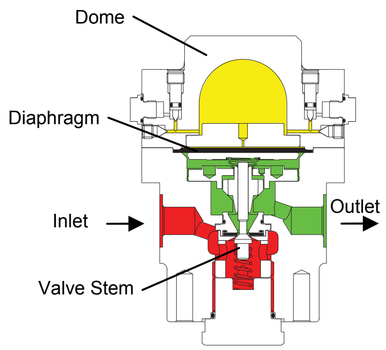
HALE HAMILTON®
Excellence in Pressure & Flow Control
A CIRCOR International, Inc. Company

Guidance Notes



Guidance Notes

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CE Marking

Safety Instructions

We design, machine, build and test all our products on one site in Uxbridge. If you don't see what you want in our standard ranges, contact us and we'll do our best to meet your needs.

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Sep 10

Guidance Notes 1

SAFETY

High Pressure

High pressure gas is potentially dangerous. The compressed gas contains a lot of energy which, in an accident, can propel part of a valve like a bullet.

Never undo or disconnect anything unless you are sure it is not pressurised.

To put it in perspective: a car tyre typically runs at 1.5 to 2 bar (about 20 to 30psi); our valves typically operate at over 300bar (about 4500psi). That's about 150 times as much energy although the contained volume is much smaller. A car tyre bursts with a heck of a bang; I leave the rest to your imagination.

Adiabatic Shock

Sudden changes in pressure, such as those that occur when an actuated stop valve is opened, can cause localised increases in temperature in a phenomenon known as "Adiabatic Shock". Under some circumstances this can ignite lubricants or other contaminants. This is called "Dieseling".

In high pressure Oxygen systems, adiabatic shock is a very serious problem as it is much easier to ignite tiny traces of contamination. In some circumstances the seal materials and even the metal parts of the valve can ignite and burn fiercely.

We have valves for use with medical Oxygen that have been subjected to adiabatic shock testing at an independent test house.

See the notes on Construction for more information about valves for Oxygen.

PRODUCT RANGE

This is a short introduction to our products; they are described in more detail in the following sections.

Regulators

Pressure regulators (also known as controllers or reducers) control the outlet pressure and hold it constant over a range of inlet pressures and flow rates. They are sometimes called "Forward regulators" to distinguish them from Back Pressure Maintaining Valves.

Back Pressure Maintaining Valves

Back pressure maintaining valves (also known as back pressure regulators or controllers) control the inlet pressure.

Back pressure maintaining valves are not suitable for use as safety protective devices.

Relief Valves

Relief valves release the inlet pressure when it exceeds a set value. There is some similarity in function between relief valves and back pressure maintaining valves but relief valves are designed to reduce the inlet pressure as quickly and reliably as possible whereas back pressure maintaining valves are intended to keep the inlet pressure constant.

Many of our relief valves are available as "Safety Accessories" qualified to PED (Pressure Equipment Directive) category 4.

Stop Valves

Stop valves are the "taps" of the high pressure world; they simply open and close to block flow.

Non Return Valves

Non return valves (also known as check valves) allow flow in one direction but block it in the other direction.

Solenoid Valves

Solenoid valves are electrically operated stop valves.

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Filters

Filters trap particulate contamination and stop it from reaching further into the system.

Panels & Manifolds

As well as manufacturing individual valves and components, we can design and build panels and manifolds using components of our own manufacture or high quality items from other suppliers.

All panels can be supplied mounted on a frame or skid. Safety features such as relief valves, isolation valves and pressure gauges can be fitted as required. Stop valves can be supplied with pneumatic actuators and we can provide programmed electro-pneumatic controls to operate the valves. Transducers and valve position sensors can be integrated into the controls.

We can build and test large panels at our premises and offer integration facilities for panels that incorporate third party equipment. We can also design and build more complex mechanical systems such as cylinder handling and safety interlock systems.

A manifold can provide a significant reduction in size over a panel. Our expertise in base-mounted and cartridge valves allows us to offer systems that are easy to maintain and repair.

CONSTRUCTION

Most of our products are for high pressure air up to about 414bar (6,000psi). Many can be used with other gases such as Nitrogen, Oxygen, Carbon Dioxide, etc. The majority of our valves can used on liquids with little or no modification. Some of our regulators can accept an inlet pressure of up to 690bar (10,000psi) on hydraulic fluids.

Metals

For Naval applications many of our valve bodies are made from Nickel Aluminium Bronze. This is a strong, tough material with excellent corrosion resistance particularly against salt water. We also offer Hidurel which is a copper alloy with especially low magnetic permeability for use on minesweepers, etc.

We use austenitic stainless steels for many of our smaller items particularly those for offshore use (NACE compatibility is available) and for critical fluid applications.

Aluminium alloys are used where weight reduction is important. We use high strength, aerospace grades.

For Oxygen service we usually offer brass for the valve body as this material is the least likely to ignite under adiabatic shock. Internal parts, including springs, are made from brass, phosphor bronze, Monel or Inconel as appropriate.

For aggressive chemicals, we offer more exotic materials such as Monel, Nickel, Elgiloy and Inconel.

We can offer most of our valves in a range of different materials.

Elastomers

We use various elastomers for sealing and for flexible parts such as diaphragms.

O rings and the seal part of bonded seals are typically Nitrile, HNBR, EPDM or Viton.

Diaphragms are typically Nitrile or Viton.

For medical Oxygen applications we can supply non-fluorinated elastomers.

Seats

Seats may be metal (hard) or polymer (soft).

Hard seats may be required for high temperatures, use with aggressive chemicals, minimisation of contamination (e.g. by out gassing) etc. Hard seats may be necessary to resist ignition due to adiabatic compression in high pressure Oxygen.

Soft seats can provide a bubble tight shut off which may be difficult with a hard seat. The closing force required to seal onto a soft seat is much lower than that required for a hard seat.

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Metal seats are typically copper or Monel. In some cases the seal is made directly onto the valve body. Polymer seats are typically Nylon, PEEK or Vespel.

Spares & Repairs

With very few exceptions, our valves can be dismantled using the minimum of special tools. After replacing the elastomer and polymer parts and any metal parts that are worn or broken, the valve can be considered to be as good as new.

We can repair and refurbish valves at our Uxbridge site or we can supply spares kits and instructions for field repair.

Cleaning and Lubrication

All parts are thoroughly degreased and cleaned before assembly. Assembly is in a clean environment and the minimum of lubrication is used. Only suitable lubricants are allowed in the assembly area. Clean, dry (un-lubricated) air is used for blow guns.

For Oxygen service, lubricants are banned except for those approved and specified for the purpose. Even these are applied very sparingly. All our assembly personnel are trained in the importance of cleanliness in Oxygen systems.

To ensure the continued reliable service of our valves, we recommend that the supply gas or liquid is filtered to remove large particles.

Testing

All our products are hydraulically proof tested usually to 1.5 times maximum working pressure. All valves are function and leak tested after assembly. The function test rigs use clean dry air and some rigs are dedicated to Oxygen use to avoid cross contamination from dirty valves.

We have facilities to carry out tests to qualify and characterise new valve designs.

Many of our valves have been tested by external test houses for independent verification of their fitness for purpose. In particular valves intended for use with Oxygen are subjected to adiabatic shock testing.

Critical Fluid Applications

HP (High Purity) and UHP (Ultra High Purity) valves are for service where the product must be kept free of contamination. The design is kept simple to minimise “dead” areas where contaminants might collect. Elastomers are not used and polymers are carefully selected for suitability.

UHP uses the same design as HP but the parts are machined to a better surface finish to improve cleanliness. The valve is assembled in a clean room and is Helium leak tested by mass spectrometer.

HP and UHP valves may be used on reactive, corrosive and/or toxic products. Special materials are available for resistance to particularly aggressive chemicals.

UHP valves are built to ultra high purity standards in a dedicated clean room facility. The wetted surfaces are electro-polished to a finish of Ra 10 to 15 micro inch. Final assembly and testing is carried out under class 10 clean room conditions. Each valve is tested for leakage using a mass spectrometer to give a leak rate of less than 10^{-9} mbar l/s of Helium, inboard, outboard and across the seat.

No lubrication is used in the flow path and the seat materials are chosen for minimal gas absorption.

Ports

Most of our valves use G series threads (equivalent to British Standard Parallel Pipe). These are usually sealed by bonded seals and suitable sealing faces are provided.

Valves for high purity and offshore typically have NPT threads.

Valves for ultra high purity usually have fittings compatible with the Cajon VCR system.

We can provide any kind of connection either directly into the valve body or by adaptors.

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QA & Legal Compliance

Legal Compliance

As a manufacturer in the European Community we comply with European Directives as implemented by UK law in the form of Statutory Instruments.

The main directives that apply are:

PED - Pressure Equipment Directive

TPED - Transportable Pressure Equipment Directive

ATEX - Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres

All our products are assessed for compliance with PED and are marked accordingly. Note that products that come into the SEP (sound engineering practice) category must not be CE marked or have a declaration of conformity.

Products are assessed for TPED or for ATEX as required.

Quality Assurance

Our manufacturing and design meet the requirements of ISO 9000 and we are regularly audited for accreditation by a Notified Body.

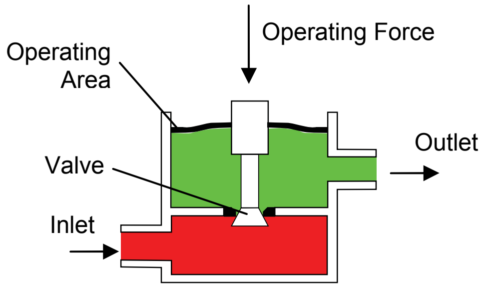
We have accreditation for the manufacture of PED products to Category 4, TPED products and ATEX products.

REGULATORS

Principle of Operation

Stripped to their essentials all regulators look like Figure 1.

Figure 1 Regulator operating principles



The operating force can be supplied by a spring or by gas pressure. As long as the force provided by the outlet pressure acting on the operating area is greater than the operating force, the valve stays closed. If the outlet pressure drops, the valve opens and allows fluid to pass from the inlet to the outlet. When the outlet pressure increases, the valve closes again.

Dome Loaded Regulators

In dome loaded regulators, the operating force is supplied by pressurised gas in the dome. The dome gas is isolated from the outlet by a flexible diaphragm. As the area on each side of the diaphragm is the same, the set outlet pressure is about the same as the pressure in the dome.

Figure 2 shows a typical dome loaded regulator. Small springs hold the valve stem and the diaphragm plate in place when there is no pressure in the unit. Restrictors control the flow of gas in the various compartments and prevent oscillation under some dynamic conditions.

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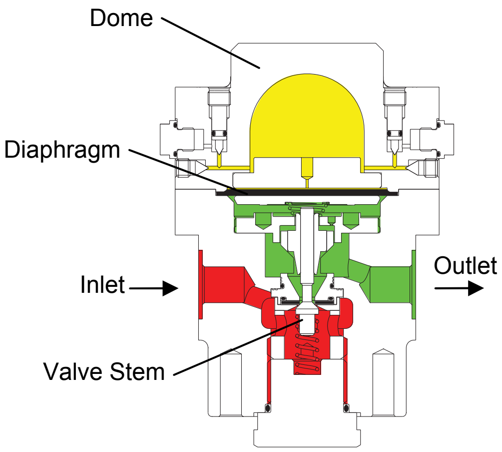
Figure 2 Typical unbalanced dome loaded regulator RH2

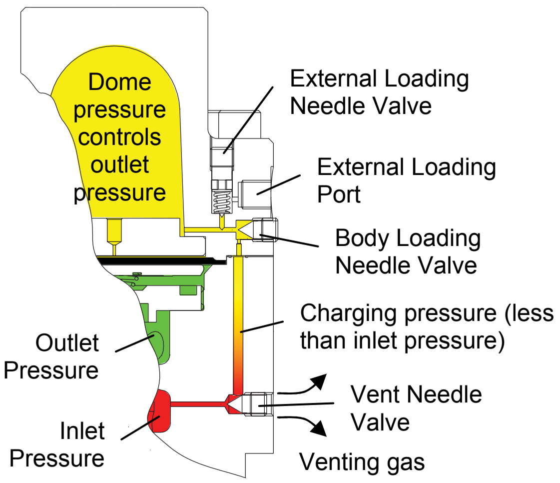


Charging

Dome loaded regulators are supplied with the dome un-pressurised. To get the regulator working or to change the set pressure, the dome must be charged with an inert gas such as air or nitrogen. DO NOT use liquid.

If the process gas can be vented safely to atmosphere it may be used to charge the dome – we call this "Body Loading". Alternatively, the dome may be charged from an external source – we call this "Mono Loading". Provision can be made for either or both methods ("Dual Loading").

Figure 3 Charging a dome loaded regulator



Body Loading Charging Procedure

Unscrew the Vent needle valve approximately two turns. Process air or gas will vent past the valve. This needle valve acts as a crude regulator to give a reduced pressure to charge the dome.

Unscrew the Body Loading needle valve a small amount. This needle valve allows you to control the charging rate. The outlet pressure rises as the dome is charged.

When the outlet pressure reaches the required value, close the Body Loading and Vent needle valves.

External Loading Charging Procedure

If there is a plug in the External Loading Port, remove it.

Connect a source of pressure to the External Loading Port. Ideally, this should be from an adjustable regulator. Alternatively, the external pressure can be controlled by a needle valve.

Set the external pressure to zero. Undo, but do not remove the External Loading needle valve.

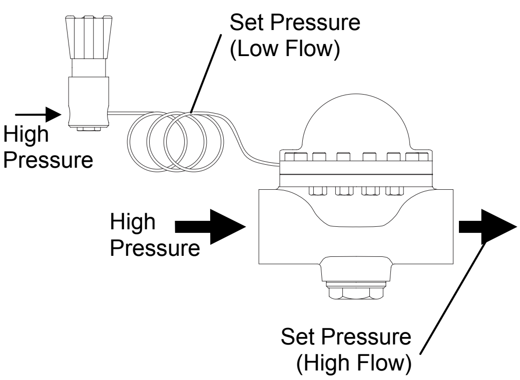
Apply external pressure to the dome. The outlet pressure will rise as the dome is charged.

When the outlet pressure reaches the required value, close the External Loading needle valve.

Remote Control

A simple remote control system is shown in Figure 4.

Figure 4 Remote control



A small, low flow, spring loaded regulator is connected to the external loading port of a larger dome loaded regulator. The set outlet pressure of the dome loaded regulator is controlled by adjusting the spring loaded regulator. The spring loaded regulator can be placed on a convenient control panel some distance from the dome loaded regulator.

Balancing

As you can see in Figure 1 the inlet pressure acts on the area of the valve seal. This creates a force opposite to the operating force and tends to reduce the outlet pressure. In other words: as the inlet pressure goes up the outlet pressure goes down. If you need to allow for this effect, a calculation factor is included in the data sheets.

If the outlet must be constant regardless of changes in inlet pressure (e.g. for systems supplied from storage cylinders) a balanced valve should be selected.

Figure 5 Typical balanced dome loaded regulator RH20

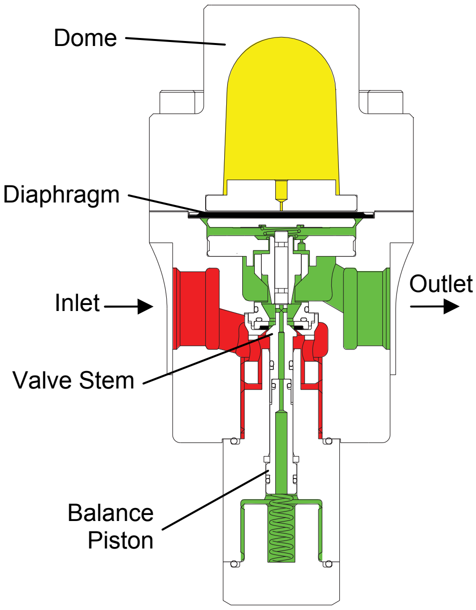


Figure 5 shows a typical balanced regulator. The outlet pressure is routed to the back of a piston through small drilled holes in the valve stem. The area of the piston seal is the same as the area of the valve seal. The pressure and area is the same on both sides of the valve so the force is balanced and the inlet pressure has no effect.

Apart from the extra cost, size and complexity, the balanced valve has the disadvantage that the closing force on the valve is low and sealing at shut off may be poor.

Spring Loaded Regulators

In spring loaded regulators, the operating force is provided by a spring. Depending on the outlet pressure range, the internal mechanism uses either a piston or a diaphragm to isolate the process fluid from the spring compartment. The range of outlet pressure is set by the diameter of the piston or diaphragm and the strength of the spring.

Figure 6 shows a typical diaphragm regulator and Figure 7 shows a typical piston regulator.

Turning the handwheel to the right (clockwise) increases the preload on the spring which increases the outlet set pressure. On the regulators shown here the handwheel is non-rising so the operating screw has a left hand thread.

Figure 6 Typical spring loaded regulator with diaphragm GLD15

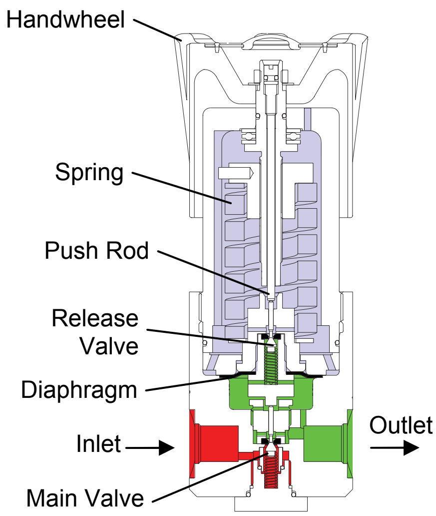
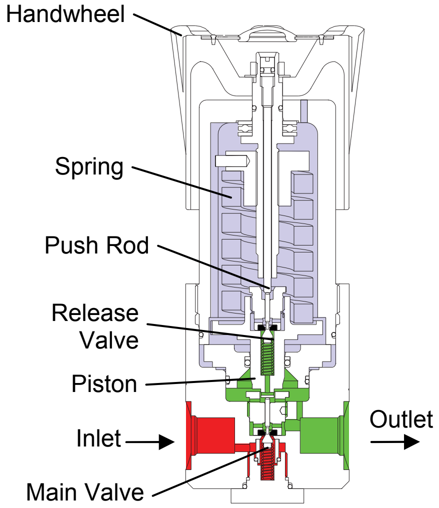


Figure 7 Typical spring loaded regulator with piston GLP15



Release Valve

The basic regulator mechanism has no way of venting downstream pressure. The regulators in Figure 6 and Figure 7 both have an extra valve called a release valve to do this.

If the outlet pressure increases above the set point, the diaphragm or piston rises further than is required to close the main valve. The stem of the release valve is brought up to contact the push rod. This opens the release valve and vents the outlet pressure.

The release valve outlet is usually into the spring compartment where it may be allowed to vent to atmosphere. For liquids or gases that must be contained, the spring compartment is sealed and the release valve outlet is routed to a spill port. The spill port must not be sealed or pressurised or the regulator will not work properly.

The main purpose of the release valve is to reduce outlet pressure when the regulator set point is reduced by turning the handwheel. The release valve will also vent outlet pressure if it increases for any other reason.

The release valve should not be considered as a safety device; a properly sized relief valve should be used for this purpose.

Balancing

Spring loaded regulators can be balanced in the same way as dome loaded ones. In fact, the larger sizes of spring loaded regulators have to be balanced or the effect of inlet pressure would be unacceptable.

Turn Down

All regulators can be turned down to almost zero pressure but at the low end of the range they become inaccurate, unstable and erratic. The main reason for this is that the friction forces in the mechanism become significant compared to the pressure forces.

Because of this a regulator must always be chosen so that the required range of outlet pressures matches the high end of the operating range. Do not be tempted to use a regulator of a higher than necessary outlet pressure rating.

Staging

If the pressure drop from inlet to outlet is large there is a significant cooling effect in the regulator. If the gas passing through has any water content it is likely to freeze and stop the regulator from working.

To prevent this it is usual to put two regulators in series in a two stage reduction. If freezing is a problem, the pipework between the stages should be heated or allowed to reach ambient temperature.

A two stage system is also much more stable with respect to changes in inlet pressure as can be seen in the following example:

1st stage - RH2 (1/4”) 2nd stage - RL2 (3/8”)		
Inlet	Interstage	Outlet
276	34	17
68	36.4	16.9
Outlet pressure change		-0.6%

Single stage - RH2 (3/8")		
Inlet	Interstage	Outlet
276	N/A	17
68	N/A	22
Outlet pressure change		+30%

A two stage system is inherently safer than a single stage. If the second stage regulator fails wide open, the outlet will only reach the interstage pressure. If the first stage regulator fails wide open the second stage regulator reverts to operating as a single stage. Because of this the inlet of the second stage regulator should be rated at the maximum inlet pressure of the system.

In the smaller sizes of spring loaded regulator it is possible to combine both stages in one body to make a very compact unit. An example is our HP1700.

Spring versus Dome

Spring loaded regulators are easy to adjust but are limited in flow rate.

Dome loaded regulators are available for high flow rates although the pressure ranges may be limited.

For a given flow rate a dome loaded regulator is more compact than a spring loaded one.

Dome loaded regulators should be installed vertical with the dome at the top while spring loaded ones can be used in any orientation.

The set pressure of a dome loaded regulator varies with temperature; an increase of 2.8°C (5°F) gives a 1% increase in outlet pressure.

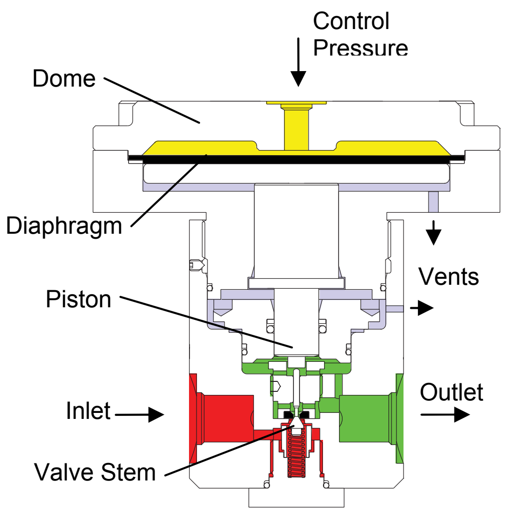
Dome loaded regulators generally do not have release valves.

Proportional Regulators

In a proportional regulator, the operating force is supplied by pressurised gas in the dome. A flexible diaphragm in the dome acts on a piston which in turn is acted on by the outlet pressure. The ratio of the area of the diaphragm to the area of the piston gives a proportional loading on the regulator. The diaphragm is isolated from the process fluid and the space between the diaphragm and the piston is vented.

On most variants the control pressure (i.e. the pressure in the dome) is in the range 0 to 7bar (100psi). The range of outlet pressure that corresponds to this control pressure is selected by choosing an appropriately sized piston.

Figure 8 Typical proportional regulator RH7



A typical proportional regulator is shown in Figure 8.

A release valve can be fitted into a proportional regulator.

Electronic Control

An example of an electro-pneumatic control system is shown in Figure 9. The set pressure in the dome of the proportional regulator is provided by an I/P (current to pressure) converter. The electrical control signal for the I/P converter comes from a programmable controller.

The programmable controller can respond to input from various sensors. In this case a pressure transducer measures the outlet pressure to give much more accurate and stable control than the regulator would achieve with a fixed gas volume in the dome.

The controller can be programmed to change pressure according to a pre-determined curve. For example, we supply filling systems for

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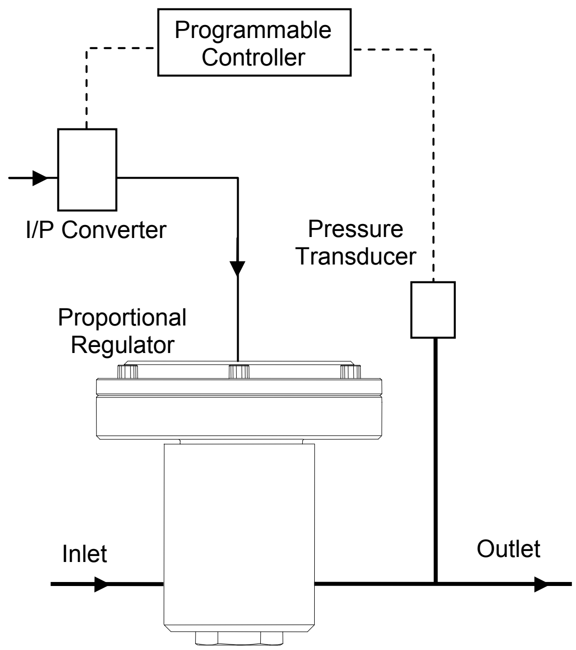
breathing gas cylinders that fill the cylinders as quickly as possible while minimising heating by compression.

Figure 9 Electro-pneumatic control

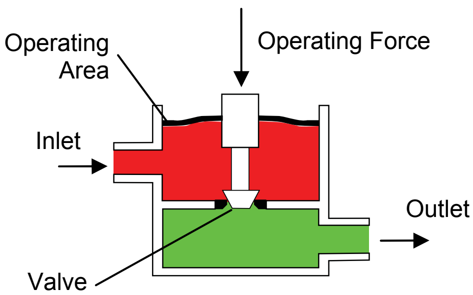


BACK PRESSURE MAINTAINING VALVES

Principle of Operation

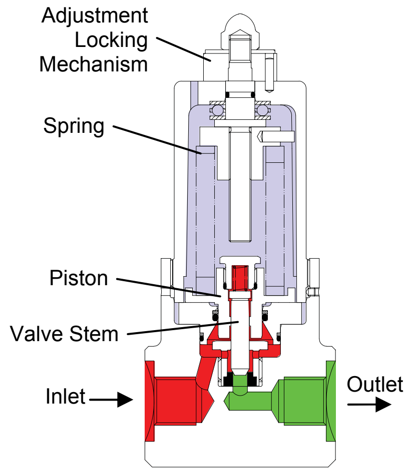
If you compare Figure 10 with Figure 1 you can see that the back pressure maintaining valve is like a regulator in reverse.

Figure 10 BPMV operating principle



As with a regulator, the operating force can be supplied by a spring or by gas pressure. When the force provided by the inlet pressure acting on the operating area is greater than the operating force, the valve opens and allows fluid to pass from the inlet to the outlet.

Figure 11 Typical BPMV GLP17



A typical back pressure maintaining valve is shown in Figure 11. The valve stem is allowed to move in the piston. This is to prevent the full load of the large spring from pressing the valve into the seat.

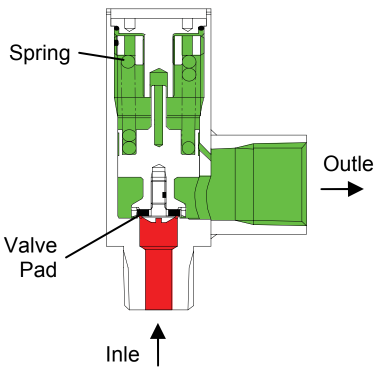
RELIEF VALVES

We offer two types of relief valve: direct acting and differential.

Direct Acting

A typical direct acting relief valve is shown in Figure 12.

Figure 12 Typical direct acting relief valve RV105

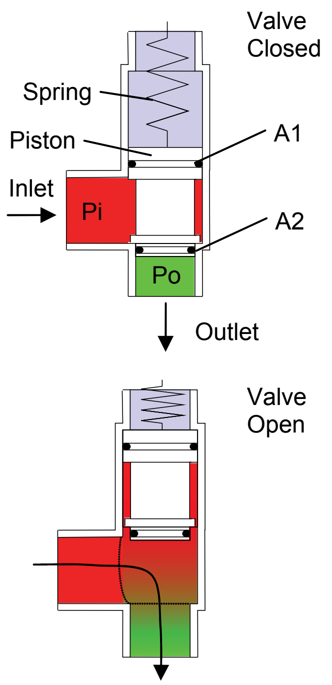


The valve opens when the force created by the inlet pressure acting on the seal area is greater than the spring force.

Differential

Figure 13 shows the principle of operation of a differential relief valve.

Figure 13 Differential relief valve operating principle



When the valve is closed, the spring force is opposed by:

((A1-A2) x Pi) + (A2 x Po)

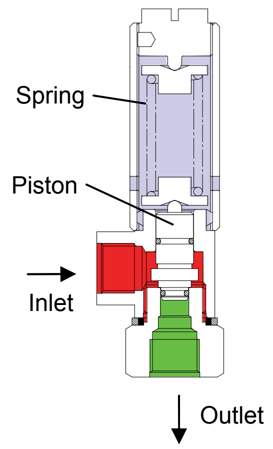
where Po is much smaller than Pi.

As the inlet pressure (Pi) increases, the valve opens when the force on the valve exceeds the force applied by the spring. As soon as this happens, the area under A2 is subjected to the full inlet pressure (Pi). The force opposing the spring is much higher and the valve snaps open to its full extent.

The name "differential" refers to the difference in areas between the operating piston and the valve seat.

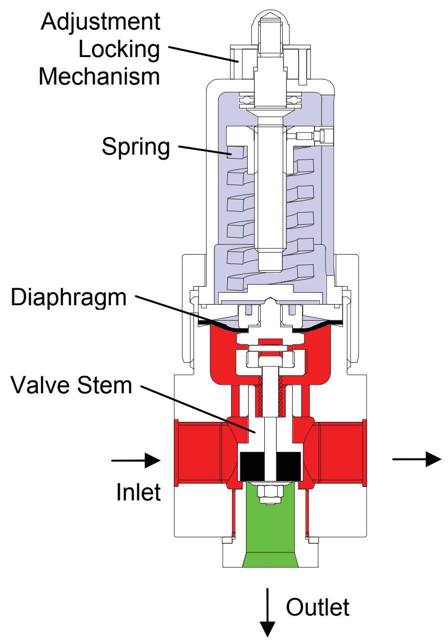
Figure 14 and Figure 15 are examples of differential relief valves.

Figure 14 Typical differential relief valve RS9



The RS series can be supplied with a banjo bolt fitting on the inlet. This makes it easy to position the valve at a convenient angle.

Figure 15 Typical differential relief valve RVA10



The RVA series allows flow through the body with the outlet exhausting to the side or below.

The valve stem is allowed to move in the diaphragm nut. This is to prevent the full load of the large spring from pressing the valve into the seat.

For higher pressures the diaphragm is replaced by a piston.

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The locking mechanism shown here was developed for the RVA series. Because the spring housing design is common to some of our regulators the same locking mechanism is used so we call it "RVA locking".

Differential versus Direct

For a given pressure and flow rate a differential valve has a much smaller spring than a direct acting valve because it only has to act on the differential area. A differential valve opens fully whereas in a direct acting valve the opening depends on the pressure and flow.

STOP VALVES

The function of a stop valve is simple: it blocks or allows flow. In metering versions the valve stem is in the shape of a cone which allows the valve to act as a variable orifice to control flow.

Figure 16 Typical simple stop valve SV60

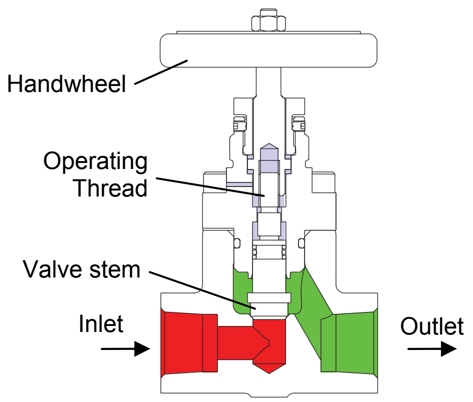


Figure 16 shows a typical unbalanced valve. The inlet pressure acts on the area of the valve seal and pushes on the operating thread. At high pressures the friction forces on the thread make it difficult to turn. This puts a limit on the flow and pressure capability of the valve.

This model seals directly to the body of the valve.

Balancing

Balancing reduces the end load on the operating spindle which cuts down the friction and the torque at the handwheel. It also allows a much smaller actuator to be used.

All of our larger stop valves are balanced.

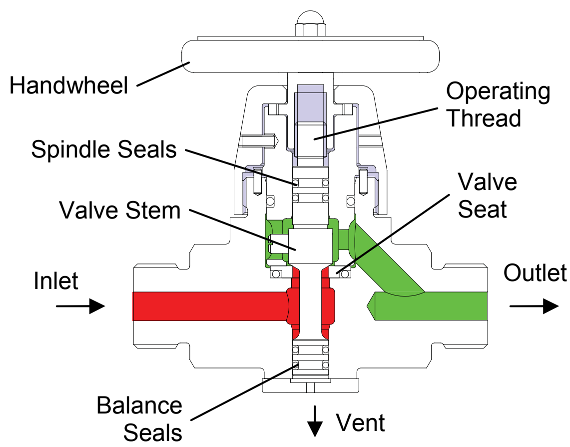
Even on perfectly balanced valves increasing the inlet pressure increases the operating torque. This is because the pressure activates the seals (i.e. forces them into their recesses) which increases friction.

Two balancing methods are available: external or internal.

External Balancing

Figure 17 shows a typical externally balanced valve. The valve stem has identically sized seals at the handwheel end and in the bottom of the body. The inlet pressure exerts no net force on the valve stem.

Figure 17 Typical externally balanced stop valve N6

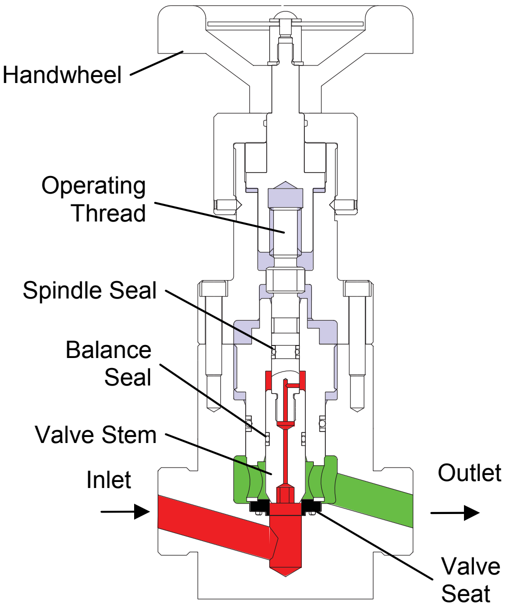


Internal Balancing

Figure 18 shows a typical internally balanced valve. The valve stem has small drilled holes to route the inlet pressure to the back of the balance seal. As the balance seal is the same diameter as the valve seat and the pressures are the same there is no net force on the valve stem.

Although this valve is slightly larger and more complicated than the externally balanced type it does not have the additional potential leak path to atmosphere. For this reason it is preferred for gases, such as Oxygen, which must be contained.

Figure 18 Typical internally balanced stop valve SV130



Actuators

Pneumatic actuators are available instead of handwheels for many of our stop valves. These are operated by air at 7bar (100psi) and returned by springs. Normally closed and normally open configurations are available.

Electric motor actuators can also be supplied.

SOLENOID VALVES

A solenoid valve is a stop valve operated by a coil. A coil can only provide a low force so the pressure/flow characteristics are limited. Direct-acting, high-pressure solenoid valves are only available with a small nominal bore.

To provide high flow rates at high pressures, a solenoid valve is used to operate a pneumatic (or hydraulic) valve of higher capacity. This system is known as a piloted valve and the two stages are incorporated into a common body.

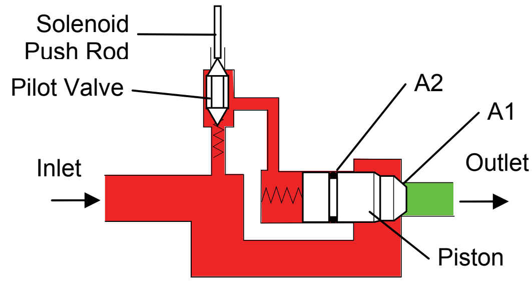
Because solenoid coils are configured to push on the valve spindle, normally open and normally closed valves have different internal configurations. The return force is provided by a spring in the valve body.

Changeover or 3 port configurations are also available.

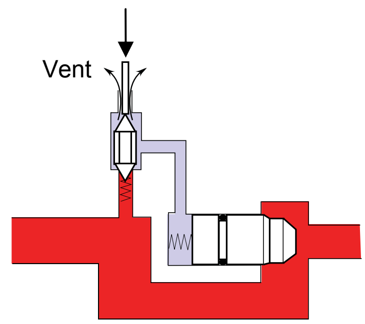
Piloted Valve Principle of Operation

Piloted valves may be normally closed (Figure 19) or normally open (Figure 20).

Figure 19 Principle of operation normally closed piloted valve



Solenoid De-energised - Valve Closed



Solenoid Energised - Valve Open

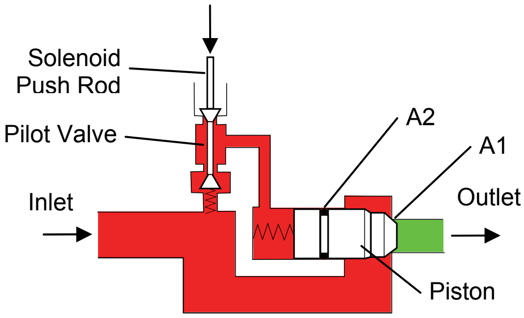
When the solenoid is not energised, the valve is held in its normal state by springs and by process pressure. When the solenoid is energised, the valve switches from its normal state. The valve does not latch.

The solenoid-operated pilot valve controls the pressure in the compartment behind the piston. Pilot pressure is usually taken from the inlet as shown in the figures. However, because of its small passageways, the pilot stage is susceptible to dirt. If the process fluid cannot be kept clean, we can configure the valve with a separate pilot supply.

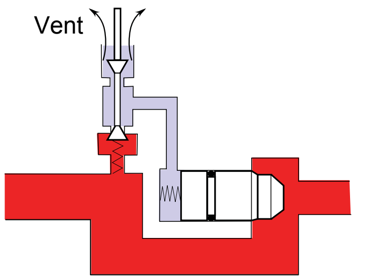
Because the area under the main valve seat (A1) is smaller than the area under the piston seal (A2), the valve is held closed when the compartment behind the piston is at inlet pressure.

When the compartment behind the piston is vented, the inlet pressure acts on the area under the piston seal (A2), overcomes the spring and opens the valve.

Figure 20 Principle of operation normally open piloted valve



Solenoid Energised - Valve Closed



Solenoid De-energised - Valve Open

FLOW CALCULATIONS

The following pages contain charts for calculating flow of gas or liquids through our valves.

The flow characteristic of a valve is given as C or Cv for gases or K for liquids to meet with industry conventions but the numerical value is the same.

Cv is defined as US gallons/minute of water for a 1psi pressure difference but it is measured using a flow of air.

1 US gallon = 0.833 Imperial Gallons

= 3.78 litres

A C value is shown on the data sheet where it is known. Note that these values are typical and variations in the design can affect the value.

If the flow factor is not known, use the nominal bore.

The C value for a valve, regulator, etc. is for when the device is fully open. As the valve closes C will reduce, reaching zero when the valve is fully closed.

Flow characteristics for some of our regulators under varying conditions of pressure and flow rate are shown on the data sheets.

The curves for gas flow are based on this equation:

$$Q = \frac{23Cv\sqrt{(P1 - P2)P2}}{\sqrt{Sg \times T}}$$

Q = flow in SCFM (Standard Cubic Feet per Minute)
Cv = flow factor for valve
P1 = inlet pressure psi absolute
P2 = outlet pressure psi absolute
Sg = specific gravity of gas relative to air
T = temperature degrees Rankine (degrees F +460)

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Gas Flow Calculation

In this example the inlet pressure is 100bar absolute.

Absolute pressures must be used for this calculation. Absolute = Gauge + 1bar (14.5psi).

The outlet pressure is 90bar absolute so the pressure differential is 10bar.

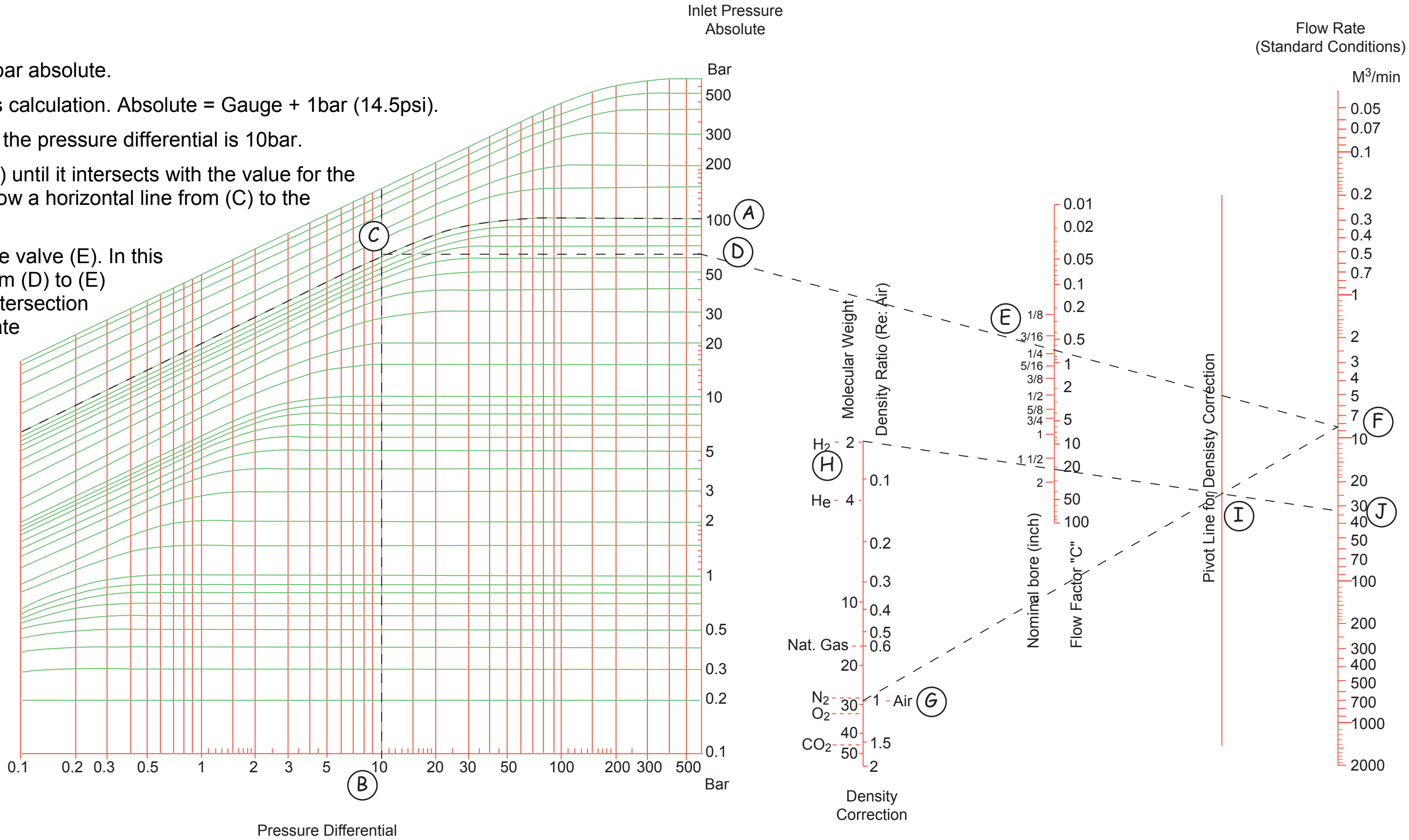
Follow the curve for the inlet pressure (A) until it intersects with the value for the pressure differential (B) at point (C). Follow a horizontal line from (C) to the axis at (D).

Find the flow factor or nominal bore of the valve (E). In this example C = 0.7. Draw a straight line from (D) to (E) and extend it to the flow rate axis. The intersection with the flow rate axis at (F) is the flow rate for air: 8.5 m^3/min.

To correct for other gases, draw a line from the calculated flow rate for air (F) to “1 - Air” on the density correction axis (G).

Find the gas that you want on the density correction axis. In this example it is Hydrogen at (H). Draw a line from (H) to cross the pivot line at the same point (I) as the line from (F) to (G). The intersection with the flow rate axis at (J) is the flow rate for Hydrogen: 32 m^3/min.

For ease of use this chart is reproduced without the example and to a larger scale on the following pages. There is also a version in Imperial units.



We design, machine, build and test all our products on one site in Uxbridge. If you don’t see what you want in our standard ranges, contact us and we’ll do our best to meet your needs.

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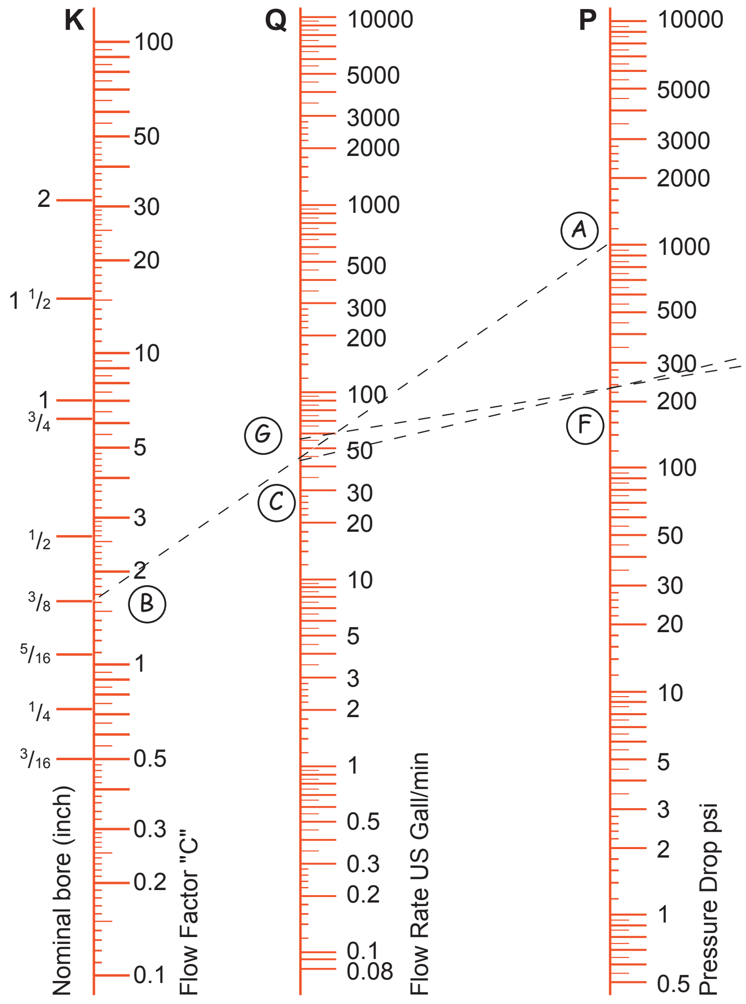
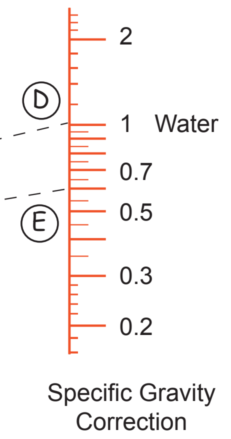


Liquid Flow Calculation

In this example the pressure drop across the valve is 1000psi. The absolute inlet pressure is not important for this calculation.



Find the pressure drop on the P axis (A).

Find the flow factor or nominal bore of the valve on the K axis (B). In the example the nominal bore is 3/8" or flow factor 1.6.

Draw a line from (A) to (B). The intersection with the Q axis at (C) is the flow rate of water in US gallons/minute: 43 g/m.

To correct for other liquids, draw a line from the calculated flow rate for water (C) to "1 - Water" on the specific gravity correction axis (D).

Find the specific gravity of the liquid that you want on the specific gravity axis. In this example it is 0.6 at (E). Draw a line from (E) to cross the P axis at the same point (F) as the line from (C) to (D). The intersection with the flow rate axis at (G) is the corrected flow rate: 55 g/m.

For ease of use this chart is reproduced without the example and to a larger scale on the following pages.

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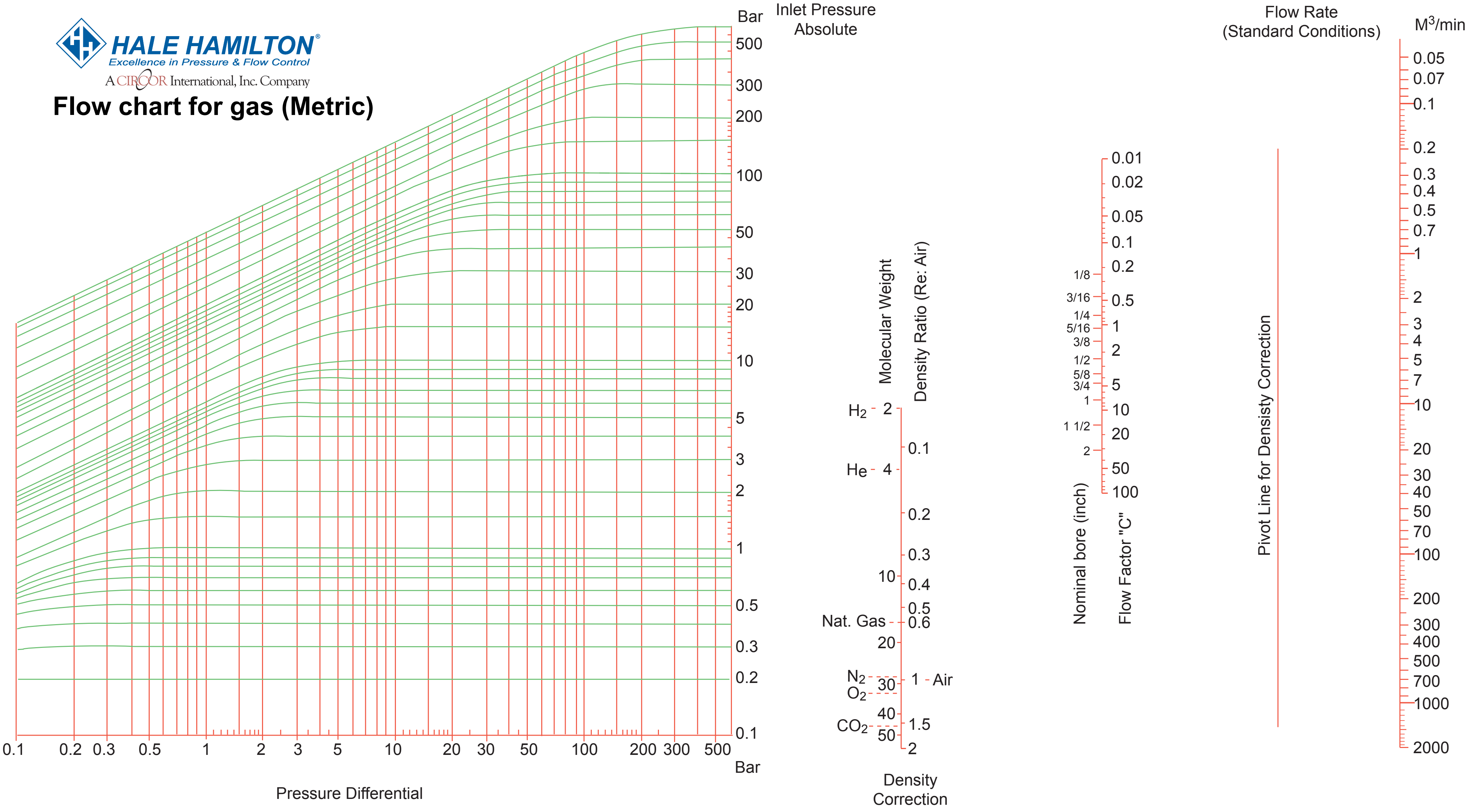
Flow chart for gas (Metric)



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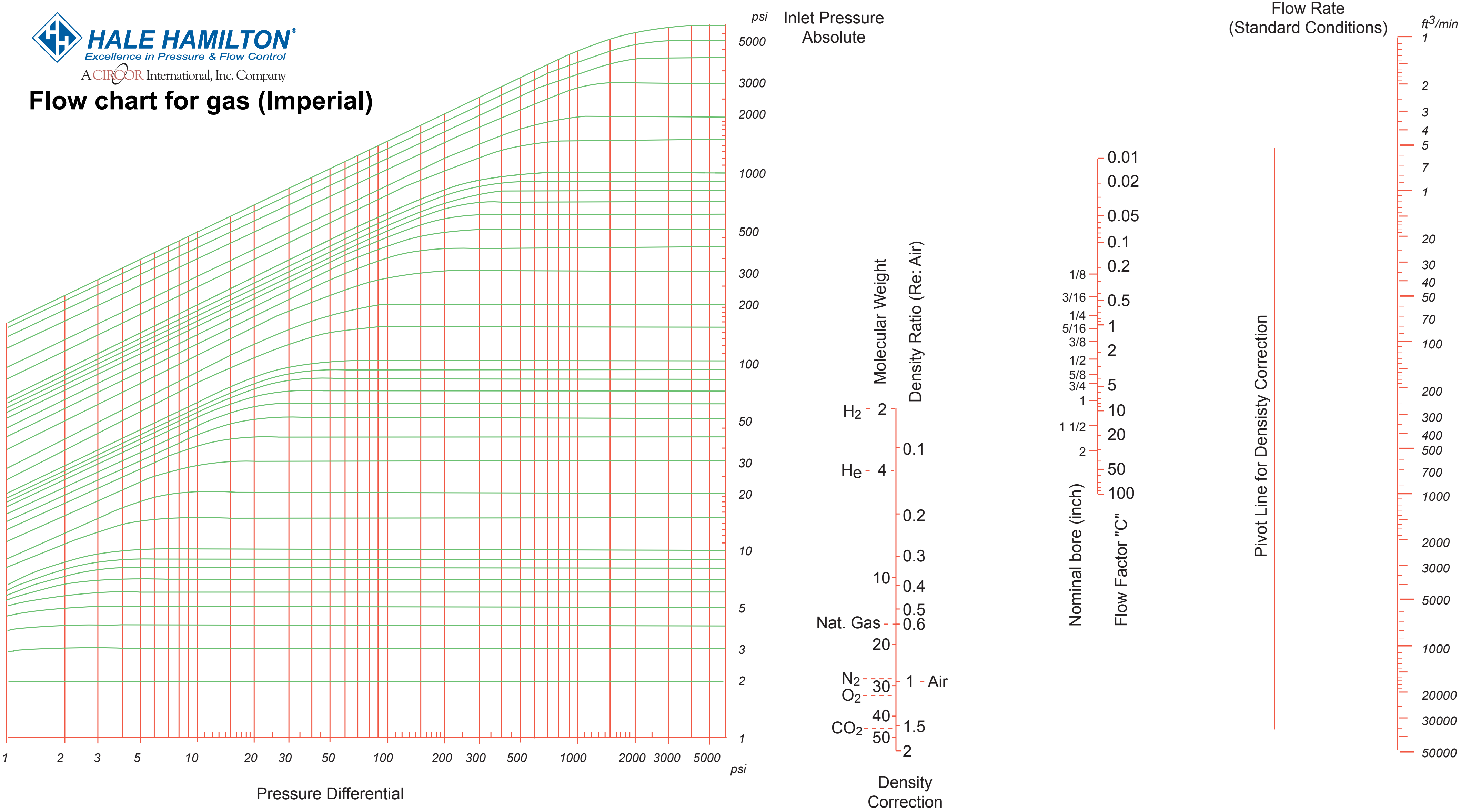
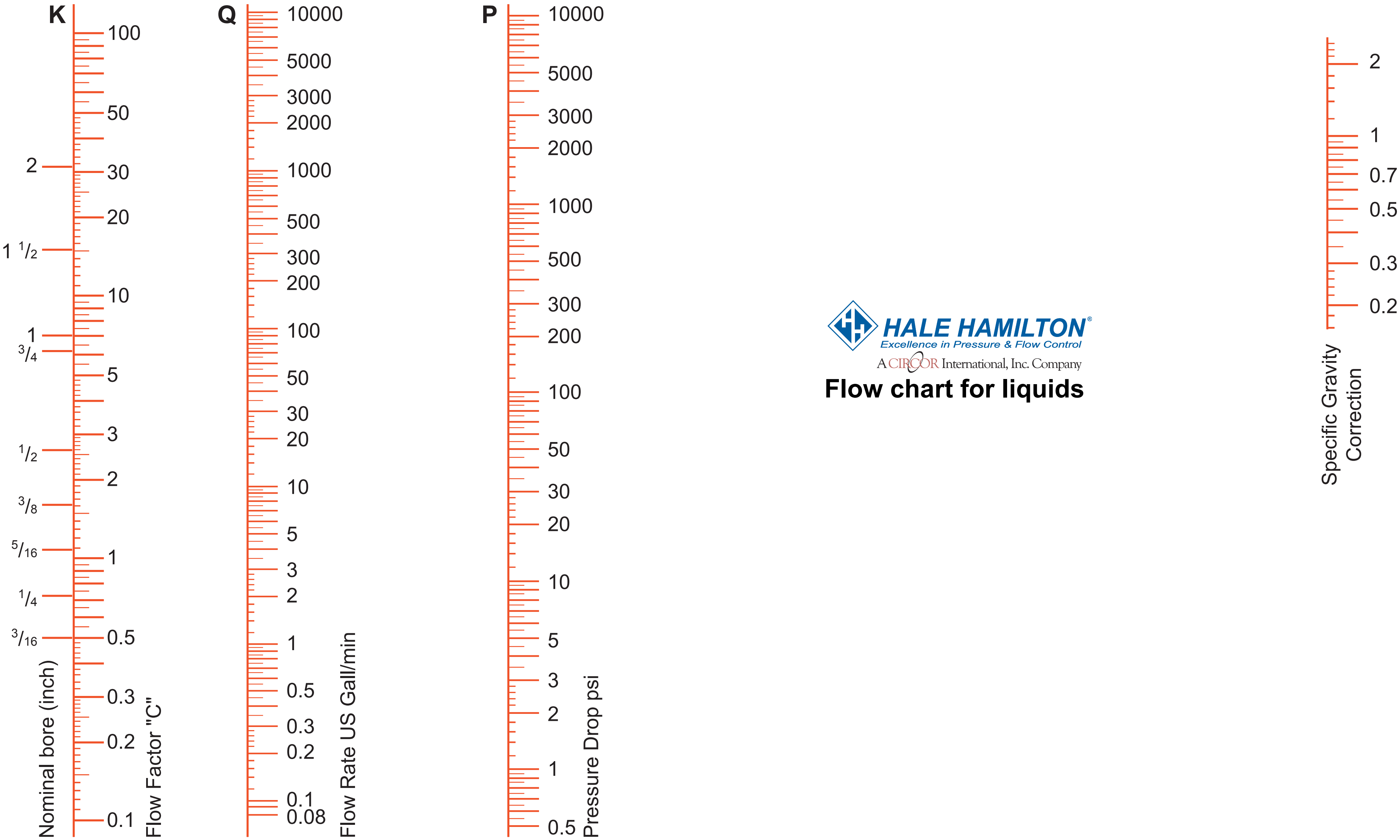
Flow chart for gas (Imperial)





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Flow chart for liquids

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CE Marking

PED

All our equipment is assessed to the Pressure Equipment Directive 97/23/EC (PED). This is a European Community directive, which is intended to harmonise the safety requirements of pressure equipment throughout the European Economic Area.

The Pressure Equipment Directive is implemented in the UK as: Statutory Instrument 1999 No. 2001 “The Pressure Equipment Regulations 1999”.

The Pressure Equipment Directive requires that equipment used to retain pressure is assessed for potential hazard. The hazard category is based on contained pressure and either nominal bore (DN) or volume. It also takes into account whether the contained material is hazardous (e.g. flammable or toxic). Categories are SEP, 1, 2, 3 and 4 in order of increasing hazard.

Category SEP means “Sound Engineering Practice”. The manufacturer’s usual controls on manufacturing and design are considered to be sufficient. NOTE that products in the SEP category meet all the requirements of the regulations and directive BUT they must not be CE marked and a declaration of conformity to PED must not be given. Most of our products are in the SEP category.

Our quality assurance system for manufacturing and design is accredited for PED by a notified body. The notified body carries out continuous assessment and review.

Devices used as “Safety Accessories” are automatically placed in category 4 regardless of pressure and volume. Category 4 products require additional assessment by a notified body. Amongst our products selected relief valves are available as safety accessories and have been assessed accordingly. These items are CE marked.

Further guidance can be obtained from: “Pressure Equipment, Guidance Notes on the UK Regulations”, DTI URN 05/1074

TPED

We can provide equipment to TPED - the Transportable Pressure Equipment Directive 1999/36/EC. This is a European Community directive, which is intended to harmonise the safety requirements of transportable pressure equipment throughout the European Economic Area.

TPED is implemented in the UK as: Statutory Instrument 2001 No. 1426 “The Transportable Pressure Vessels Regulations 2001”

TPED applies to products that may be carried or transported, i.e. it does not apply to products which will be used in fixed installations.

TPED is concerned with pressure containing vessels such as gas cylinders. Valves are only covered by TPED when they form part of the pressure containment of the vessel such as a cylinder valve or a safety valve directly attached to the cylinder (i.e. when they are a “primary closure”).

Valves for filling or emptying a pressure containing vessel, but not the primary closure, do not have to meet the requirements of TPED but do have to comply with PED.

To meet the requirements of TPED, equipment must be designed to an appropriate EN standard. If no standard exists, the design is assessed by a notified body. The equipment is π (“Pi”) marked for TPED.

Our quality assurance system for manufacturing and design is accredited for TPED by a notified body. The notified body carries out continuous assessment and review.

CE Marking

ATEX

We can provide equipment to ATEX - Equipment and Protective Systems for use in Potentially Explosive Atmospheres ATEX 100a Directive 94/9/EC. This is a European Community directive, which replaces previous legislation regarding the use of equipment in potentially explosive atmospheres (e.g. CENELEC and BASEEFA).

The ATEX Directive is implemented in the UK as: Statutory Instrument 1996 No. 192 "The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 1996".

ATEX applies to all equipment used in potentially explosive atmospheres including those without electrical components. NOTE that this is a change from previous regulations.

It seems that the intention of the ATEX regulations with regard to non-electrical equipment was misunderstood by the industry. The original interpretation was that ALL equipment needed to be assessed and marked for ATEX use. The 2nd edition of the ATEX guidelines (ec.europa.eu/enterprise/atex/guide/index.htm) includes new sections (3.7.2, 3.7.3 and 5.2.1) that clarify this point. Section 5.2.1 states that "*simple mechanical products do not fall under the scope of directive 94/9/EC*". This definition clearly covers the non-electrical equipment that we supply. Such equipment must not be ATEX (Ex) marked and does not require special documentary support.

Equipment with electrical components (such as solenoid valves) can be supplied to category 3 (suitable for Zone 2) and for some equipment to category 2 (suitable for Zone 1). This equipment is ATEX (Ex) marked.

Our quality assurance system for manufacturing and design is accredited for ATEX by a notified body. The notified body carries out continuous assessment and review.

Further guidance can be obtained from: "Equipment and Protective Systems intended for use in Potentially Explosive Atmospheres", DTI URN 97/814

Machinery

The Machinery Directive 2006/42/EC was published on 9th June 2006 and it is applicable from 29th December 2009, replacing the Machinery Directive 98/37/EC.

Machinery is defined as *"an assembly, fitted with or intended to be fitted with a drive system other than directly applied human or animal effort, consisting of linked parts or components, at least one of which moves, and which are joined together for a specific application"*

The guidelines clarify this definition as follows: *"The Machinery Directive does not apply as such to separate machinery components such as, for example seals, ball-bearings, pulleys, elastic couplings, solenoid valves, hydraulic cylinders, flange-connected gearboxes and the like, that do not have a specific application and that are intended to be incorporated into machinery."*

The directive only applies to items defined as machinery. Items supplied by us do not meet this definition so the Machinery Directive does not apply.

Further guidance can be obtained from: "Guide to application of the Machinery Directive 2006/42/EC" available from "http://ec.europa.eu/enterprise"

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SAFETY INSTRUCTIONS

This equipment is for use on high-pressure systems. Improper use can endanger human life.

Every reasonable precaution has been observed in the design of this equipment to ensure that competent persons can use and service it safely.

Unauthorised personnel should be prohibited from tampering with this equipment.

Some variants of this equipment may be used with Oxygen, which reacts violently with any combustible substance. If using with Oxygen, ensure that there are no traces of combustible substances such as oils, greases or sealants. Observe the cleaning and lubrication instructions specified on the GA drawing, available on request.

INSTALLATION

Where the equipment has arrangements for mounting to a bracket or panel, these arrangements should be used to support the weight of the equipment. Where no mounting provisions exist, the equipment may be supported by the connecting pipework.

Ensure that the equipment is connected the right way round. Observe flow arrows or Inlet/Outlet markings. If unsure, refer to the relevant GA drawing, available on request.

Do not blank off or obstruct any vents, drains or spill ports.

Protect the equipment against impact.

Do not subject this equipment to pressure higher than the design or operating pressure marked on it.

Do not operate or store this equipment below 0°C or above 70°C unless a different temperature range is stated on the equipment or associated documents.

PED

This equipment has been assessed to the Pressure Equipment Directive 97/23/EC (PED) and CE marked accordingly. Where no CE mark is shown, the equipment is in Category SEP (Sound Engineering Practice).

CONTACT US

If you are unsure about anything or require further information, please contact our Sales department at the address below.

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Issued: March 02

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GENERAL OPERATING INSTRUCTIONS

For specific operating instructions, please request the relevant Service Instruction.

Spring Loaded Regulators:

For Spring Loaded regulators fitted with a control knob, turn the knob clockwise (to the right) to increase the outlet pressure. The minimum outlet pressure is when the knob is turned fully anti-clockwise.

Regulators without a control knob can only be adjusted by authorised personnel. Please request the relevant Service Instruction for details of how to do this.

Dome Loaded Regulators:

Dome Loaded regulators require special equipment to set their operating pressure and can only be adjusted by authorised personnel. Please request the relevant Service Instruction for details of how to do this.

Stop Valves:

Turn the handwheel clockwise (to the right) to close the valve, anti-clockwise to open it. Do not use excessive force at the end of the valve travel as this may damage the seals. The valve should not be operated partially closed unless it is designed for metering.

Relief Valves:

Relief valves should be checked for operation and relief pressure by an authorised person at least every 6 months. Please request the relevant Service Instruction for details of how to do this.

Relief valves must not be adjusted or tampered with in any way by unauthorised persons.

SERVICING

The equipment must be isolated from high-pressure supplies and all pressure must be vented before any servicing work is undertaken.

The recommended service for this equipment is to dismantle it and replace all the recommended spare parts.

If no service interval is stated in associated documents, we recommend a service interval of 2 years.

For more detailed information, please request the relevant GA drawing and Service Instruction.

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