General Training Pty Ltd

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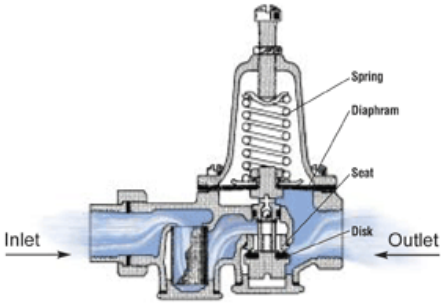
The Purpose, Use and Care of Pressure Reduction Stations.

Training For Operators, Maintainers, Technicians and Engineers.



Training Objective

This training teaches users and maintainers of pressure reduction stations and equipment why they are used, how they work, what causes them to go wrong and what is necessary to keep them operating properly.

Training Contents

- Purpose of the equipment.
- The principles of how the equipment works.
- Important parts and assemblies.
- In-service design and operation.
- How the equipment achieves its purpose and the necessary operating conditions.
- Most likely failure modes, their causes and what to do about them.
- On-Site, workshop or test bench observations of an equipment installation.
- Conduct site tests and trails on the equipment operation.
    - Compare the installation to the minimum design required.
    - Predict effect of changes.
    - Observe actual changes.
    - Identify impact of changes to the equipment operation.
- Learning Assessment
    - Explain purpose and use of equipment.
    - Identify how the equipment achieves its purpose.
    - Specify the required operating conditions for proper performance.
    - List what failures are possible at the workplace and how to fix them.
    - Training Supervisor review.

Outcomes of the Training

This training will make the trainee clear and knowledgeable in the proper use, care and maintenance of pressure reducing stations. It will give them in-depth knowledge of the equipment and the factors that affect its operation. They will use the new know-how to better operate, care-for and maintain such equipment in future.

Time Required

The training takes one hour to complete for able people with some industry experience.

Training in the Purpose, Use and Care of Pressure Reduction Stations

Purpose of the Equipment

A pressure reduction station is used to drop a high supply pressure down to the pressure used by the downstream installation. They operate on liquids, vapours and gases.

Many times a liquid, vapour or gas is provided at high pressure because it is more efficient to make at pressure, easier and more economical to transport under pressure (more gas and steam can be sent through a pipeline when it is compressed under high pressure than at a lesser pressure) or the pressure is a natural state of the process used for its creation.

By supplying a high upstream pressure and lowering it only when necessary, less expensive equipment can be used downstream, as it does not need to be designed and built of materials to take the high pressure. A pressure reduction station is used to make low pressure from high pressure.

A similar situation arises for a pressure sustaining station. In this case the aim is to maintain pressure upstream and allow the downstream pressure to intentional fall if there is not enough supply pressure available.

How the Equipment Works

Pressure reduction stations serve one of two purposes, either to maintain a chosen downstream pressure or to sustain a required upstream pressure. Figure 1 shows a pressure reducing station and Figure 2 shows a pressure sustaining station. Note the position of the sensing point for each station. Often the sensing line is actually an opening and passage made inside the valve body and cannot be seen from the outside.

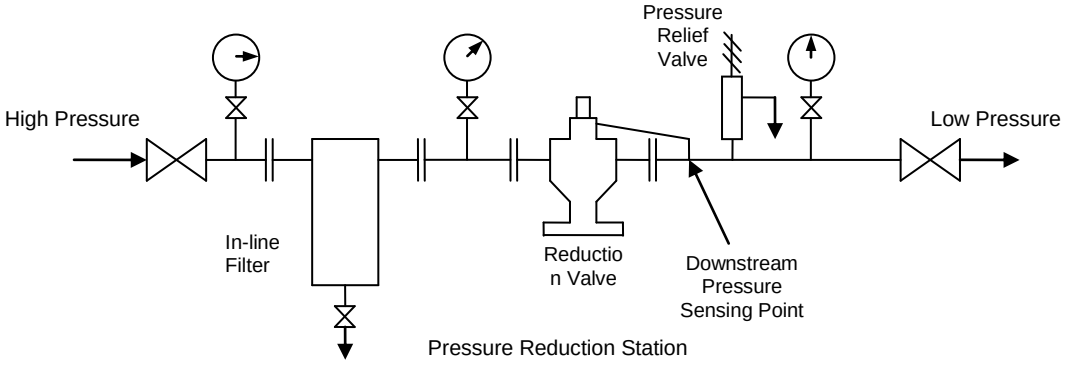


Figure 1 Location of Pressure Sensing for a Reduction Station

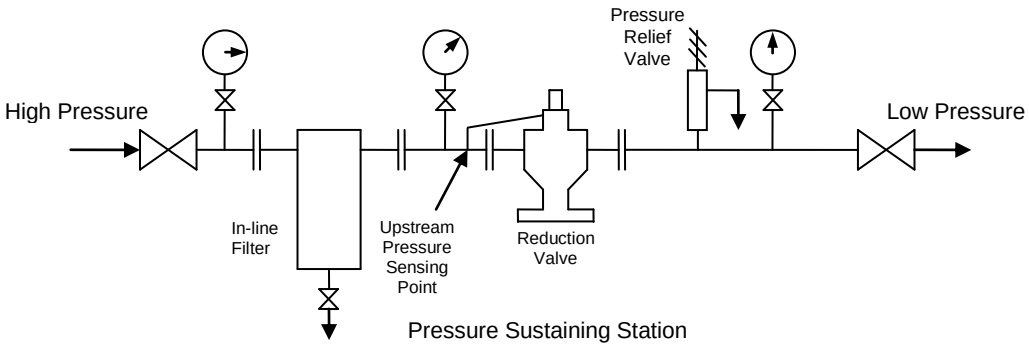


Figure 2 Location of Pressure Sensing for a Sustaining Station

Within a pressure control station are entry and discharge piping, isolation valves, filters and/or strainers, pressure gauges, drain points, the sensing points and the pressure controlling valve. The downstream pressure relief valve protects the downstream equipment from being exposed to high pressure if the regulating valve was to fail open and allow high pressure through.

The pressure reduction valve is designed to be self-regulating, which means it adjusts the size of the opening through which the liquid, vapour or gas passes so that only enough to cause the necessary downstream pressure is permitted past. The valves work by balancing one force against another, like a never ending tug-of-war game, as shown in Figure 4. When one force is larger than the other the valve stem moves in the opposite direction.

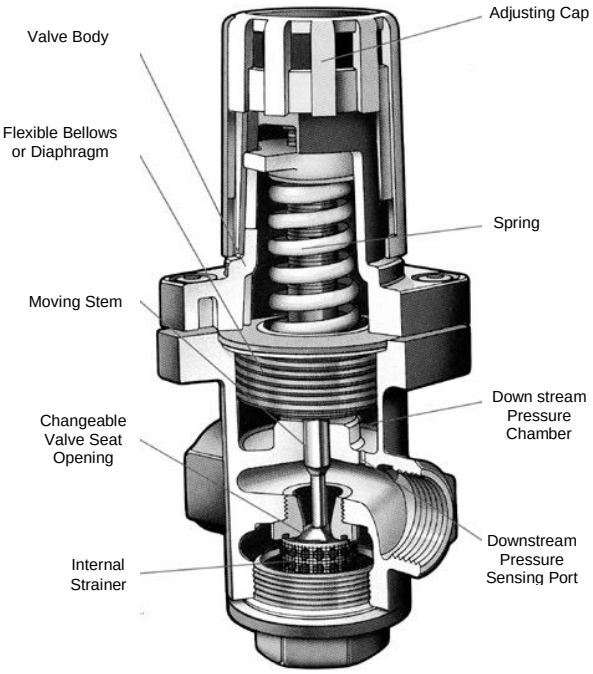


Figure 3 Direct Acting Pressure Reducing Valve

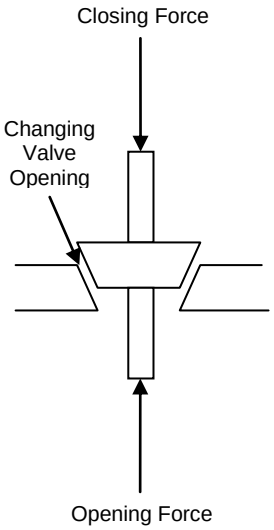
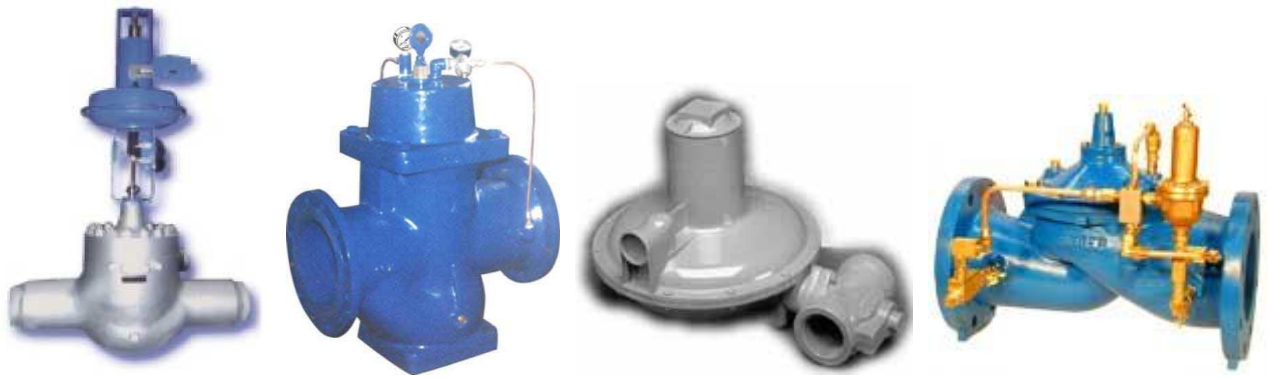


Figure 4 Balancing Forces

There are several ways to produce the opening or closing forces within the regulating valve. They can be by spring force as in Figure 3. It can also be by using the system's own pressure against a bellows or diaphragm. Or by using an external pressure source fed to the regulating valve. It can even be controlled completely away from the valve by a control loop that moves a controller mounted outside the valve. Figure 5 shows several arrangements for controlling the opening of regulating valves.



Externally Controller | Internal Pilot Operated | Diaphragm with Relief Valve | External Pilot Operated

Figure 5 Various Types of Regulating Valve Arrangements

The regulating valve in Figure 3 is the simplest design and uses a spring to open the valve seat. The downstream pressure enters the sensing port into the sensing chamber and pushes against a roof of the bellows (or diaphragm).

The valve spring acts to keep the valve open. It is open from the start and lets the upstream pressure flows through. Eventually enough pressure flows downstream and the downstream pressure rises toward the upstream pressure. The downstream pressure starts to enter into the sensing chamber in the valve. The downstream pressure continues to rise downstream and inside the chamber. As the pressure rises it pushes harder against the bellows roof. Once the chamber pressure gets high enough it pushes the bellow roof upward and the valve opening closes.

Important Parts and Assemblies

The key items in a pressure reduction station are the pressure regulating valve, the pressure gauges and the in-line strainer and/or filter.

The pressure gauges allow you to set the valve so it controls at the pressure you want. They also let you watch how the valve behaves during operation and to detect if it is no longer controlling. The in-line strainer/filter removes particles and matter from the flow so that solids and sludge do not enter the valve to block internal ports and passages.

In-Service Design and Operation

The assembly of equipment in Figure 1 forms the basic pressure reduction station.

As a system to lower pressure from high to low in a reliable and safe way each item of equipment has an important part to play.

Often there is only the downstream pressure gauge in a station. The assumption is made during the design that there is always an upstream pressure and that only the downstream pressure is necessary to be known. Mostly that is a reasonable choice. But it does not allow for easy fault-finding and detection of changed delivery pressure or blocked strainers and filters.

Figure 6 Pressure Gauges

The isolation valves permit shut-down and maintenance. The pressure gauges indicate the pressures in each section of the station and allow you to compare the current operation to what is acceptable. They also allow you to adjust the regulating valve to deliver the right pressure.

The in-line stainer protects the regulating valve from contamination. It also allows the draining away of any liquid collecting in the piping. The regulating valve knocks-down the pressure to the set value. The pressure relief valve protects the downstream equipment should the regulating valve fail or is set incorrectly.

How The Equipment Achieves Its Purpose And The Necessary Operating Conditions.

Providing a regulated downstream pressure of known value is the entire purpose of a pressure reducing station. Maintaining an upstream pressure of known value is the entire purpose of a pressure sustaining station.

For a pressure reduction station to operate correctly there must be a high enough upstream pressure supply. The upstream pressure is shown on the upstream pressure indicator. This is especially important if the regulating valve uses the system pressures to move the valve stem.

For a regulating station there must also be a sufficient downstream pressure so that the pressure can fill the sensing chamber. If there is insufficient downstream pressure the regulating valve will forever be open.

To set-up the station so it provides the necessary service you must know what it is intended to do – regulate downstream pressure, or sustain upstream pressure. You set the required pressure by adjusting the device producing the external force on the stem while watching the correct pressure gauge pointer move. If you are setting the downstream pressure, watch the downstream pressure gauge. If you are setting a sustaining pressure, watch the upstream pressure gauge.

Make adjustments gradually and give the system time to stabilise pressure before making another adjustment.

Possible Failure Modes Causes, Prevention and Corrective Actions

There are several key factors that must be confirmed to insure successful equipment operation.

- **Downstream pressure will not build** if the draw-off is more than the valve can supply. That means the might be a large leak downstream, or thee are many small leaks downstream, or a big user of the pipe contents is drawing heavily or the regulating valve is undersize and cannot pass enough of the contents.

- **Loss of upstream pressure** may result if valves are closed, or there is a large leak, or there are many small leaks, or the pressure creating device is out-of-service, or a big user of the pipe contents is drawing heavily.

- **Internal ports and passages can block** from sediment, contamination, bacterial growth, the gradual deposition of materials on surfaces, items accidentally left behind after a repair, a broken filter screen letting material through or a change of process fluid having unexpected chemical or corrosion consequences.

- **Valve housings can fail from corrosion** either internally by the contents or externally because of the local environment. In such situations it becomes necessary to select long-lived materials and/or to do some strip down and rebuild maintenance or replace the equipment after a set number of years to ensure the station behaves correctly in future.

- **Parts internally become 'frozen'** from corrosion or product build-up. This is especially likely in those installations where the pressure into and out of the station have not changed for years and material has deposited in tight places or on sliding surfaces and become bound.

- **Pressure hammer can come from both directions** and burst the strainer screen, damage the regulating bellow or diaphragm, break pressure gauges, it can cause flange leaks and blow out gaskets. To avoid pressure hammer close valves more slowly.

- **Slug of liquid condensate smashes into internals** in systems that regulate moisture laden gases and vapours like steam. In such situations it is necessary to install a trap to capture the liquid and condensate and remove it before it gets to the regulating valve. There may be a need to install several water traps throughout the inlet to the station. Often the pipe work

can be intentionally turned into a drip leg to capture and remove liquid through a self-regulating trap, our automatic drain.

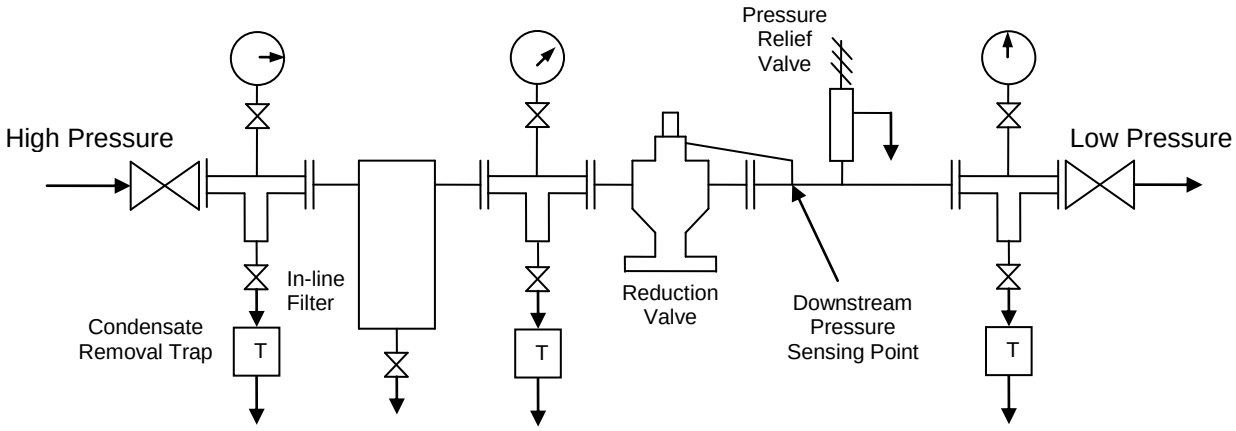


Figure 7 Pressure Reduction Station with Condensate Removal

- **Bellows or diaphragm fails** from old age, contamination, incompatibility with process fluids, damaged during installation, wrong diaphragm material supplied by mistake.

- **Internal springs are the wrong force rating** to supply the required pressure. Usually there is a choice of spring ratings to select from depending on the range of pressures the valve has to regulate. If the spring rating is too low the valve will not move against the process pressure, and if rated too high the pressure cannot move the valve.

- **The pressure sensing line is not installed or installed incorrectly**. There have been times that an installer or maintainer has accidentally left off the sensing line connecting the sensing point to the valve and the valve does not regulate. Situations can arise where the sensing line is accidentally squashed and crimped closed so that no pressure reaches the valve. Or the hole up the centre of the sensing tube gets blocked with thread tape or other foreign matter.

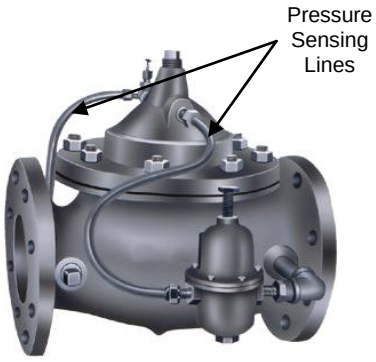


Figure 8 Connect the Sensing Lines

- **Pressure gauges can reading wrongly** and cause the station to be set to the wrong pressure. Pressure gauges used to set the regulating valve should be replaced with new, or tested, every 24 months.

- **In-line strainer/filter gets blocked** over time from contaminant or foreign matter. The strainer screen should be cleaned regularly to keep it clear of blockage and to check it is not damaged and letting sediment through to the valve.

- **Wrong fail safe position was chosen for the regulating valve.** When the valve fails from loss of position signal, or there is no pressure in the system, it is necessary to be sure the valve will either shut itself or open itself so that the final resting position is safe. Usually a spring will drive the stem to its rest position and this position must be safe for operators and the process.

On-Site Test, Workshop or Lab Test of an Installation and Learning Assessment

It is now time to do some 'hands-on' training in the field, or with a spare, or on the test-bench. To thoroughly understand this topic it is best to see what happens in a working situation and practice by making and controlling changes. You will better understand what the equipment does, and how to run it well, if you can operate it. Locate suitable equipment in your plant that you will be allowed to adjust and inspect.

1. Locate the manufacture's operating manual if available or find it on-line over the Internet. Take the time to read it. Tag anything you don't understand and come back to it at the end of the training to see if you come to know what they mean.

2. Hand-sketch below the equipment installation at your workplace and write the name of the individual equipment items on the sketch. If there is more equipment used in the station than the minimum basic design shown previously write down what each extra item of equipment is used for in the space under the drawing.

3. Close Inspection

3.1. Get a reducing valve, open it and look inside. If that isn't possible get a manufacturer's manual for the valve you use. Using the manufacture's manual name and describe each equipment part.

3.2. Write a short description of how the reducing valve is built and how it is designed to work.

3.3. Describe how to set the pressure reducing valve station up for the required pressure of a station in your facility.

4. If at all possible, and once you have supervisor permission, operate the equipment to see what effects happen as the operating conditions change. If you cannot operate a real item of equipment, then describe as best you can using information from your reading and discussion with others, what will happen to the process due to the change.

4.1. Start-Up Conditions.

Starting with no pressure at the station, describe what see and hear, and how much the pressure changes, upstream and downstream of the pressure regulating valve once pressure is introduced.

4.2. Pressure Build-up.

Shut the downstream isolation valve as if there were a blockage and describe what happens to the pressure and equipment in the station.

5. Possible Modes of Failure

5.1. List the ways that pressure reducing stations have failed to perform properly at your workplace. Talk to the experienced operators and maintainers if necessary.

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5.2. Getting the Equipment Back to Proper Operation.

For each failure mode listed above, describe in detail what needs to be done to correct them.

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This is the end of this training. Please record the following details and hand your answers back to the supervisor in charge of this training.

Trainee _____ **Signature** _____
(Print Name) (Trainee)

Supervisor _____ **Signature** _____
(Print Name) (Supervisor)

Assessment Result: ☐ Pass

☐ Repeat

Completion Date _____ 'Pass' recorded in the Trainee's training records ☐