Bord Gáis Networks
Extending the Natural Gas Network

Bord Gáis Networks is currently engaged in extending the natural gas network in Ireland to a number of new towns as detailed in the New Towns Study. This programme of work is carried out on behalf of Gaslink as approved by the Commission for Energy Regulation. The New Towns Study Analysis, by Bord Gáis Networks, considered the viability of extending the natural gas network to 70 towns, of which a number have proven viable for connection. In this lesson we will consider the various elements of extending the network to a new town including feasibility assessment, planning, processes and materials involved.

Establishing the Viability for Connecting New Towns

The Gaslink Connections Policy sets out the criteria for connecting new towns to the natural gas network. To evaluate the potential viability for the connection of a new town, an economic appraisal is carried out. This appraisal takes into account the following:

- Transmission and distribution network tariff revenues based on a forecast of the potential new housing and Industrial & Commercial loads in the town over 25 years against.
- The estimated full connection costs (including both transmission and distribution elements) required to facilitate the projected load requirements in the town.
- If the appraisal returns a positive result then the town is viable for connection to the Bord Gáis natural gas network subject to approval from the Commission for Energy Regulation.

Bord Gáis Networks generates revenues by applying the relevant transmission and distribution tariffs for the use of the pipeline system by shippers. At present there are twelve shippers signed up to the Code of Operations in ROI and one shipper in Northern Ireland.

Designing the Network

There are two main divisions of a gas distribution network:

- A transmission system which transports gas at high pressure (85 bar to 7 bar) from storage facilities to cities and towns.
- Distribution networks which transport at lower pressure (7 bar to 20 mbar) to individual users.

Transmission pipes are made of steel, while distribution mains (local “gas pipes”) are made of polyethylene (PE). These PE mains are used for pressures not exceeding 4 bar. PE mains have gradually replaced cast iron and other metallic mains.

Pipe sizing depends on the required final pressure (at the customer point) and on the expected load or demand. Potential large industrial/commercial and contract customers in the towns are consulted with regard to future expansion plans and these loads are catered for in the network design.

The route to be taken by a new pipeline is determined by a number of factors, including: minimising the overall length of the route to feed the town(s); minimising joints and bends; accounting for danger points, obstructions, geographical hazards and flood-prone areas; other utilities that may share or impede the route; use of pre-existing gas pipelines; suitability of terrain for pipe-laying; areas of environmental and historic importance and availability of wayleaves that allow access to land, and associated compensation costs.

Under Section 32 of the Gas Act 1976, Bord Gáis can apply to the Commission for Energy Regulation (CER) for a Compulsory Purchase Order (CPO), to acquire compulsorily any land or right over land that is required by the Board to carry out its functions, but generally does not.
The Wonders of Plastic

High density yellow polyethylene (HDPE) gas pipes are lightweight, non-corrosive, available in coil lengths, and easy to install by heat fusion or mechanical fittings. They are used at pressures up to 4 bar and now dominate the gas distribution network. PE pipework should not be laid with less than 375 mm depth of cover regardless of cover material.

What’s in a Bar?

Gas is transported at 150 bar across the Irish Sea, and then reduced to 85 bar, the maximum pressure permitted on land. It is reduced further at various gas installations and it eventually enters the customer’s premises at a few millibars for a domestic installation.

The bar is not an SI unit. The SI unit for pressure is the pascal — one newton per square meter (N m\(^{-2}\) or kg m\(^{-1}\)s\(^{-2}\)). The bar is equal to 100 kilopascals, 14.5 pounds per square inch (psi), and roughly equal to the atmospheric pressure on Earth at sea level. A standard atmosphere is defined as 1.01325 bar or 1013.25 mbar or 1013.25 hPa (hectopascal)

Keeping it Safe

Natural Gas as delivered to homes is almost pure methane, CH\(_4\) (with traces of ethane, propane, butane etc.). A smell is added for safety purposes. Methane is non-toxic, highly flammable and lighter than air. In high concentration in confined spaces it can cause asphyxiation. Methane is a major greenhouse gas, largely emitted by natural sources such as animals and microorganisms in wetlands.

Great care must be taken by contractors working anywhere near the gas network. Mechanical excavators pose the highest risk and are not used within 500 mm of a gas distribution pipe and 3 m of a transmission pipe. Power tools must not be used within 1.5 m of transmission pipes.

Methane Combustion

Methane burns and produces only carbon dioxide and water. The overall chemical reaction is:

\[
\text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O}
\]

Gas pipes are installed using standard trenching in which a pipe is laid with a sand or pea gravel surround and with gas marker tape on top. Polyethylene pipes can also be inserted into existing cast-iron pipes. Alternatively a moling machine can be used to insert pipes under roads or buildings without disturbing the surface. In the latter two cases there is no sand or tape identification. Pipes must be laid to an adequate depth.

Bord Gáis Networks

Overview of Bord Gáis Networks and Network Connections Policy

Bord Gáis Networks has developed a world-class gas infrastructure in Ireland. 13,229km of gas pipelines and two sub-sea interconnectors have been constructed and are carefully maintained, with safety and community relations at the heart of all that Bord Gáis Networks does. On behalf of Gaslink, the independent system operator, Bord Gáis Networks is responsible for connecting all new gas connections, and for work on service pipes and meters at customers’ premises, on behalf of all gas suppliers in Ireland. Gaslink is the independent gas system operator for Ireland. Under the 2003 EU Gas Directive for legal unbundling, Gaslink took over responsibility for the development, maintenance and operation of the gas distribution and transmission networks in 2008.

Bord Gáis Networks also manages a full 24-hour emergency response service, handling almost 20,000 call-outs each year.

To review the potential for extending the network, Bord Gáis Networks on behalf of Gaslink carried out a review study of towns not connected to the national gas network in Ireland. This review process gave rise to the Network Connections Policy in 2006, updated in June 2008. Previous reviews completed in the years 1996 & 2001 found that it was not feasible to bring gas to towns remote from the existing network. The Network Connections Policy now allows towns to be amalgamated into a regional group and subsequently appraised as a single project. Extended payback periods of 25 years were also taken into account. Gaslink owns and manages the operation of the Connections Policy.

The New Towns Analysis study and publication of associated reports took place in 2006, 2007 and 2010. The New Towns study has considered the viability of 70 towns across the country, of which a number have proven viable for a connection. Future assessments of potential new towns will be completed on an individual basis as new information or developments occur in individual areas of the natural gas network.

You can find this and other lessons on www.sta.ie.

Find out more about the work of Bord Gáis Networks on www.bordgais.ie/networks.
Leaving Certificate Technology

The contribution of existing ideas, works, systems to current technologies.

Critical appraisal of solutions for choice of materials, functionality, deployment of technology features, and reliability.

Criteria for selection of the optimum idea (or combination of ideas), selection of the most appropriate materials, tools, equipment.

Control using computers or other programmable devices.

The properties of a range of materials and the selection of appropriate materials within the context of design activities.

Physical properties of materials; comparison of materials in terms of their properties.

The proper safety procedures and working practices when using materials, tools and equipment.

Learning Outcomes

On completion of this lesson, students should be able to:

- Describe the factors determining the feasibility of delivering natural gas to towns.
- Understand the factors taken into account in designing a network.
- Describe the basic components of the gas network and the pipe material used in each.
- List the pressure levels at each point of the network.
- Describe the advantages of polyethylene pipe.
- Summarise the safety considerations of the network.
- Understand the basic units of energy, power and pressure.
- List some of the uses of ICT in the gas network.

General Learning Points

The following points can be used to enhance the lesson content and to inform discussion.

Methane and Global Warming

Methane in the Earth’s atmosphere is an important greenhouse gas with 25 times the impact on temperature of a carbon dioxide emission of the same mass over the following 100 years. The Earth’s methane concentration has increased by about 150% since 1750, and it accounts for 20% of the effect of the long-lived and globally mixed greenhouse gases. Usually, excess methane from landfills and other natural producers of methane are burned so CO₂ is released into the atmosphere instead of methane because methane is such a more effective greenhouse gas. Recently methane emitted from coal mines has been successfully used to generate electricity.

Ferrous Piping

Ferrous pipes are made of cast iron, low and medium alloyed steels and specialty steels such as tool steels and stainless steels. Note: Ferrous piping is not generally connected to non-ferrous piping such as copper. Different metals in contact can produce a galvanic effect (an electric potential between the two metals) which facilitates corrosion.

Carbon Monoxide

Carbon monoxide, CO, is a poisonous gas that is produced when carbon fuels such as coal, wood, petrol, oil, propane or natural gas do not have enough oxygen to burn completely. Carbon monoxide is highly dangerous. You cannot see or smell it.

Signs of CO are:

- A yellow or orange flame where normally blue.
- Appliances that burn slowly, badly (floppy flames), or go out.
- Staining, sooting or discolouration around the appliance.
- Condensation on walls/windows.
- An unusual smell when a gas appliance is on.
- If you experience flu-like symptoms such as drowsiness or headaches.

Pressure relative to atmospheric pressure

For gases, pressure is sometimes measured not as an absolute pressure, but relative to atmospheric pressure; such measurements are called gauge pressure. An example of this is the air pressure in an automobile tyre, which might be said to be “220 kPa / 32 psi”, but is actually 220 kPa above atmospheric pressure. A gauge pressure of 32 psi is sometimes written as “32 psig” while an absolute pressure may be written as “50 psia”.

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Student Exercises

True/False Questions

(1) The cost of running the system is called ‘capital cost’.
(2) A small commercial user is one who uses less than 200 MW h per year.
(3) Existing houses were excluded in the feasibility assessment.
(4) Peak hourly demand for a new housing customer is taken as 2 m³/h.
(5) Capital costs also include local authority charges associated with road openings.
(6) Distribution mains pipes are made of steel.
(7) Bord Gáis generally uses a CPO to acquire land.
(8) Polyethylene (PE) pipe is generally used in the distribution network.
(9) PE pipe must not be used inside buildings.
(10) The bar is the SI unit of pressure.
(11) Pressures up to 1 bar can be used in buildings.
(12) Methane is not a toxic gas.

Check your answers to these questions on www.sta.ie.

Examination Questions

Leaving Certificate Physics (OL) 2007, Q. 12b

(i) Define pressure. Describe an experiment to demonstrate that the atmosphere exerts pressure.

(ii) State Boyle’s law. A balloon rises through the atmosphere while the temperature remains constant. The volume of the balloon is 2 m³ at ground level where the pressure is 1000 hPa. Find the volume of the balloon when it has risen to a height where the atmospheric pressure is 500 hPa.

What will happen to the balloon as it continues to rise?

Leaving Certificate Physics (OL) 2005, Q. 6

- Define pressure and give the unit of pressure.
- Name an instrument used to measure pressure.
- The earth is covered with a layer of air called the atmosphere. What holds this layer of air close to the earth?
- Describe an experiment to show that the atmosphere exerts pressure.
- The type of weather we get depends on the atmospheric pressure. Describe the kind of weather we get when the atmospheric pressure is high.

The African elephant is the largest land animal.

An elephant weighs 40 000 N and is standing on all four feet each of area 0.2 m². Calculate the pressure exerted on the ground by the elephant.

Why would the pressure on the ground be greater if the elephant stood up on just two feet? (P = F/A)

Did You Know?

Most natural gas is created by two mechanisms: biogenic and thermogenic. Biogenic gas is created by methanogenic organisms in marshes, bogs, landfills, and shallow sediments. Deeper in the earth, at greater temperature and pressure, thermogenic gas is created from buried organic material. The world’s largest proven gas reserves (25% of the world’s total) are located in Russia. Through Gazprom, Russia is frequently the world’s largest natural gas extractor. The world’s largest gas field is Qatar’s offshore North Field, estimated to have 25 trillion cubic meters. The world reserves of oil and gas in energy terms is very similar (equivalent to about 1.2 trillion barrels of oil each).

Reserves in the Corrib gas field are believed to be about 28 billion cubic metres, 70% the volume of the Kinsale field. The natural gas in the Corrib Gas Field is a very pure form of gas, consisting of approximately 97% methane and ethane.
Biographical Notes

Blaise Pascal (1623-1662)

Pascal was a major intellectual figure in the 17th century. A child prodigy, he became a noted philosopher, mathematician, and scientist. He made important contributions to the study of fluids, and clarified the concepts of pressure and vacuum by generalizing the work of Evangelista Torricelli. The name ‘pascal’ (symbol Pa) has been given to the SI unit of pressure and to a programming language, and Pascal’s law (an important principle of hydrostatics), Pascal’s triangle, Pascal’s calculator and Pascal’s wager still bear his name, as do elements of conic sections which he derived when he was just 16. In literature, Pascal is regarded as one of the most important authors of the French Classical Period and is read today as one of the greatest masters of French prose. His two most famous works were the Lettres provinciales and the Pensées.

Revise The Terms

Can you recall the meaning of the following terms? Revising terminology is a powerful aid to recall and retention.

Asphyxiation, bar, capital costs, cast iron, CH4, Code of Operations, CPO, customer point, economic test appraisal, feasibility, Gaslink, greenhouse gas, hazard symbol, HDPE, heat fusion, mbar, methane, moling machine, natural gas, pascal, pea gravel, pipe sizing, polyethylene, projected load, psi, shipper, SI, viability, wayleaves.

Check the Glossary of terms for this lesson on www.sta.ie.