BOOK 1
Changeover natural gas to LPG

by Ian Oultram
LPG SAFETY
by Ian Oultram

BOOK 1  Changeover natural gas to LPG
Foreword

This LPG Safety handbook is the result of many years development. We have worked hard to provide a reference resource that can be used on a day to day basis.

This LPG Safety handbook is the subject of continual improvement, your suggestions and comments are welcome.

You are encouraged to highlight sections of text and make your own notes in this handbook. We suggest that you write your name in the box below in order that your copy does not get mixed up with anyone else’s.

Ian Oultram

This handbook belongs to:
The publishers would like to thank the following organisations and companies for their kind assistance in the preparation of this LPG handbook.
Contents

1. Properties of LPG
2. Combustion
3. LPG Storage
4. Gas Supply Equipment
5. Gas Pipework
6. Tightness Testing
7. Purging
8. Ventilation
9. Fluing
10. Appliance Controls
11. Unsafe Situations
12. Appendices
A brief history of LPG

A short introduction to the history of LPG.
A brief history of LPG

The LPG industry is a relative newcomer to the world of energy, only making its first appearance early in the 20th century.

However the occurrence of flammable gases is not a new phenomenon, they were first recorded by the ancient Egyptians as far back as 2000 B.C. They took it is a sign from the gods, because it appeared as a mysterious fire escaping from cracks in the ground.

Even thousands of years ago man was using flammable gases for heating and lighting.

Bottled Gas in its modern form was brought to life in 1904 by a German chemist called Dr Herman Blau. He created a bottled gas consisting mainly of permanent gases, liquid gases and light petroleum, he called it Blaugas. It was very expensive to produce but this did not stop its marketing to the wealthy throughout mainland Europe and the USA.

It was also used in the Graf Zeppelin airships of the day.
A brief history of LPG

Around 1909 American scientist Dr. Walter Snelling was working on the problems with the refining and storage of petrol; at this time petrol would quickly evaporate whilst in storage.

Through his experiments, it was soon discovered that the gases which evaporated could be condensed and stored as a liquid under moderate temperatures and pressures.

By 1911 he had isolated and identified the two major components of LPG - propane and butane, and soon after developed a practical method of removing them from petrol.

In 1913 Dr. Snelling was granted a patent for his Liquefied Petroleum Gas, he later became known as the Father of LPG.

1912 saw the introduction of the first residential cooking range.

Modern LPG cookers are highly regarded by professional and home cooks alike.
By 1913 the first LPG powered car had been developed.

Modern high-performance LPG powered cars are now beating petrol fuelled rivals.

Recently an LPG powered car won the British Touring Car Championship at Brandshatch, third place was also claimed by an LPG powered car.
1. LPG properties and characteristics

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>3</td>
</tr>
<tr>
<td>Origins</td>
<td>3</td>
</tr>
<tr>
<td>Appearance</td>
<td>4</td>
</tr>
<tr>
<td>Common Usage</td>
<td>5</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>5</td>
</tr>
<tr>
<td>Calorific Value</td>
<td>6</td>
</tr>
<tr>
<td>LPG pressures</td>
<td>6</td>
</tr>
<tr>
<td>LPG Liquid</td>
<td>7</td>
</tr>
<tr>
<td>LPG vapour</td>
<td>9</td>
</tr>
<tr>
<td>Flammability</td>
<td>11</td>
</tr>
<tr>
<td>Viscosity</td>
<td>12</td>
</tr>
<tr>
<td>Hazards</td>
<td>12</td>
</tr>
<tr>
<td>Safety Advice</td>
<td>13</td>
</tr>
<tr>
<td>BLEVE</td>
<td>16</td>
</tr>
<tr>
<td>Effects of LPG</td>
<td>17</td>
</tr>
</tbody>
</table>
Overview

LPG is the abbreviated form of Liquefied Petroleum Gas. It is a hydrocarbon gas, made up of carbon and hydrogen. LPG is described as a 3rd family gas, there are several gases within this group, the most common types of LPG in use today are commercial propane and commercial butane.

Origins

LPG is a fossil fuel, so called because it was formed millions of years ago from the remains of tiny sea animals and plants. When the plants and animals died, they sank to the bottom of the oceans where they were buried by layers of silt and sand. Over many years, the layers became thousands of feet thick. They were subjected to enormous heat and pressure, changing the energy-rich remains into petroleum and natural gas deposits. Eventually, pockets of these fossil fuels became trapped in rocks much as a wet sponge holds water. Propane and butane along with natural gas, oil and various solid fuels are all fossil fuels.

LPG is obtained from two large energy industries: oil refining and raw natural gas production.

In crude oil refining LPG is produced by a process known as fractional distillation, this method also produces heavier fuels such as diesel, jet fuel, fuel oil, and petrol.

About 3% of a typical barrel of crude oil is refined into LPG, this method of LPG production accounts for about 40% of LPG production worldwide.
When raw natural gas is drawn from the earth, it is a mixture of several gases and liquids.

Methane accounts for about 90% of this mixture, this is then distributed as natural gas. The remaining 10% consists of varying amounts of other hydrocarbons such as butane, isobutane, pentane and ethane.

The processing of raw natural gas provides approximately 60% of all LPG produced globally.

<table>
<thead>
<tr>
<th>Table 1.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw natural gas</td>
</tr>
<tr>
<td>90% Methane</td>
</tr>
</tbody>
</table>

LPG produced from these sources is assured since the primary motive for oil refiners and natural gas processors is to create fuels other than LPG, but first LPG must be produced. Although tied to the production of natural gas and crude oil, LPG has its own distinct advantages and can perform practically every function of the other fuels from which it is created.

**Appearance**

LPG looks very similar to water, both as a liquid and a vapour, it is also colourless and odourless.

A smell is added to LPG to enable users to be aware of any leaks. This is achieved by the addition of a stenching agent to the gas. Common additives are Ethyl Mercaptan or Dimethyl Sulphide, these chemicals have a very strong odour to allow detection of a very small amount of gas, just 0.4% of gas in air will be detectable by smell.
2. Combustion

Overview 3
Combustion 4
Air supply 5
Complete combustion 6
Incomplete combustion 7
Burner types 9
Carbon monoxide (CO) 12
Carbon monoxide detectors 15
Combustion analysis 17
Pre-aerated burner

Flames created by a pre-aerated burner receive about 50% all air for combustion before being burned and the remaining 50% from around the flame after exiting the burner.

Pre-aerated burners mix gas with 50% air for combustion as it enters the burner.

A pre-mix burner (illustrated above) is very popular in the domestic gas industry

- The injector directs gas into the mixing tube
- Air around the ‘primary air port’ is induced or drawn into the burner
- The gas and primary are mixed in the mixing tube
- Baffles inside the burner ensure the mixture arrives at the burner ports evenly distributed
- The gas and air mixture flows through the burner ports and ignites
- Secondary air from around the flame is consumed to complete the combustion process
- The flame should be stable, quiet, sit down on the burner and be blue in colour

Most central heating boilers are now fitted with modulating burners, this simply means the gas supply is adjusted automatically to match the demand for heat as required by the appliance control system. When there is a large demand for heat, the system will increase the amount of gas to the burner and reduce it when demand lessens.
Observation of the *flame picture* is an important diagnostic tool for use in determining satisfactory combustion. The flame should be blue in colour, well defined with quiet operation. Any flame that appears yellow, lazy or floppy should be regarded as suspect and investigated.

If the gas pressure is correct, the injector correctly sized (not worn or damaged) with sufficient air supply, then the combustion process should have no problems.

**Full pre-mix burner**

Fully pre-mixed burners were originally developed for industrial and commercial markets. In recent years, due to the efficient nature of these burners, they have been developed for domestic appliances. Modern energy efficient appliances require a more efficient burner.

This type of burner mixes the gas and air together fully, before delivering it to a special burner head, often circular in design and fashioned from stainless steel or ceramic.

Designs vary and gas may be mixed with the air before or after the centrifugal fan.

This mixture is then forced into the burner head where a short, very hot flame is produced.
3. LPG storage

Bulk Storage 6
Vessel requirements 8
Siting requirements 8
Line of sight 14
Overhead cables 15
Earthing 16
Bulk storage compounds 18
Cylinder Supplies 23
Calculating cylinder requirements 28
Residential Park Homes 30
Leisure Accommodation Vehicles 30
Boats 34
Overview

LPG is stored in specially constructed vessels and cylinders as a liquid, under moderate pressure.

At a temperature of 15°C and atmospheric pressure of 1 bar, the pressure inside a storage vessel or cylinder will be approximately:

- **Propane** 6.9 bar
- **Butane** 1.8 bar

Higher or lower air temperatures will alter the liquid temperature within the vessel and therefore vary the pressure inside. In cold weather the pressure is lower and in warmer weather it is higher.

The size of the storage container has no bearing on the pressure within. For instance, compare a 3.9 kg propane cylinder and a 12 tonne bulk storage vessel, although the bulk vessel contains over 3,000 times more gas by volume, both are subject to the same pressure of approximately 6.9 bar.

All LPG users should be aware of these basic properties.

There are major variations in the requirements for LPG storage depending on the type of dwelling, you must always check the specific requirements for the type you are working on.

v2.03 © LPG Training & Assessment Ltd 2014
Underground vessel installations are now a familiar aspect of LPG supply. This is due to more flexible siting arrangements and added security for the installation.

The three vessels shown below have been installed as semi-mounded, this means the ground level has been built up around them.

This helps to disguise their shape and lessen the overall visual impact.
4. Gas supply equipment

Single stage 4
Two stage 5
Three stage 6
Types of regulator 7
Automatic change-over device (ACD) 8
Connections 9
Regulator standards 10
Touring caravans & motorhomes 12
Pressure related safety devices 14
Bulk storage vessel fittings 16
Twin stream regulators 19
Pressure regulation

LPG used in a supply system will require the pressure to be reduced to the necessary operating pressure, this is achieved by the use of a regulator.

A regulator is designed to control the operating pressure from an LPG cylinder or vessel, through the installation pipework to the appliance(s), the pressure is maintained at a constant level.

Regulators are designed to deliver a constant outlet pressure to the appliance, within strict tolerances. There are many different types of regulator and care should be taken in selecting the right one for the job.

Siting regulators safely

Always ensure the breather hole situated on regulator housings is pointing down, this prevents the ingress of water and debris which could affect the safe operation of the regulator.

The inlet to any regulator or ACD should always be mounted above the outlet of the cylinder valve connection. Under some conditions liquid LPG can condense in high pressure pigtails between a cylinder and regulator. If the regulator is placed below the level of the cylinder outlet (or a significant proportion of the pigtail is above the regulator inlet), any liquid LPG may drain into the regulator and compromise non-metallic components. Continual exposure may cause premature failure of the regulator, with potentially catastrophic results.
Two stage

If there is a large gas demand anticipated or supplies are from a bulk storage vessel, pressure reduction is usually accomplished in 2 stages. This can be achieved by using 1st and 2nd stage regulators as illustrated below.

This is the most popular arrangement installed at domestic properties.

If the storage vessel is sited some distance from the point of use (or a large gas demand is anticipated), the second stage regulator may be sited at the building, as illustrated below.

This is known as an intermediate pressure supply.
Types of regulator

Regulators designed for use with propane may utilise POL connections, do not use any PTFE or jointing compound on the threads or connectors.

Butane cylinders may use either a clip on regulator (below left) or a screw on type (below right), both very different to the fittings found on propane installations.

N.B. When used in a domestic environment a minimum capacity of 4 kg is recommended.
Pressure related safety devices

UPSO/OPSO

Under Pressure Shut Off/Over Pressure Shut Off

All domestic installations fed by a bulk tank must have an UPSO/OPSO fitted to protect pipework and appliances. On a single supply installation the device could be fitted at the tank end. On multiple supply installations such as metered estates or holiday parks, each dwelling would be provided with such a device.

OPSO – over pressure shut off

The over pressure shut off device is designed to protect downstream pipework from being subjected to high pressures.

The OPSO will trip or close the LPG supply if the pressure downstream of the outlet becomes excessive. This may occur if supply pipework is subjected to excessive pressure, this may be caused by a faulty second stage regulator or excessive heat from a fire impinging on pipework.

It is mandatory that OPSO protection is provided for all installations utilising MDPE pipework.

An OPSO must never be re-set without first consulting the gas supplier, the cause of the tripping must be investigated before resetting the device. Not all OPSO devices are fitted with a visible indicator that the unit has tripped. Some models have the indicator and reset positioned under a metal cover, this requires the cover to be removed in order to check the OPSO status.
LPG pipework

Overview

All pipework to be used in the installation must be of suitable quality, strength and suitable for the purpose they are being used. When selecting the materials remember to consider the location of pipework i.e. internal, external, exposed, etc., also the proposed route of the pipework. Compliance with current Gas Safety (Installation and Use) Regulations and applicable pipework standards is required.

Due to its ease of use most domestic installations will utilise copper tube. Steel, low carbon steel or cast iron fittings protected from corrosion by galvanising are often used for external pipework by gas suppliers. Stainless steel tube with screwed or compression fittings can be used but is more expensive. Corrugated stainless steel pipework is becoming more popular in commercial projects.

Since the Lord Gill report in 2009 metallic pipework buried underground is subject to special provisions and should only be considered when there are no viable alternatives.

Materials to avoid

• Aluminium easily damaged and prone to corrosion problems
• Lead prohibited by the Gas Safety Regulations
• Brass tendency to seasonal cracking

Gas pipework must be sited at least 150 mm away from electric meters and a minimum of 25 mm away from electrical switches or cables, further details can be found in BS 5482-1.

The requirements for pipework and fittings used in LPG installations are varied and many, although very similar to natural gas requirements there are some important differences.

The safe and correct design of an LPG pipework system is a prime consideration before starting installation work. Time spent planning an installation will pay dividends later and ensure a safe gas system.
Example (internal copper installation pipework)

Consider the following installation, it contains two appliances, a cooker and a fire and has a propane supply with an OP of 37 mbar.

Information required to carry out the calculation:

- The length of pipe run to each appliance
- How many fittings will be used and where
- The heat input (in kW) or the gas rate (in m³/h) of each appliance
- The location of all appliances within the installation

<table>
<thead>
<tr>
<th>Section</th>
<th>Pipe length (m)</th>
<th>Fittings</th>
<th>Appliance</th>
<th>Input (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A to B</td>
<td>3</td>
<td>3 elbows + 1 tee</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B to D</td>
<td>2.5</td>
<td>4 elbows</td>
<td>Cooker</td>
<td>14</td>
</tr>
<tr>
<td>B to C</td>
<td>4</td>
<td>3 elbow + 1 coupler</td>
<td>Fire</td>
<td>3.5</td>
</tr>
</tbody>
</table>
5.30 ▷ GAS PIPEWORK

Example (external service pipework)

Consider the following low-pressure service pipework installation, it has a total maximum load of 55 kW and will be operating at 37 mbar.

<table>
<thead>
<tr>
<th>Table 5.13</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section</strong></td>
</tr>
<tr>
<td>A to B</td>
</tr>
</tbody>
</table>

Calculate the pipe size

- Refer to Table 5.9 (page 5.20) in the left hand column go down to the next length greater than 38 m this will be 40 m

- Now look to the right to decide which diameter pipe will be capable of carrying the full load. The first column (25 mm) indicates 50.9 kW this would be insufficient for the required load

- Carry on to the next diameter pipe. This will be 32 mm this size pipe is capable of carrying 105 kW over a distance of 40 m. Therefore this size of pipe will be acceptable
The pressure loss between the final stage regulator and the point of entry to the building should be no more than 1.0 mbar (if a meter is to be installed) and 1.5 mbar (if no meter is to be installed). These pressure losses are acceptable providing any pressure loss in the installation pipework between a meter (or point of entry) and any appliance is no greater than 1.0 mbar.

Most domestic installations will be carrying a smaller load over a shorter distance. Therefore MDPE pipework with a 25 mm diameter is used extensively in the majority of these installations.
6. Tightness Testing

Overview 3
Measuring pressure 4
Standing pressure 6
Operating pressure 6
Gauge movement 6
IGEM/UP/1B 9
IGEM/UP/1B – Air test 10
IGEM/UP/1B – Let-by test 12
IGEM/UP/1B – Tightness test 14
Overview

The Gas Safety (Installation & Use) Regulations (GSIUR) require gas systems to be safe. Tightness testing forms part of ensuring the safety of an installation and should be carried out in the following circumstances:

- New installations or extensions to existing installations
- Alterations to (or replacement of) existing installations
- Before working on existing installations
- Before re-establishing an existing gas supply
- If a gas escape is suspected or there is a reported smell of gas
- Where there has been a complete loss of supply pressure i.e. upstream of the ECV, or of installation pressure
- Routine testing of existing installations
- Immediately before purging of installations (except when taking components permanently out of service)
- Whenever work is carried out that might affect gas tightness

The standard used for tightness testing installations (up to 35 mm copper tube) will vary dependent on a number of factors, always ensure you are utilising the correct standard for the installation being worked on.

<table>
<thead>
<tr>
<th>Dwelling type</th>
<th>Condition</th>
<th>IGE/UP/1B</th>
<th>BS EN 1949</th>
<th>UKLPG COP 22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic properties (house or bungalow) Small commercial premises</td>
<td>New or existing</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential park Home (RPH)</td>
<td>New or existing</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leisure Accommodation Vehicles (LAV)</td>
<td>New or existing</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPG service pipework only</td>
<td>New or existing</td>
<td></td>
<td>✔</td>
<td></td>
</tr>
</tbody>
</table>
IGEM/UP/1B – Air test

Air Test for new pipework systems before connecting live gas supplies.

Preparation

- Visual inspection of the entire installation
- For best results ensure there are no regulators included in the test
- All open ends are sealed with an appropriate fitting
- Any appliances are isolated or disconnected from the supply

Procedure

1. Connect gauge and test tee to a suitable position
2. Attach a hand bellows to the test tee
3. Raise pressure in system to 45 – 46 mbar*
4. Allow 1 minute for pressure and temperature stabilisation**
5. Allow 2 minutes test period
6. Check there is no perceptible movement of the gauge

* It is assumed for air testing there is no regulator in the section to be tested. However if a regulator is fitted in the section to be tested, avoid higher pressures to prevent regulator lock-up.

** It may be necessary to extend this time until a stable reading is obtained.

** There may be a slight pressure change during temperature stabilisation, if this happens re-adjust the pressure to the Tightness Test Pressure (TTP) then turn off the pressure source.

Test results

If there is no perceptible gauge movement (fall) the installation has passed the test.

Otherwise the installation will have failed and require further investigation.
START

Raise pressure to 45 - 46 mbar

Allow 1 minute for temperature stabilisation

Note gauge reading

Wait 2 minutes test period

Read gauge and compare with previous

Does the gauge show perceptible movement?

Test passed PROCEED (see note 1)

Test failed HALT (see note 2)

Note 1   System to be purged and then re-tested with fuel gas
Note 2   Trace and repair any escapes then re-test or make the installation safe
7. Purging

Overview 3
Purge Volume 4
Installation Volume 5
Purge procedure 9
Gas Input Rating 11
8. Ventilation

Overview 4
Permanent dwellings 8
Residential Park Homes 8
Leisure Accommodation Vehicles 15
Boats 24
9. Flues

Overview 3
Types of flue 3
Appliance designation 4
Residential park homes 6
Flue flow test 13
Spillage test 14
Room-sealed appliances 17
Condensing Boilers 30
Flues in voids 30
Boats 31
Overview

Gas operatives may come across different types of dwelling or property whilst carrying out gas work. It is vital that the type of dwelling being worked on is identified correctly.

This chapter covers the fluing requirements for the following dwelling types:

- **RPH** Residential Park Homes
- **LAV** Leisure Accommodation vehicles
- **B** Boats

Types of flue

The purpose of a flue is to safely discharge the products of combustion (POC’s) to outside air, under all weather conditions. This is achieved in part by the selection of the correct materials, terminal and outlet location.

Any gas appliance that uses a flue has the potential to become a danger. Flues must be regularly inspected to ensure safe operation and check correct installation in accordance with manufacturer’s instructions and British Standards.

Flues come in many shapes and forms, it is of vital importance that the operation of the different flue types is fully understood.

Flue types commonly found in RPH and LAV installations:

- **Open flues**
- **Closed flues**
- **Room-sealed - balanced flues (natural draught)**
- **Room-sealed - balanced flues (fan assisted)**

British Standard BS 5440-1 applies to flue installations in PD, RPH and LAV type dwellings. This British Standard provides detailed guidance on flue design and installation. However, the instructions provided by manufacturer’s of approved appliances (e.g. CE marked) take precedence over British Standards and must always be adhered to when installing any flue.
Appliance designation

With an increasing number of flue types available for modern appliances, a method of cataloguing them has been created, this system utilises letters and numbers to identify particular flue systems.

<table>
<thead>
<tr>
<th>Table 9.1 Appliance flue designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category letter</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1st digit</th>
<th>Flue feature</th>
<th>2nd digit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Natural draught</td>
</tr>
<tr>
<td>B₁</td>
<td>With draught diverter</td>
<td>B₁₁</td>
</tr>
<tr>
<td>B₂</td>
<td>Without draught diverter (previously closed flues)</td>
<td>B₂₁</td>
</tr>
<tr>
<td>C₁</td>
<td>Horizontal balanced flue/inlet air ducts to outside air</td>
<td>C₁₁</td>
</tr>
<tr>
<td>C₂</td>
<td>Inlet and outlet ducts connected to common duct system for multi-appliance connections</td>
<td>C₂₁</td>
</tr>
<tr>
<td>C₃</td>
<td>Vertical balanced flue/inlet air ducts to outside air</td>
<td>C₃₁</td>
</tr>
<tr>
<td>C₄</td>
<td>Inlet and outlet appliance connection ducts connected to a U-shaped duct for multi-appliance system</td>
<td>C₄₁</td>
</tr>
<tr>
<td>C₅</td>
<td>Non-balanced flue/inlet air ducted system</td>
<td>C₅₁</td>
</tr>
<tr>
<td>C₆</td>
<td>Appliance sold without flue/air inlet ducts</td>
<td>C₆₁</td>
</tr>
<tr>
<td>C₇</td>
<td>Vertical flue to outlet with air supply ducts in loft Draught diverter in loft above air inlet</td>
<td>C₇₁</td>
</tr>
<tr>
<td>C₈</td>
<td>Non-balanced flue system with air supply from outside and flue system into a common duct system</td>
<td>C₈₁</td>
</tr>
</tbody>
</table>
Fan-assisted appliances

Negative pressure

Modern room-sealed appliances generally utilise a fan to extract the flue gases, the fan draws the flue gases out and this action results in a negative pressure being created within the appliance combustion chamber.

Any case seals that were defective would permit the entry of air from the room into the appliance and out through the flue, this may in turn upset the flame picture and lead to incomplete combustion. It is therefore vital that all case seals are examined periodically (not more than 12 months) for deterioration, wear and damage.

Fan-assisted flues are very popular due to the flexibility of siting and termination points, also the possibility of long flue runs or the use of bends. They may also use a more efficient heat exchanger that in turn increases the appliance’s overall efficiency, very important in today’s energy conscious world.
## 10. Appliance controls

<table>
<thead>
<tr>
<th>Overview</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas tap</td>
<td>3</td>
</tr>
<tr>
<td>Thermo-electric device</td>
<td>4</td>
</tr>
<tr>
<td>Atmospheric sensing devices</td>
<td>6</td>
</tr>
<tr>
<td>Liquid expansion thermostat</td>
<td>7</td>
</tr>
<tr>
<td>Safety shut-off device</td>
<td>8</td>
</tr>
<tr>
<td>Electrical solenoid valve</td>
<td>9</td>
</tr>
<tr>
<td>Multi-function control valve</td>
<td>10</td>
</tr>
<tr>
<td>Air pressure switch (APS)</td>
<td>11</td>
</tr>
<tr>
<td>Flame rectification</td>
<td>12</td>
</tr>
<tr>
<td>Zero governor or gas-air ratio valve</td>
<td>14</td>
</tr>
<tr>
<td>Electrical thermostat</td>
<td>16</td>
</tr>
<tr>
<td>Spare-parts</td>
<td>17</td>
</tr>
</tbody>
</table>
11. Unsafe situations

Overview 3
Gas incidents 3
Immediately Dangerous 7
At Risk 8
Not to Current Standards 9
Examples of unsafe situations 11
RIDDOR 13
12. Appendices

Abbreviations 2
Glossary 3
Mathematical symbols 3
Conversion tables 4
Documentation by topic 6
Specialist handbooks in our LPG SAFETY series

Book 1  Changeover Natural Gas to LPG
Book 2  Bulk Storage & External Pipework
Book 3  Residential Park Homes & Leisure Accommodation Vehicles
Book 4  Boats & Inland Waterways Craft
Book 5  Touring Caravans & Motorhomes
Book 6  An introduction to LPG

Visit our website for more information

www.lpgtraining.co.uk