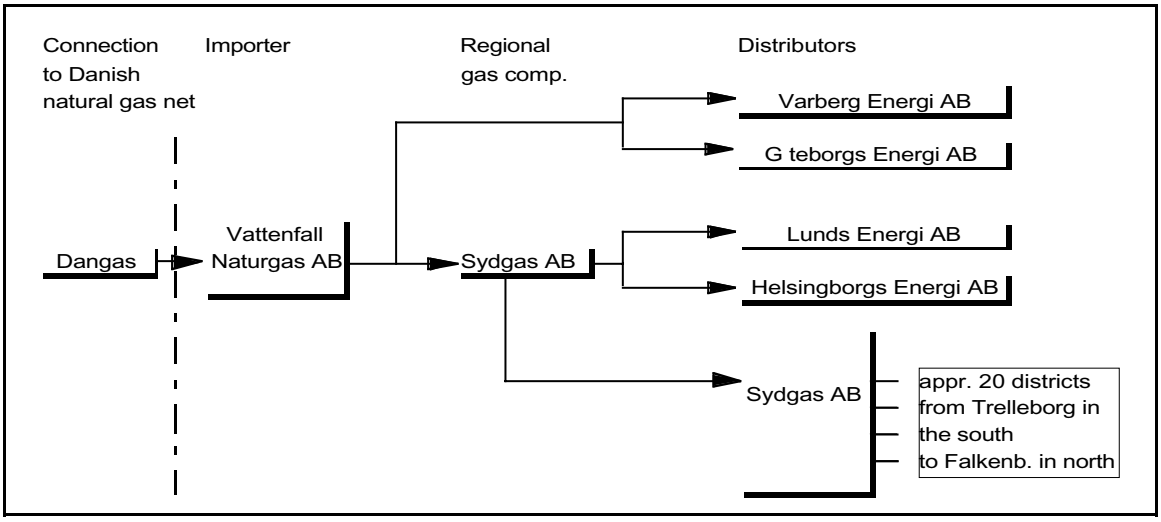


Figure 4 The organisation

Supplied quantity of energy and total pipe length in 1996 for the respective distribution companies can be seen in table 1.

Table 1 Distributor	Distributed energy quantity 1996 (GWh/year)	Total pipe length 1996 (km)
Sydgas AB	5765	1250
Lunds Energi AB	680	136
Helsingborg Energi AB	645	140
Varberg Energi AB	130	50
G teborg Energi AB	1890 [1)]	470 [2)]
Total	9100	2050

[1)] Of which 90 GWh natural gas/air mixture in the original city gas network
[2)] Of which 331 km original city gas network

2.4 Legislation and standards

Handling and distribution of natural gas is regulated in the law covering flammable and explosive goods (SFS 1988:868)[1] with ordinance according to SFS 1988:1145. The National Inspectorate of Explosives and Flammables is the central authority responsible for adherence to the laws and regulations covering flammable and explosive goods, as well the conditions laid down by the law and ordinance.

For natural gas systems with higher operating pressures than 4 bar the National Inspectorate s directions for natural gas (S IFS 1987:2)[2] and the standards for natural gas systems (NGSN 87) are applied. For distribution systems with operating pressure of maximum 4 bar the National Inspectorate, in constitution S IFS 1995:3, notes exceptions to the law about flammable and explosive goods. The permit duty is then replaced by other particular demands which, briefly explained, means that the responsibility for the plants and for operation and control of the system can be placed with the distribution company according to rules prepared in consultation with the National Inspectorate of Explosives and Flammables.

[1] SFS= The National statute-book
[2] SÄIFS = The statute-book of the National Inspectorare of Explosives and Flammables

Based on this constitution the legislation for natural gas and the legislation for bottled gas in vapour phase and biogas with a maximum operating pressure of 4 bar have been co-ordinated in the energy gas standard (EGN 94). For the construction of plants with a maximum operating pressure of 4 bar, EGN 94 is normally applied. Alternatively it is necessary to apply for a special permit from the National Inspectorate of Explosives and Flammables in each individual case.

The Swedish Gas Association has prepared EGN 94, which is a trade association for the gas industry. The activities of the association include preparation of standards and directives for the safe use of energy gases. Members of the association are gas distributors, energy companies, oil companies, manufacturers of gas equipment, consulting firms, etc.

According to Swedish legislation the distributor has overall responsibility, and exercises a control function right up to the site, where the gas is used, in principle up to and including the gas flame, in contrast to what is often the case in other countries. This means that the control also includes, for instance, the laying of pipes and gas appliances within the customer s plant in the distributor s area of responsibility.

3. TECHNICAL DESIGN OF THE DISTRIBUTION NETWORK

3.1 General

The introduction of natural gas in Sweden took place relatively late compared with other countries in Europe, which has, among other things, meant that the distribution network could be designed with modern technique mainly based on experiences from the European natural gas networks. The basic principles of the design are stated in EGN 94, containing instructions on the technical design in order to have safe plants, at the same time leaving room for variations in the detailed design. The description contains the distribution network from the MR station up to the customer s substation.

3.2 MR stations

The MR station is by definition part of the high-pressure system, and is the point separating the high-pressure network from the distribution network. The MR station has always two identical, parallel armature lines constituting standby for each other. In case of malfunction in the pressure regulating equipment in the line in operation, the parallel line is connected automatically.

After pressure reduction in the MR station, pressure, temperature and flow are normally measured. Measured values are used for debiting of gas quantity between Vattenfall Naturgas AB and the respective distributor.

The Swedish natural gas network contains at present approximately 30 MR stations located as shown in the map, figure 5.

Figure 5 The Swedish high-pressure network for natural gas with MR stations

3.3 Line network

3.3.1 Design

The distribution network contains two pressure levels, i.e. 4 bar and 100 mbar respectively. The capacity of a given pipe dimension increases at higher pressure. Maximum pressure level for pipes of plastic is 4 bar. The prerequisite for a100 mbar network to be of interest is that the installation density is high, which is normally only the case in areas with family dwellings, which have been densely built up. For a 100 mbar network, costs for a regulating station and, in most cases, also bigger pipe dimensions, have to be added. On the other hand the substations are cheaper and simpler to construct in a 100 mbar network. The Swedish distribution network for natural gas contains a relatively limited number of distribution areas for operating pressures of maximum 100 mbar. This means that the majority of the distribution networks have an operating pressure of maximum 4 bar.

In most cases planning and design of the distribution networks in Sweden have been based on a technical/economical evaluation made by the distributor. The pipe networks have thus been designed in such a way that the highest possible safety against damages and service interruptions have been achieved and that consequences of can be limited. In a branched network a service interruption would mean that a number of consumers are cut off from the gas supply. The supply safety in the distribution system can be improved by designing the network as a ring network, in which case the

majority of subscribers can receive gas through more than one supply pipe. Within the Swedish distribution system it has been endeavoured to apply ring feeding, wherever it can be defended economically.

Networks with complete ring supply, i.e. when two or more supply pipes for the network are available, exist today in Malm and Lund. In Malm supplies to the entire network can take place from three different MR stations.

The development of the natural gas system in G teborg has primarily been concentrated on connection of relatively big industrial customers. Therefore the natural gas networks consist mainly of supply pipes of larger dimensions for relatively big customers with remote location. At present the distribution system is connected to the high-pressure network via two MR stations.

In Helsingborg an extension of supply pipes from a new MR station at M rarp is taking place, which means that the distribution network will get two supply pipes. According to plans this extension should be ready in the spring of 1997, and then the network in Helsingborg has the possibility of complete ring supplies.

3.3.2 Distribution in older city gas networks

Previously Malm and G teborg had city gas networks supplying the central parts of the respective city with city gas, which was produced from petroleum raw materials in a gas works. The development of distribution systems for natural gas in these cities has partially taken place by utilising the city gas networks, in which a mixture of natural gas and air are distributed. The natural gas is diluted with air in mixing stations. These mixing stations are located on the site of the old gas works.

The mixing proportions are 53 % natural gas and 47 % air, so that a Wobbe index corresponding to that of city gas is obtained. Thus the mixture of natural gas and air can be used in existing city gas installations. In Malm , monoethylene glycol is added in order to also give the mixture of natural gas and air a consistency similar to that of the city gas to reduce risk of damage to older types of pipe joints, which are found in the old city gas network.

The original city gas network in Malm comprises approximately 100 km pipes of cast iron and steel. Certain parts of the network have been renovated for conversion into 100 mbar natural gas networks, partly through relining with PE pipes in old pipes of cast iron, and partly through so called sleeving , i.e. a reinforcement of each joint in existing pipes of cast iron with aluminium foil glued on the inside.

In G teborg, distribution of the mixture of natural gas and air takes place in the entire old city gas network containing approximately 340 km pipes, of which approximately 75 km are an intermediate pressure network with approximately 200 mbar operating pressure. 18 regulating stations are connected to the intermediate pressure network, for regulation of the gas pressure to approximately 10 mbar.

In both cities an inventory of the existing city gas networks has been made, and the plan is to gradually replace the older steel and cast iron pipes by modern PE pipes over a period of 10-20 years.

3.3.3 Safety distance

Gas pipes are built considering demands for a minimum distance to buildings and other installations. In densely built-up areas the distance from gas pipes to buildings are generally at least 2 metres. However,

exceptions are granted for placements under streets. Outside densely built-up areas the safety distance to buildings is at least 12 metres for pipes without protection, and at least 2 metres if the pipes have protective conduits or lie in road reserves.

The safety distance between gas pipe and other parallelly laid and crossing pipes varies depending on the contents and function of such pipes.

When constructing the distribution networks in Sweden it has on the whole been possible to apply these safety distances without too serious problems. For critical passages with accessibility problems, solutions with heat insulating material between the gas pipes and heat emitting pipes have been applied. For crossing of, or parallel laying with pipes and cable conduits, gas-tight conduits are sometimes used.

3.3.4 Pipe material

The distribution networks for natural gas are almost exclusively constructed with pipes of polyethylene (PE). Pipes of steel in pressure vessel quality with PE coatings corrosive protection are used to some minor extent. The choice between PE and steel has mainly been determined by the price. Generally, it is cheaper to build systems with plastic pipes, and maintenance costs are lower, since no cathode protection (electro-chemical protection) is required for such systems. However, for large dimensions the PE pipes are not economical, partly due to the fact that pipe parts like buoys, drilling saddles, T-pipes, etc. are not available as standard products, and partly because the material for these dimensions is so thick that the material costs will influence the total costs to a considerable extent. PE pipes in these large dimensions are also heavier and more difficult to handle during the execution of the piping work. It has thus been calculated that it would in general mean higher costs to use PE pipes in dimensions larger than d_e=225 mm, than for steel pipes with a corresponding capacity. Therefore steel pipes with PE coating have normally been used in case of dimensions exceeding d_e=225 mm.

PE pipes in larger dimensions ($\geq d_e$=90 mm) are normally supplied in lengths of 10 metres. For smaller dimensions only pipes in rolls of 100 and 50 metres respectively are in principle used. Dimension d_e=63 mm is preferably supplied in straight lengths of 10 metres but is also found in rolls of 50 metres.

3.3.5 Jointing of pipes

PE pipes laid in the ground are normally joined with weld joints. Welding of PE pipes is carried out either as welded butt joint, also called mirror welding, or as electro-sleeve welding. Butt welding is chiefly used for joining straight pipe parts, whereas electro-sleeve welding is mainly used for jointing of smaller dimension, for jointing of other pipe parts like bifurcated pipes, restrictions, pipe buoys, etc. or when it is necessary, for instance in case of narrow passages and the like, to carry out the jointing work directly in the trench. Connection of new service pipes is often carried out during operation by placing an electro-sleeve in the form of drill clamps with a drill sleeve around the main pipe.

When steel pipes are laid in the ground, welding is applied as jointing method.

3.3.6 Corrosive protection for steel pipes

From a corrosion point of view pipes of plastic are better than steel pipes and do not require any special corrosive protection for laying in the ground.

Natural gas pipes of steel laid in the ground are provided with a protective surface coating of PE carried out in the factory. The surface coating constitutes a passive corrosive protection and shall be electrically insulating and diffusion-tight. The joints are corrosion protected by means of tape of polyethylene. As a supplement to the passive corrosive protection all steel pipes in the distribution networks are provided with electro-chemical protection.

The distribution company is responsible for supervising the electro-chemical protection, and for checking its function at regular intervals.

3.4 Laying technique

The usual method used when laying natural gas pipes is laying by means of excavation. According to experience, the costs for pipes and ground works represent at least 50% of the total costs for the distribution network, mainly due to pipe dimension, type of ground and building types /3/.

Gas pipes laid in the ground are normally laid with coverage of earth of 0,6-1 m. If there is risk of high loads on the pipe, for instance from earth or traffic loads, the pipe must be laid in a conduit, or at increased depth. The normal procedure is to avoid laying in conduits as far as possible. A normal coverage in fields is, for instance, approximately 1,1 m considering agricultural drainage pipes and loads from agricultural machines. In order to prevent damage to the natural gas pipes, high demands are made on material for pipe bedding and filling around the pipes.

For crossing of roads, where it is not possible to arrange sufficient coverage of the gas pipe considering the road traffic, or if excavation of a road is not permitted, the gas pipe is laid in conduits. In case of crossing of a railway, or when the pipe is laid within the track area, the pipe is always laid in conduits according to ruling directives prepared by the National Rail Administration and Swedish Railways.

3.4.1 Pressing

Pressing of conduits of steel, by means of hydraulic jacks, is used approximately 80% for crossing of roads, and to 100 % for crossing of railways. However, pressing has not become generally accepted as a method for building of natural gas networks without excavation.

3.4.2 Ploughing

Laying of natural gas pipes by means of ploughing is a method of building without excavation, which has since around 1990 been applied to a certain extent in the southern part of the Swedish natural gas area, where loosely stratified earth and clay are found. The northern part of the natural gas area is a mountainous area with boulders in the ground, which makes ploughing difficult.

Ploughing of PE pipes for natural gas has been carried out in Sweden up to and including d_e=160 mm.

Based on investigations arranged by SGC, the costs for pipe and ground works including preliminary investigations and restoring works for laying through ploughing is calculated to be 50-75% of the costs for conventional excavation /6/ /7/.

3.4.3 Earth rocket

A compressed air operated earth rocket is chiefly used for making service connections in existing built-up areas. From a smaller pit in the pavement at the boundary of the property an earth rocket draws a conduit of PE material up to the house front, where the subscriber cabinet is to be mounted. The maximum range of the earth rocket is approximately 30 m.

Earth rockets are relatively widely used in the southern parts of the natural gas area. In the northern part of the natural gas area earth rockets are almost not used at all, for the same reasons as described under ploughing, i.e. the share of rocks and boulders in the ground is too high.

3.4.4 Crossing of watercourses

Crossing of watercourses with natural gas pipes, where the natural gas pipe is laid in bridges, is found only in very few places within the Swedish distribution system, and then only in bridges with very low traffic intensity. Instead crossings of watercourses are normally carried out by means of controlled drilling.

3.4.5 Controlled drilling

Controlled drilling is often used for laying of natural gas pipes without excavation for crossing of roads, watercourses etc. Controlled drilling can be applied for conduits with an outer diameter of up to 500 mm. The method is based on that drilling takes place from the ground surface, i.e. no underground devices are required. The deviation of the drill hole is controlled by means of laser technique and jet flushing. When applying controlled drilling, a pilot hole is first drilled, which is then enlarged in different steps depending on the final dimension desired. Controlled drilling has a maximum range of approximately 200 metres.

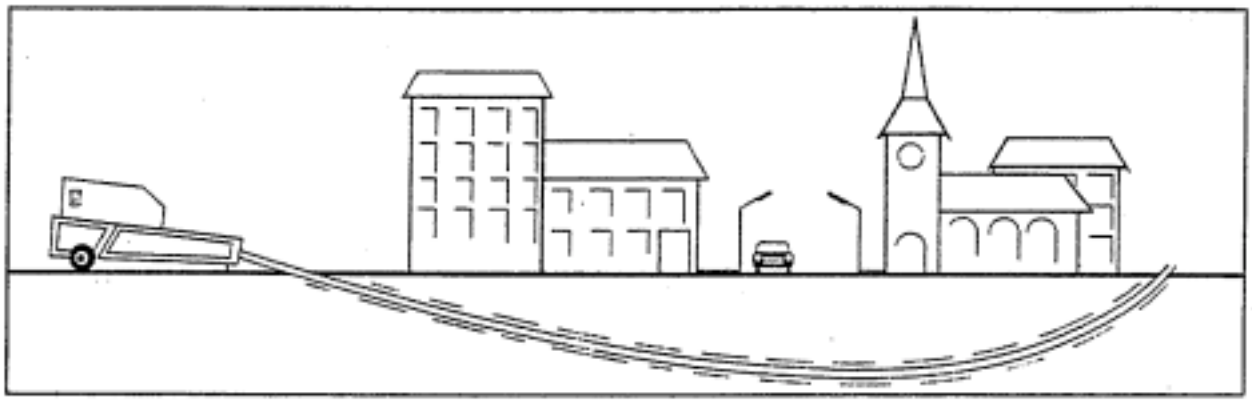


Figure 6 Procedure when applying controlled drilling

3.5 Marking of natural gas pipes

Experience has shown that the majority of all service interruptions are caused by digging damages to the pipe line networks. In order to reduce the risk of digging damages all distribution pipes are provided with a plastic warning band over the crown of the pipe. It is also quite usual that all plastic pipes are provided with devices for pipe location in the form of a so called tracer cable, which is fastened in earth plate poles and in subscriber stations. The tracer cable can, when pipe indication is required, be activated and be used for pipe location in the same way as indication of electrical cables.

Above ground the distribution pipes for natural gas are marked with signs, making it possible to follow the pipe line route. Figure 7 shows the appearance of marking signs within the Sydgas distribution area. The figure has been arranged and shows the sign used for marking in the countryside or outside densely built-up areas (the lower, bigger sign) and the sign for marking of pipes within densely built-up areas (the upper, smaller sign).

Figure 7 Marking signs

3.6 Pipeline accessories

Pipeline accessories in distribution systems for natural gas consist chiefly of cut-off valves for sectioning of the distribution system. Cut-off valves in the distribution system are normally placed on the in-going pipe to the regulating station, in connection with larger consumption areas, in-between extension stages, and before crossing of watercourses and railways. In 100 mbar networks cut-off valves are normally only placed on outgoing pipe from the regulating station and in-between extension areas.

During the development of the Swedish distribution system for natural gas, different valve types and valve material have been used. During the first part of the main development period, i.e. during the years 1981-90, mainly wedge sliding valves of steel were installed as valves in the ground. Over the years ball valves of plastic were gradually introduced. During a transition period ball valves composed of welding ends of plastic and metal housing with polyurethane covering and metal ball were used. In the Sydgas distribution area valve arrangements in the distribution network are today carried out, in all dimensions, as all plastic valves with even housing and ball made of plastic. Also in other distributor networks the tendency is that the share of plastic valves has increased in the last few years.

It is estimated that at present approximately 30% of all ground laid valves in the Swedish distribution network are plastic valves.

The position of ground-laid valves is marked with signs as described in section 3.5.

3.7 Regulating stations

Regulating stations in the distribution network are used to reduce the pressure from 4 bar to 100 mbar, when the distributor chooses to build the network as a 100 mbar network. The different distribution companies with business within the natural gas distribution system have endeavoured to find standardised solutions for the construction of regulating stations.

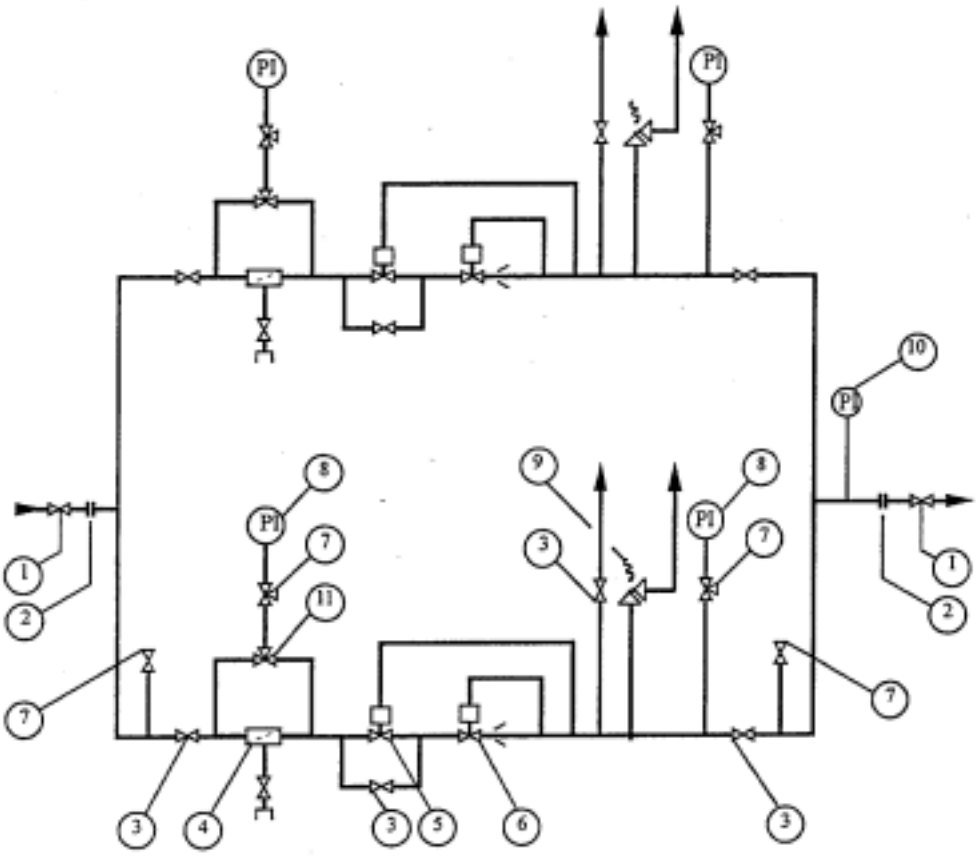
3.7.1 Motives for different pressure levels in the distribution system

The distribution system is mostly constructed with 4 bar pipes, which is the highest-pressure level plastic pipes can be used. Technically there is no difference between a plastic pipe for 4 bar and one for 100 mbar except that the 4 bar pipe has a higher capacity at a given dimension. The 100 mbar networks must always be supplemented with a regulating station, which means that the costs for it are added for these networks. 100 mbar networks are therefore exclusively used in areas of family dwellings and urbanised areas with high installation density. Generally, distribution networks for maximum 100 mbar are easier to adapt to residential districts and buildings with respect to construction and size of the consumer substation cabinet. In a 100 mbar network the consumer substation cabinet can be made in a considerably simpler construction and requires less space than a consumer substation cabinet for 4 bar.

The Swedish distribution system for natural gas is chiefly constructed for a maximum operating pressure of 4 bar. Distribution networks for maximum 100 mbar are found to a relatively limited extent. In the later part of the main development period also the extension of 100 mbar networks has decreased, and is today found only in areas with narrow space, where it can sometimes be difficult to place the consumer substation on an outside wall. At present approximately 85 regulating stations exist, for pressure regulation from 4 bar to 100 mbar, of which 75 stations are within the Sydgas distribution area. The capacity of the regulating stations varies from approximately 400 kW up to 10 MW.

3.7.2 Construction of the regulating station

Regulating stations contain equipment for pressure regulation and for quick switching off of gas supply with associated pipes. The equipment consists of two complete lines, of which one is standby, which will automatically take over operation in case of malfunction. Figure 8 shows an example of a skeleton diagram for a regulating station.



1. Cut-off valve in ground
2. Contact flange
3. Cut-off valve
4. Filter
5. Quick closing valve
6. Pressure regulator
7. Needle valve with connection for control manometer
8. Manometer
9. Leak flow valve
10. Thermometer
11. Valve

Figure 8 Skeleton diagram for regulating station according to EGN 94

Regulating stations are normally housed in detached buildings, which are built as protection against external influence on the gas equipment. Most of the regulating stations are made as prefabricated constructions like the regulating station for 5 MW connecting power shown in figure 9.

Figure 9 Regulating station of precast concrete units in Hj rup, 5MW connecting power

As an example of a regulating station with a special aesthetic design to fit in with an existing town environment, figure 10, shows the regulating station in the Tivolitorget in Laholm.

Figure 10 Regulating station in the Tivolitorget in Laholm, 10 MW connecting power

3.8 Service pipes

Service pipes, i.e. the part of the distribution network connecting the individual consumer s installation with the rest of the network, are always made in at least DN 25 (de=32 mm) and are normally provided with a service valve at the property boundary. The service pipe ends with a main cut-off valve before the subscriber station. Sometimes service pipes are made without a service valve for the smallest type of service pipes, i.e. DN 25. In that case the distribution network must be equipped with a sectioning valve common to maximum 30 service pipes.

Normally service pipes are laid through excavation or by means of an earth rocket depending on which method is deemed to be best suited in each individual case.

4 CONTROL OF THE DISTRIBUTION NETWORK

The distributor is responsible for control of the distribution network. An inspector, who is approved by the Swedish Gas Association, shall carry out all inspection and control. The control procedure for natural gas distribution systems comprises construction and manufacturing control, commissioning control and recurrent controls.

The construction control checks whether the constructions meet all demands according to ruling standards.

Pressure testing is carried out as a differential pressure measurement before commissioning of the pipe network. The commissioning control is concluded in the way that the inspector formally establishes the maximum permissible pressure for the pipe.

Recurrent control comprises control of corrosive attacks or damages, density, marking of pipes and valves, and the manoeuvrability of valves. Density control of ground-laid pipes takes place at least every 4th year as a leak detection of the pipe network, usually by means of a flame ionisation instrument or semi-conductor instrument carried by a person.

The recurrent density control is in many cases a comprehensive and time-consuming task. Usually the Swedish distribution companies carry out the density control with own personnel. Motorised leak detection systems, which are to a certain extent used in Germany and Great Britain, are at present not being used in Sweden.

5 MAINTENANCE OF THE DISTRIBUTION NETWORK

In the Swedish distribution network for natural gas the distributor is responsible for operation, maintenance and repairs.

The purpose is to maintain the distribution network to ensure that it functions as planned, and in a reliable and safe way.

It is also the responsibility of the distribution company to see to it that a functioning emergency service exists, with a continuously manned emergency station with 24 hours service, to which all calls for help can be addressed.
For the natural gas systems in Sweden, all accidents or incidents shall be reported to the local rescue service and to the Swedish Gas Association. The purpose of the reporting of accidents and incidents is to prevent accidents through feedback of experiences.

REFERENCES

/1/ Sydgas AB
Annual report

/2/ Vattenfall Naturgas AB

/3/ Natural Gas Distribution Technique
Training, Kjessler & Mannerstr le AB, 1988.05.24

/4/ Molin, Jan: Demands on material for filling around PE gas pipes.
Report SGC 004, April 1991

/5/ Ribberstr m, Ove: New laying technique for PE pipes
Report SGC 021, June 1992

/6/ Fallsvik, Jan et all: Laying of gas pipes with ploughing technique at Glostorp, Malm - follow-up project
Report SGC 019, May 1992

/7/ Granstrand, Nils et all: Laying of gas pipes with ploughing technique at Lillhagen, Gothenburg - follow-up project
Report SGC 023, August 1992

/8/ Rehn, Charlotte: Leak detection on gas pipes - Methods and instruments.
Report SGC 009, December 1991

Energy standards, EGN 94
The Swedish Gas Association

N slund, Mikael: Energy gas technique
The Swedish Gas Association, June 1995