Varie

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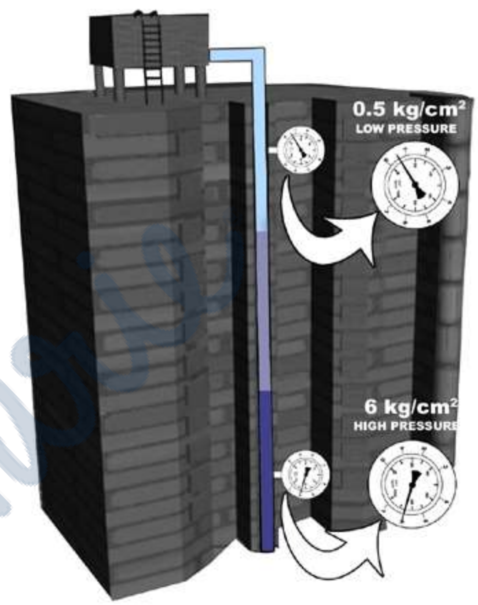
WRITE-UP ON APPLICATION OF PRV IN HI RISE BDLGS.

WHY ARE PRESSURE REDUCING VALVES REQUIRED IN BUILDINGS?



When water is supplied to the flats from the overhead tank the pressure of water increases as we go downwards due to the weight of the water column above it. Thus the pressure is maximum at the ground floor /1st floor and minimum at the top floor.
Even in a Hydro-Pneumatic system where water is supplied directly from pump to flats the pressure is higher on the lower floors of each zone.

How to estimate the static (full) pressure coming on your Unit/Apartment.
1. First Calculate the water head (WH)

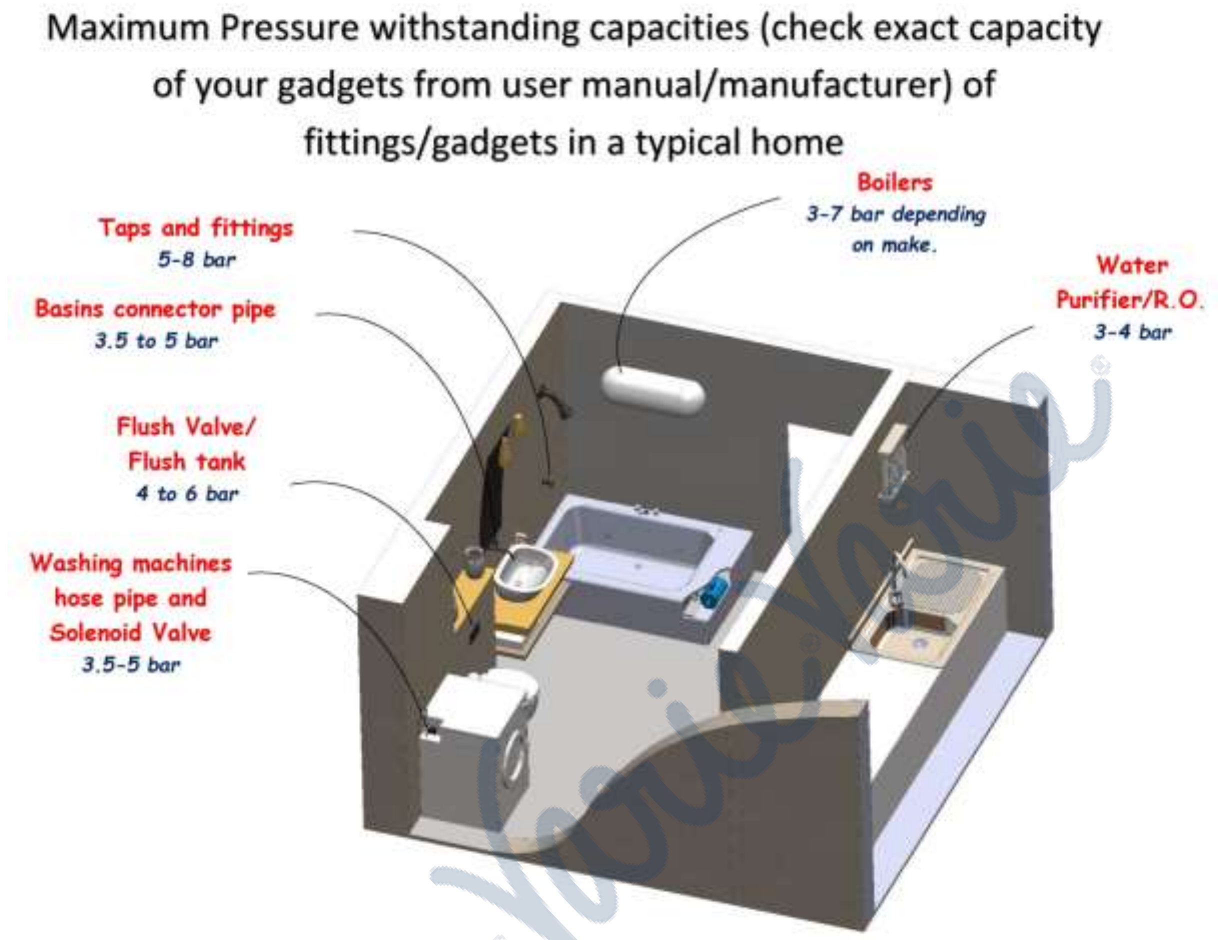
$$WH = [(n \times h) + d]$$

n = no. of floors above your unit.
h = height of each floor.
d = distance from "Top" of overhead tank to terrace.

2. Divide the WH by 10 which will give the pressure in bar or kg/cm^2 .
Such high pressure needs to be reduced for following reasons:

1. SAFETY OF EQUIPMENT FITTINGS.

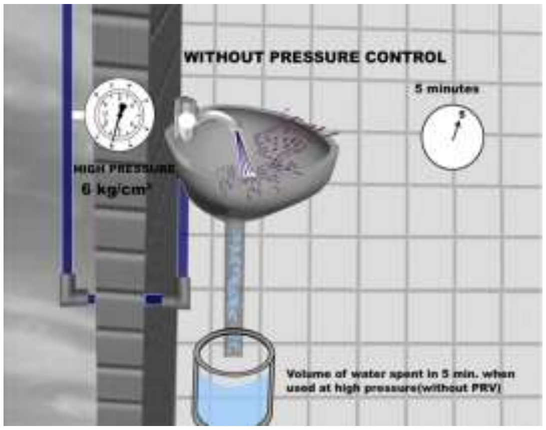
Generally all fittings, equipment like water purifier, boiler etc. are designed to withstand pressure up to a certain limit. Viz Water Purifier/R.O. units withstand 3 kg/cm^2; Boilers – 3 to 6 kg/cm^2; Washing Machine – 4 to 5 kg/cm^2; Basin connector pipes – 3.5 to 4.5 kg/cm^2. As per Bombay municipal corporation norms the pressure should not exceed 35 psi or roughly 2.4 Kg/cm^2. Thus after 24 mtrs (80 feet) from the overhead tank the pressure will exceed the limit (Because every 10 mtrs of water head means 1 kg /cm^2 of pressure).

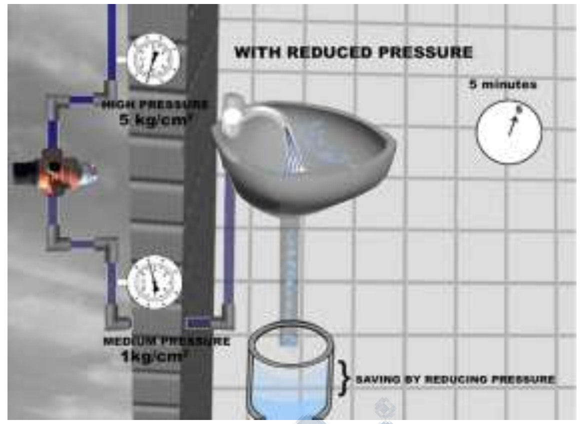


In order to reduce and regulate the pressure a PRV is used. We often hear of geyser/boiler. These are replaced frequently – one brand after another thinking that quality of geyser was bad. But in reality this happens mostly due to excessive uncontrolled water pressure.

2. SAVING OF WATER

Another function of the PRV which is equally important but sometimes ignored – is to reduce the water consumption. For any tap, shower or fitting the quantum of water actually required for cleaning is far less. But more water is used due to excessive pressure. Taller the building, greater the pressures, greater the wastage of water due to the more-than-required flow/force of water. And to add to it, water runs from tap continuously (as we rarely close the tap during intervals when water is not required) – For example while having a face wash though we may actually need about 2 liters. We spend over 10 liters due to running tap & high flow rate. And higher is the pressure, the more is the flow rate, and more is the wastage. Furthermore, sometimes the pressure/force is so high that water hits the palm and spills out causing inconvenience and waste.



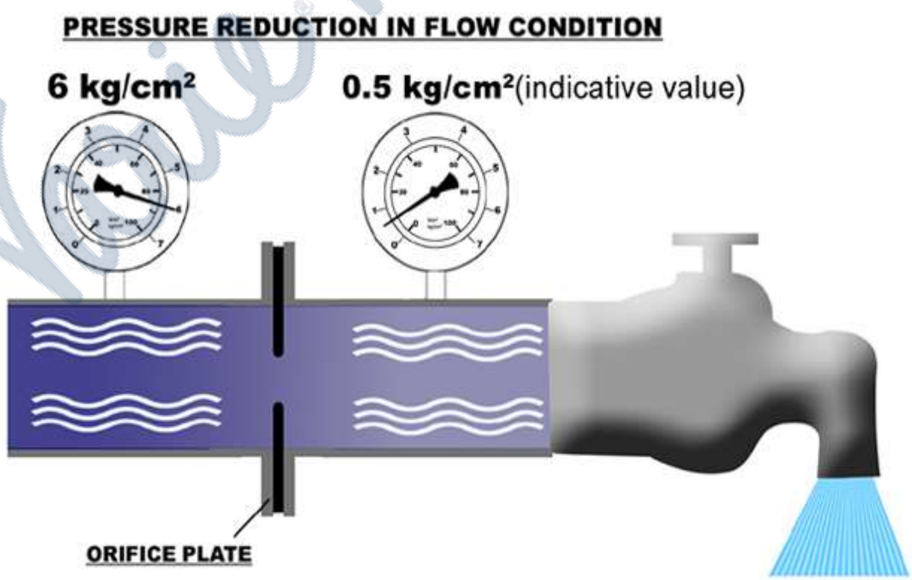


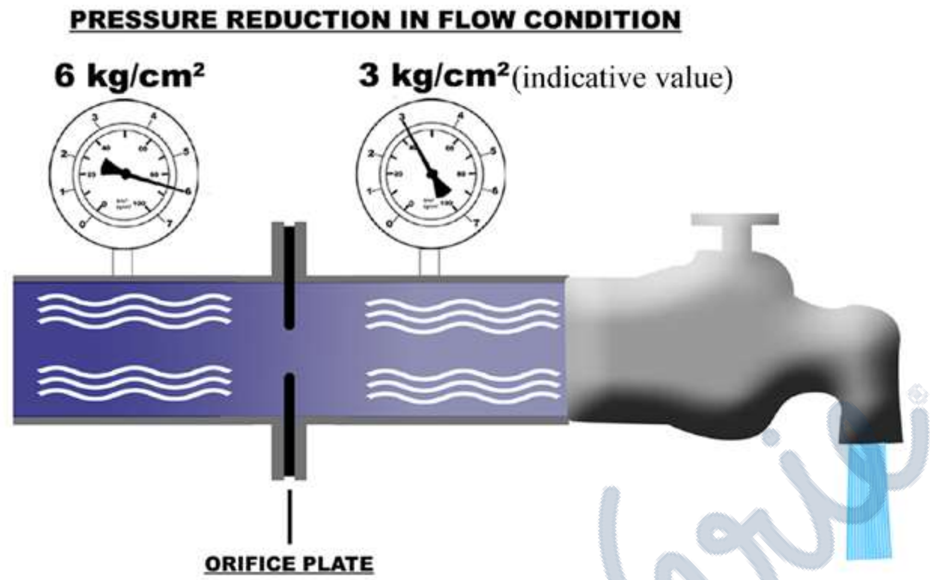
A PRV will therefore help to minimize this water wastage up to about 30% to 65% of water. Thus even a minimum 30% saving of water can save thousands of rupees per month for a society.

WHY ORIFICE PLATE / BALL VALVE CANNOT BE USED FOR THIS? AND HOW PRV WORKS

To explain this we would need to consider any pressurized system in two conditions
A) The Dynamic & **B)** The Static

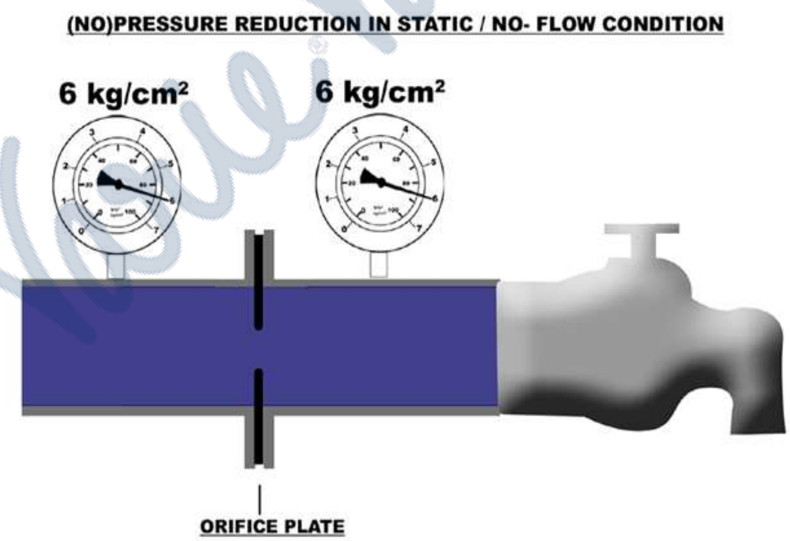
A) Dynamic – When water is flowing.
Whenever the area of cross section (c.s) is reduced, there is a pressure drop. Thus outlet pressure is reduced. So, by throttling the valve (or using Or. Plate) the area of the c.s is reduced and pressure is reduced. The more you close it and reduce the area of the c.s the more you are reducing the pressure of the flowing water.



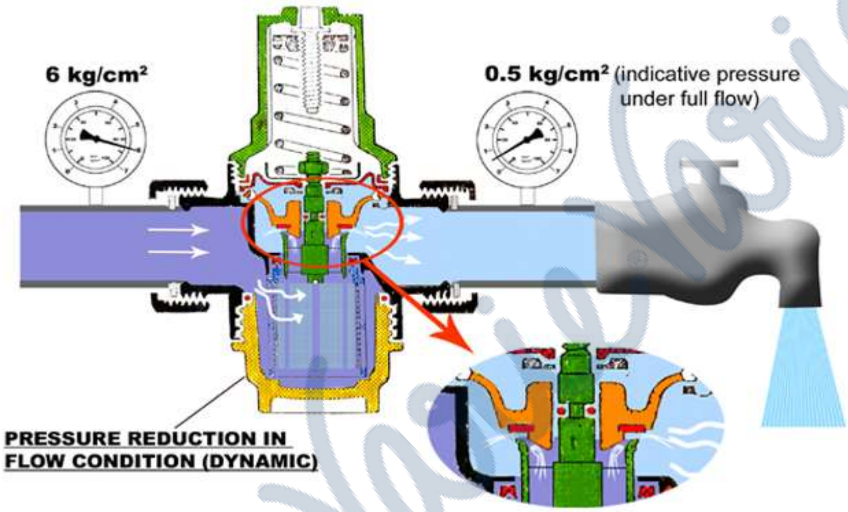


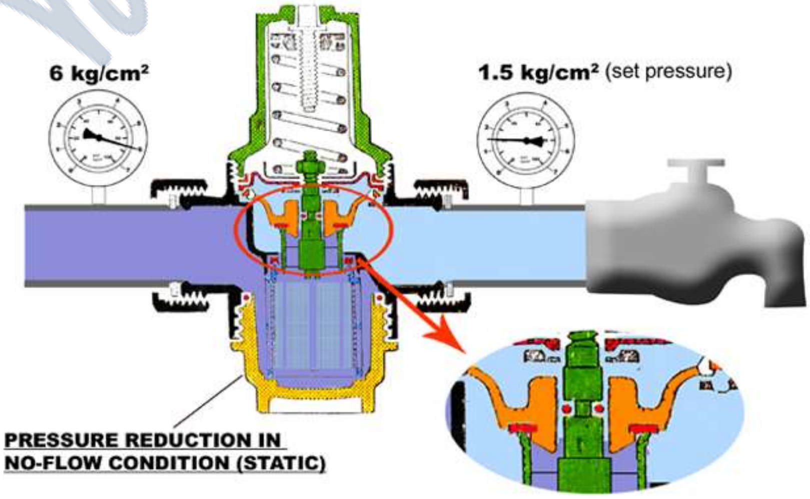
But what happens in the Static condition?

B) Static – when water is not flowing.
Especially in the night when nobody is using water then as per the simple laws of hydraulics the entire system will have the same pressure uniformly throughout. (No flow – No pressure drop). Put in simply – <u>In the static condition such a system is useless as there is no pressure reduction.</u>



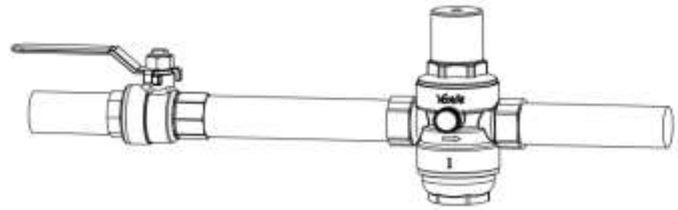
What is required is an automatic mechanism which will increase the valve opening as the water demand increases and decrease the valve opening as the water flow reduces (i.e., when pressure increases). And shut off completely when water flow stops (i.e., static condition) thus isolating the outlet from the pressurized system & preventing high pressure. Such an automatic device is nothing but a PRV. Another disadvantage with a throttled Ball valve is that even when there is peak demand for water the opening remains the same and hence the flow cannot increase completely. So, there is water shortage. But in the PRV the opening changes as per changes in the demand (pressure & flow rate are related) hence residents will neither complain of poor flow nor excessive pressure/flow.



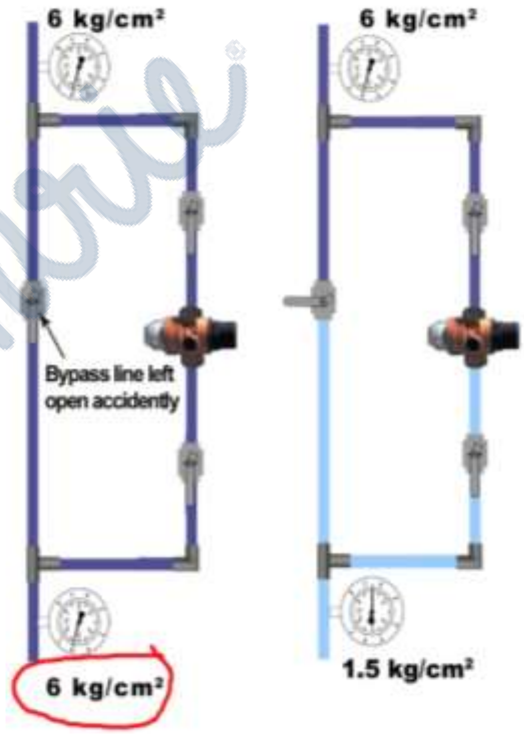


PIPING ARRANGEMETS

1) It is essential to provide a Ball valve in the downtake line before the PRV so that water supply can be cut off when the PRV is under repair / maintenance.



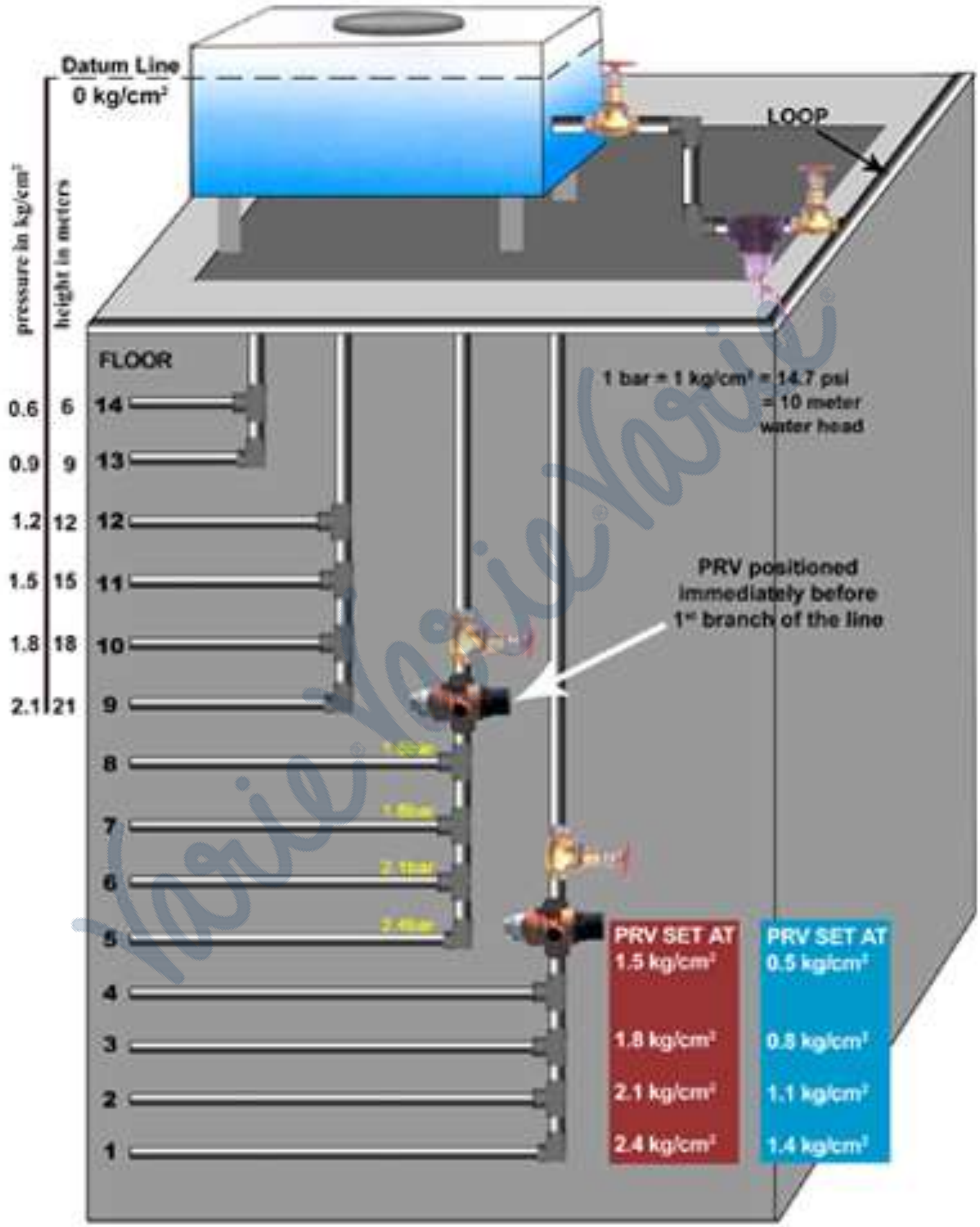
2) Many a times it is seen that a bypass arrangement is provided with a Ball Valve which could be used when PRV is under maintenance. Though bypass appears as an advantage there is a risk that the bypass line can be left ‘open’ accidentally as a result. The outlet pressure will be high (defying the entire purpose of the PRV). Generally Bypass should be avoided as it does more harm than good. Anyway with modern PRV’s having cartridge internals the repair/replacement is very quick and downtime is very less



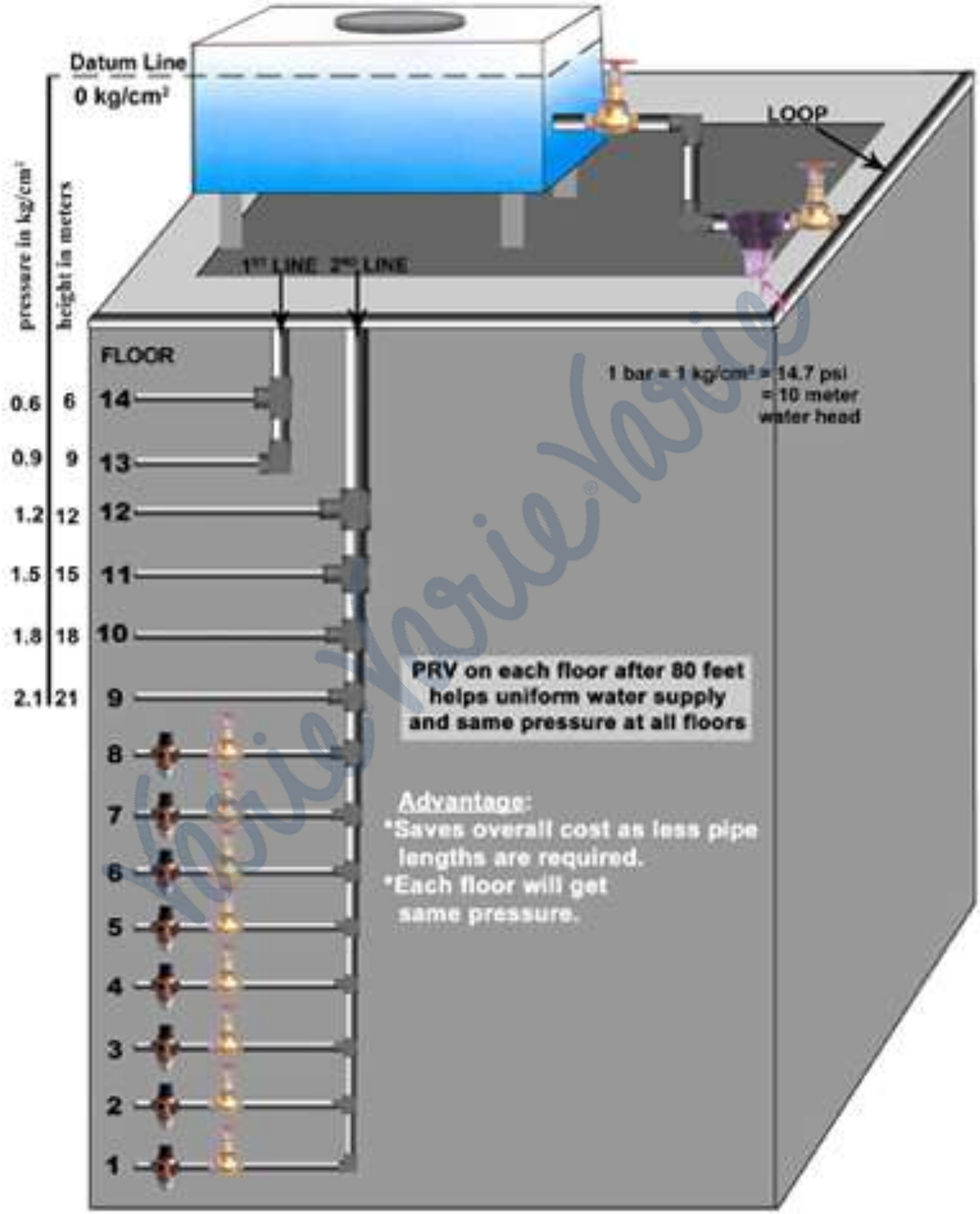
3) Installation – Some PRV’s can have limitation of not being operable in the vertical lines & would work only in the horizontal line. These limitations need to be clearly understood before purchase. Typically sizes of 40mm and above have heavy internals and are used in horizontal line. -Unless internals are of low weight plastics.!!!

PRESSURE SETTING & PRV POSITIONING

The most commonly followed design of a down take distribution is the telescopic downtake each having max 4 to 6 branches (refer to figure on next page). In this system a PRV should be put in the down take just before the first branch (and generally there are 4 branches for the 4 storeys in each downtake.) Also only one PRV is required in one downtake line unless there are possibilities of cavitation issues which typically occur when inlet pressure goes above 6 bars. Refer cavitation chart. At the 4th branch which is about 9mtrs below the PRV (assuming 3 mtrs ht. for each of 4 storeys) the pressure will add by about 0.9 kg/cm^2. Thus the maximum set pressure of PRV should not be more than 1.5 kg/cm^2. So that the last branch/storey pressure will be within safe limit. In case there is a change in the number of branches per downtake or if the permissible maximum pressure is different (other than the current norm of 2.4 kg/cm^2) than the maximum set value on PRV will have to be calculated accordingly. Pressure should be set on each PRV such that residents on 1st branch don’t complain for poor flow due to less pressure and at the same time residents on last branch don’t get excessive pressure. Also PRV should be positioned such that they are easily accessible for setting or for future maintenance.



TYPICAL TELESCOPIC DOWNTAKE OF A DUCT



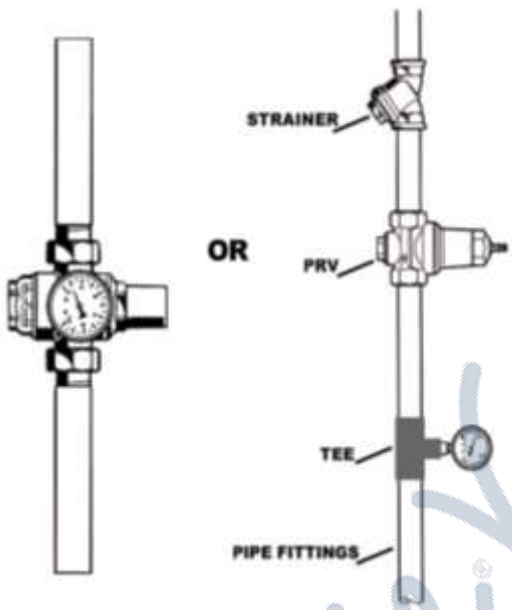
SINGLE DOWNTAKE OF A DUCT

SELECTION CRITERIA FOR THE PRV.

After analyzing the basic function of the PRV we can consider what features one should look for in a PRV.

1. PRESSURE SETTING

PRV should have a simple screw / bolt which can be easily turned to adjust the pressure setting without having to remove any other parts



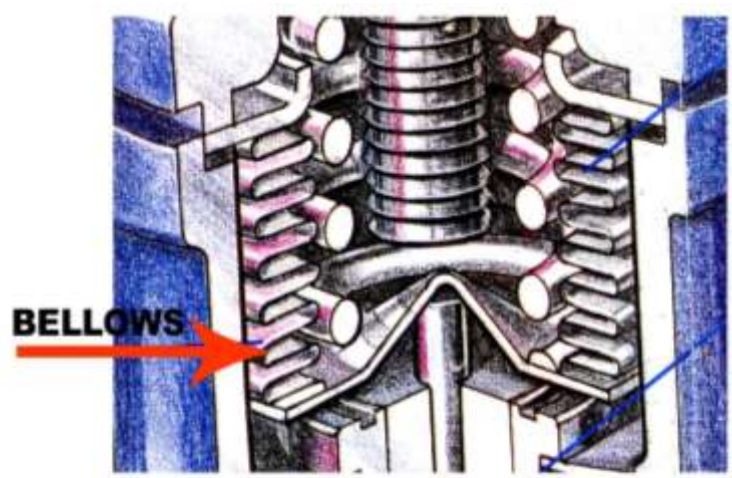
2. PROVISION FOR PRESSURE GUAGE

A separate provision must be provided in the pipe where the pressure gauge can be inserted. The actual pressure should be checked with the pressure gauge after the installation to see if the correct pressure has been set and if the correct pressure is maintained properly by the PRV. However, some PRV's have in-built provision in the body to insert a gauge. In such cases the cost of additional piping for a separate gauge is eliminated & there is some saving.

3 .DIAPHRAGM/PISTON/BELLOWS

PISTON
Most of the PRV's no more use the 'Piston' to sense and control pressure, as it is obsolete and offers poor sensitivity to flow / pressure changes.

BELLOWS
is another alternative to a diaphragm. Although it has maximum sensitivity to change in pressure due to its greatly increased surface area it is still not commonly used due to its price and bulky design.



DIAPHRAGM

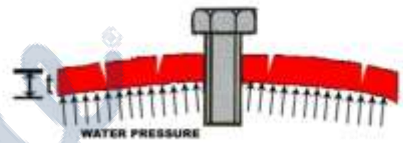
Most of the PRV's today use Diaphragm to sense pressure and control the valve opening.

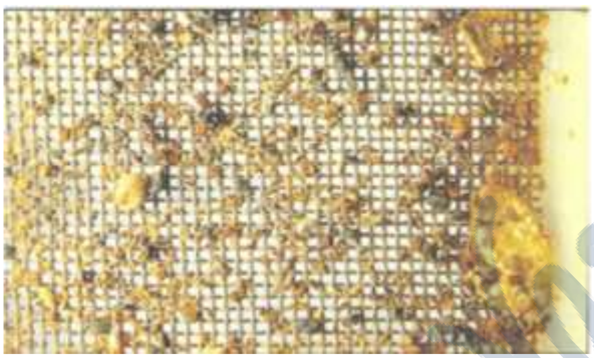
A good diaphragm will be one that has maximum sensitivity to even small changes in outlet pressure and thereby outlet flow. To achieve this the diaphragm should be as thin walled as possible and offer maximum surface area to sense the pressure changes.

THIN WALLED CORRUGATE SHAPED DIAPHRAGM

Also diaphragm should have sufficient strength to take care of wear and tear on its surface due to its continuous movement in the PRV. A good diaphragm will have a sufficient diameter; thin walled cross section; corrugated shape to achieve maximum pressure sensitivity; reinforced layer of fabric to offer good strength and long life. Alternatively they may have extra-large diameters to increase the surface area & thereby increase its pressure sensitivity. But, these diaphragms will also mean over-sized PRV's.

THICK SECTIONED DIAPHRAGM

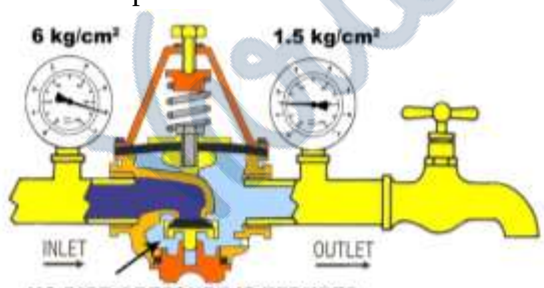




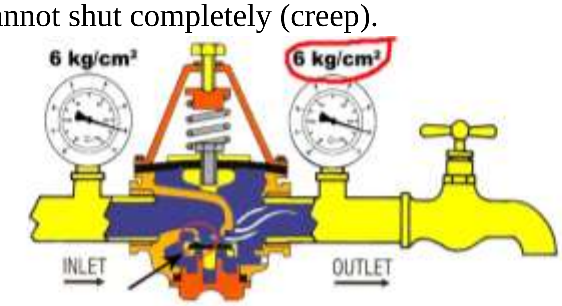
4. FILTER / SCREEN

Pipe scales, sediments from the tank etc. enter the valve and not only spoil the internals by increased wear and tear but also clog the valve resulting in ---

A) Excessive pressure in static condition as it cannot shut completely (creep).

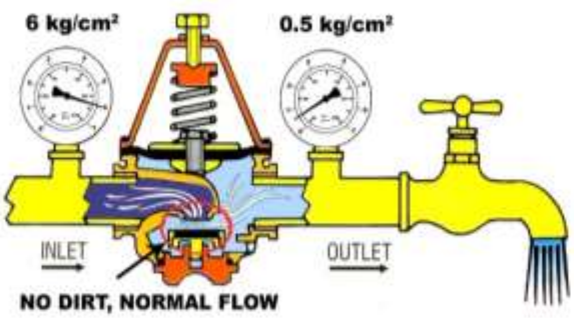


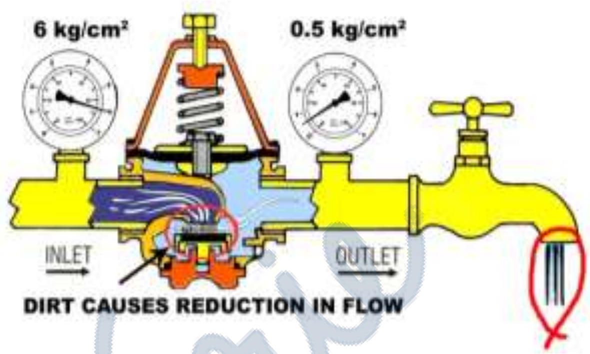
NO DIRT, PRESSURE IS REDUCED



DIRT PREVENTS VALVE FROM CLOSING. HENCE, NO PRESSURE REDUCTION IN NO-FLOW

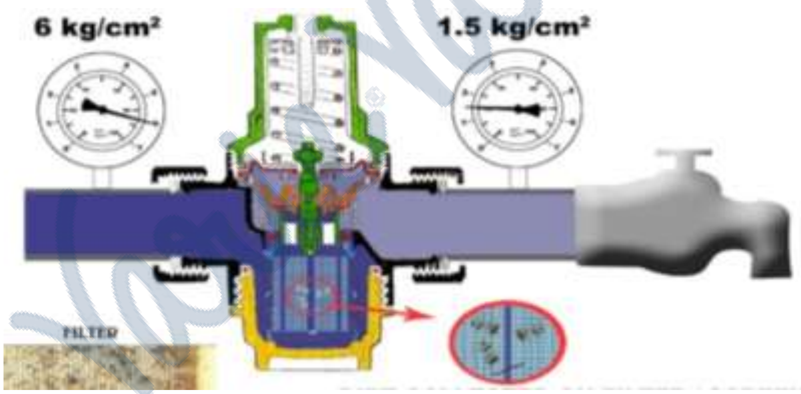
B) Inadequate supply as the c.s. area available for flow has reduced





Hence it is absolutely essential to have an in-built filter (of stainless steel) which prevents dirt from entering the internals of the valve.

If in-built filter is not there an external filter must be provided before the PRV. Even ISI standard IS: <u>9739</u> recommends filter on upstream of PRV. <u>It is also very essential that the filter is cleaned regularly</u> (depending on how fast it is blocked by dirt, scales etc.) and to do this….

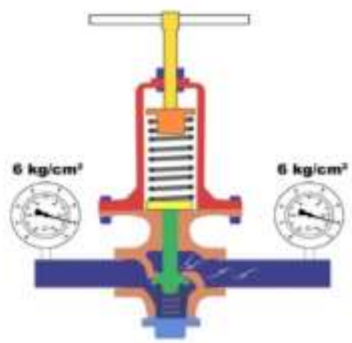


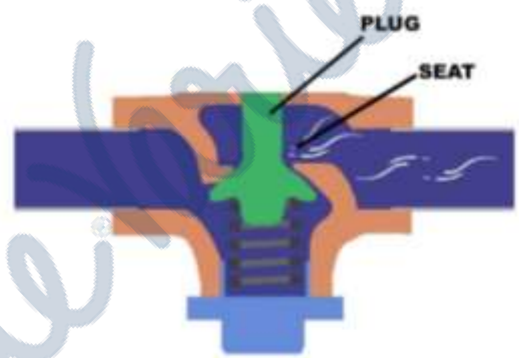
I) PRV should be easily accessible.
II) It should be easy to remove the screen from the PRV & preferably without having to remove the entire PRV from the pipe line. Furthermore if the PRV has 'dual open' design it can allow removal of the built-in filter without having to remove / disturb any other component of the PRV. Thus even a layman can easily open and clean such filters without disturbing other parts. In some PRV's an additional cleaning attachments is provided with the built-in filter. In these designs the filter can be cleaned automatically by simply turning the knob. This makes it most maintenance friendly.

5. SEAT & PLUG

As already discussed we know that, when the flow is zero a PRV should be able to close completely & not allow even the slightest leakage (creep) across the plug-seat gap.

#Metal plug & Metal seat (metal to metal sealing)
Although it may seem that a metal plug would have a longer life in reality due to wear and tear the surface finish is spoilt and over a period of time it may no longer give a leak free shutoff. Still, if at all metal to metal seal has to be used then the plug (moving part) must have lesser hardness than the seat so that whatever wear and tear that takes place is on the plug (which can easily be removed and repaired) rather than on the seat which may be fixed or difficult to remove/repair. A better choice still is…





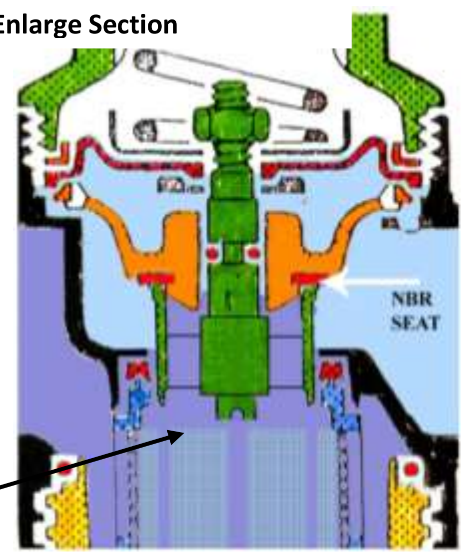
Metal plug and metal seat resulting in PRV failure in static condition.

#Nitrile rubber (NBR) Seat. (rubber to metal/plastic seal).

Here the rubber seat is reinforced into a protective frame or cartridge (as rubber is delicate & flexible) and only a small surface is exposed which will rest on moveable plug. Due to its compressibility, Nitrile rubber will have a good seal even after a long time in spite of the wear and tear.

*NOTE: For applications like corrosive gases, liquids, or steam etc. rubber is not used, as it cannot resist high temperature and chemicals. However for water, air, or other non-reactive liquids rubber is the ideal choice.

Enlarge Section

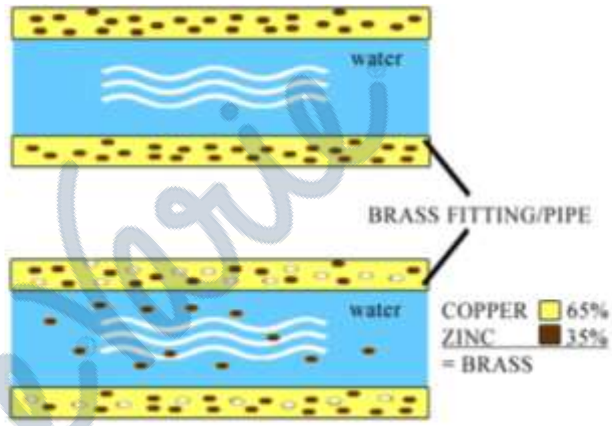


Low weight internals for fast response

6. INTERNALS

Moving parts should be low in weight. A light weight plug will always respond faster to changes in flow and pressure and thereby quickly throttle the valve as per change in demand for water. However, a heavy plug will take some extra time (though it may be in milliseconds) due to its inertia to respond to change in flow. Thus as an example, when there is an increased demand of water & the plug is expected to move away from seat and increase the flow opening quickly, it may do so, but slowly. But, if by that time the demand has reduced or stopped altogether, the plug will then be expected to move towards the seat and close the flow opening but actually at that time it may still be increasing the flow opening. Thus, such sudden changes in demand/flow will result in hunting phenomena and cause water hammer; delayed pressure / flow control or excessive velocities all of which are damaging. For this reason many PRV designs have low weight plastic – metal plugs (internals). Also internals, which are in contact with flowing water, should be rust-free. Where the PRV is exposed to external (rain) water all the internals including those which don't come in contact with the flowing water should be 100% rust-free viz: S.S, Brass, Plastic, etc.

7. MATERIAL OF THE BODY

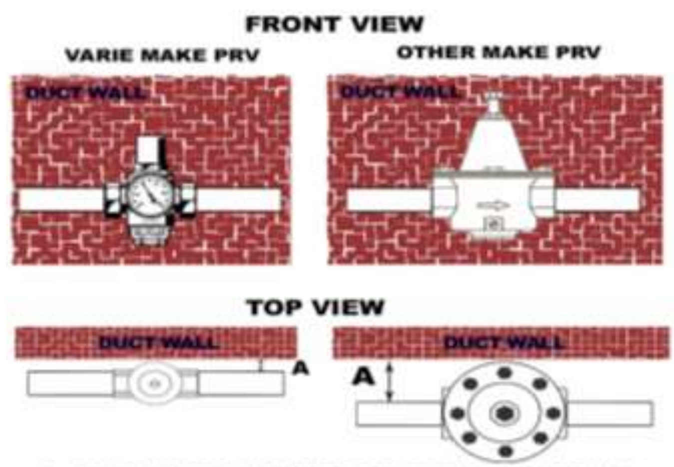


EFFECT OF DEZINCIFICATION AFTER SOME YEARS

Generally Non-Ferrous materials like brass, bronze/gunmetal are better than ferrous metals like C.I. Still, Gunmetal or Bronze are better compared to brass because they have minimum effect of Dezincification*.

DEZINCIFICATION*
It has been found that fittings and valves that are made of brass which are used in water lines suffer from this process called Dezincification. The zinc molecules which are present in the metal have a tendency to get washed away due to the presence of certain salts in water which reacts with them. This is a gradual process similar to corrosion whose effects are visible over some years depending on water quality. Due to this effect the metal becomes more porous and therefore weak. Since Brass has high zinc content which is 35% the weakening of metal is more prominent. However metals like Gun metal / Bronze have a maximum of 5% zinc content. Hence the effects of dezincification is negligible. Also, for applications close to coastal areas the effect of corrosion is much higher on Brass than Bronze. (For the same reason all valves used on a ship are of Gun Metal/Bronze).

8. WEIGHT AND DIMENSIONS.



A = MINIMUM DISTANCE REQUIERD BETWEEN DUCT WALL AND PIPE TO FIT PRV

VARIE PRV has least value of "A" amongst all brands. Hence, it eliminates the need of providing additional fixtures, bracket / clamps.

With modern technology and new designs more compact PRV's are possible. Smaller and lighter PRV's are easier to install especially in the narrow ducts of a building. Thus, saving labor costs.
Also with very heavy PRV's additional support or clamps have to be provided so that the pipe does not buckle under PRV's weight especially in the case of plastic pipes.
Also for large PRV's more space is needed in the duct. Also, to fix them the pipe has to be moved away from wall. Many a times this space is never available in the duct

FLOW CAPACITY. Kvs VALUE

Along with compactness a PRV should have a good flow characteristic which is indicated by its Kvs value. Kvs is defined as the flow rate in m^3/hour across valve for a pressure drop of 1 bar (kg/cm^2). The higher the Kvs value of a valve the better. It gives an indirect indication of the max flow rate that a valve can offer. Each valve has its own value of Kvs. Eg. A ½" PRV with Kvs of 2.4 will have better flow than PRV with Kvs of 1.8 (which may be more compact). The Kvs is determined by the pressure drop across valve which is determined by the velocity at which fluid flows across the valve. Overall we can say that the Flow Capacity of a PRV in a given installation will depend mainly on its.

A) Kvs value which is influenced by…….

a1) Surface finish of inside walls of the valve.

a2) Design of the moving parts.

a3) Overall size of the flow chamber (main valve body) and not the entire valve. Because a PRV may have a big spring chamber (upper part above diaphragm) but a small flow chamber. This valve may appear big in size but will not have the required Flow capacity.

And to some extent on……

B) Pressure setting at outlet.

C) Inlet head of pressure available which is different at all floors of the building.

9. NOISE LEVELS

In buildings where height exceeds 50 mtrs, the maximum pressure at the lowest floor will exceed 5 kg/cm^2. The noise arising from the regulating valve while reducing the pressure to a lower level may become intolerable sometimes. Often complain of a humming sound coming from the PRV is reported by residents. Unfortunately in India there is no standards or law pertaining to limit of noise levels. Care needs to be taken that the PRV are designed to minimize the noise levels. Also the PRV if faultily designed will itself contribute to the noise. This is common with PRV's having internals (moving parts/plug) which are not light weight and as a result the response to change in pressure (which is due to change in flow) is slow and sluggish. As a result water flows with excessive velocity through a smaller gap, resulting in high noise levels. Other reasons of high noise are water hammer; cavitation; excessive velocities (created by undersized pipes and valves and throttled valves).

10. EASY TO REMOVE INTERNALS

While maintaining a PRV it should be easy to remove all the internals preferably without having to remove the PRV from the pipe otherwise service/repair could be an expensive affair.

11. SPRING

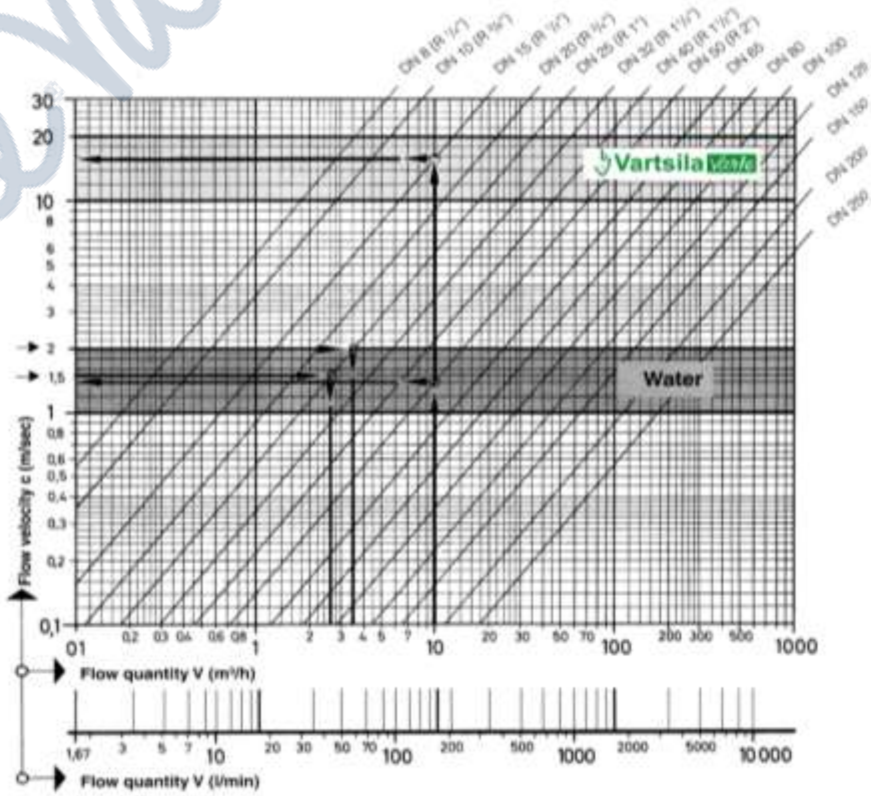
Although there are a lot of variations in the various designs of PRV's, one thing that is very important and common to all PRV's is the spring. One must ensure that the spring material is good & does not lose its strength, or crack or fail within a short period. Generally 'spring steel' material which is a grade of steel specially made for springs is a good choice. However, in case of PRV's which are installed outdoor in open ducts and exposed to rain water the spring steel springs can rusted & eventually lose its strength. In severe conditions of rusting & corrosion the 'spring steel' spring cracks into two or more pieces. Therefore, whenever the PRV's are exposed to rain water, springs made of stainless steel can prove advantageous.

'Rusting of spring'

PRV performance figures and sizing

FLUIDS

German DVGW guidelines specify that for household application water velocity should not exceed 2 m/s. The grid table shows the normal range between one and two meters per seconds in dark grey. When determining size, it is normal to assume a flow velocity of 1.5 m/s and this then leaves adequate reserves for subsequent higher loading. Using the grid table, the required performance V (m^3/h or 1/minute) enables the normal size (DN) to be determined and in cases where the normal size and performance are known, the flow velocity c (m/seconds) can be evaluated.



***EXAMPLE 1**

What size pressure reducing valve is required if ten cubic meters of drinking water are to be supplied per hour?

SOLUTION:

Follow the V line at 10m^3/hour vertically upwards to the dark grey area to point where it meets the line for the DN 50 (R 2”). From this point going horizontally to the left indicates on the C-line a flow velocity of 1.4 m/sec.

***EXAMPLE 2**

What is the flow rate in 1L/minute of a pressure reducing valve for water with a connection size of DN 25 (R 1”)?

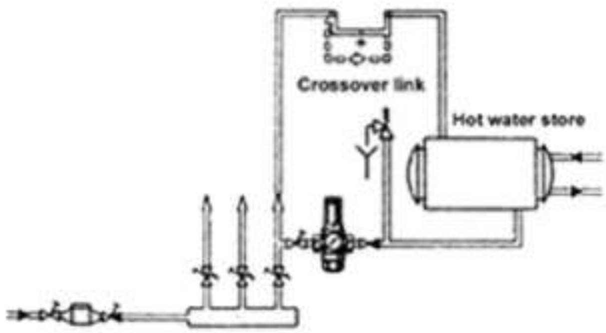
SOLUTION:

1. On the c-line at 1.5 m/s go horizontally to the right point where it meets the DN 25 (R 1”) line. From this point going vertically down to the V-line indicates a flow of 44L/minute or 2.6 m^3/h.
2. From 2 m/s on the c-line go horizontally to the right to the point meets the DN 25 (R 1”) line. From this point going vertically down to the V-line indicates a flow of 59L/minute or 3.5 m^3/hour. The normal performance of the DN 25 (R 1”) pressure reducing valve is therefore 44 L/minutes and the highest take off flow rate permitted by DVGW guidelines is 59 L/minute. However, in emergency this pressure reducing valve can deliver up to 150 L/minute.

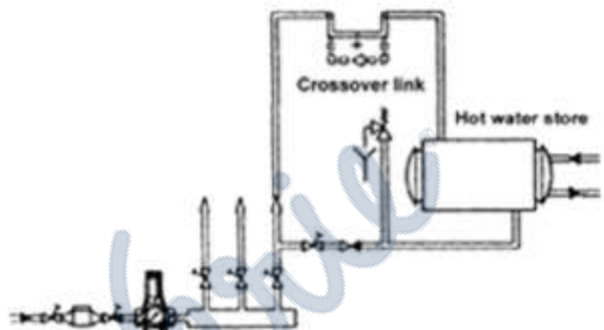
ΔP CHART: In addition to using velocity as a parameter to size a valve. The pressure drop characteristic of valve is also to be considered. Each make of valve will have unique pressure drop characteristic.

UNWANTED RISE ABOVE SET PRESSURE (TYPICAL CASES)

With the presence of a built-in fine filter, it is almost impossible for dirt to reach the valve internal-mainly the plug-seat gap. Thus, dirt cannot prevent a pressure reducing valve from closing off properly. Thus, the filter prevents any unwanted rise above set pressure (“creep”).
However care must be taken on site that no dirt is allowed to enter the outlet port of pressure reducing valve which may then prevent the proper function of the valve. Valves affected in this way are sometimes returned as “faulty”.
Pressure reducing valves are also returned on which no fault at all can be found and when a second valve on the same installation also indicates “creep”, then one can be sure that is caused by a cross-link in the system, i.e., an unwanted hydraulic link between high pressure pipe work and the pressure-reduced part of the system.

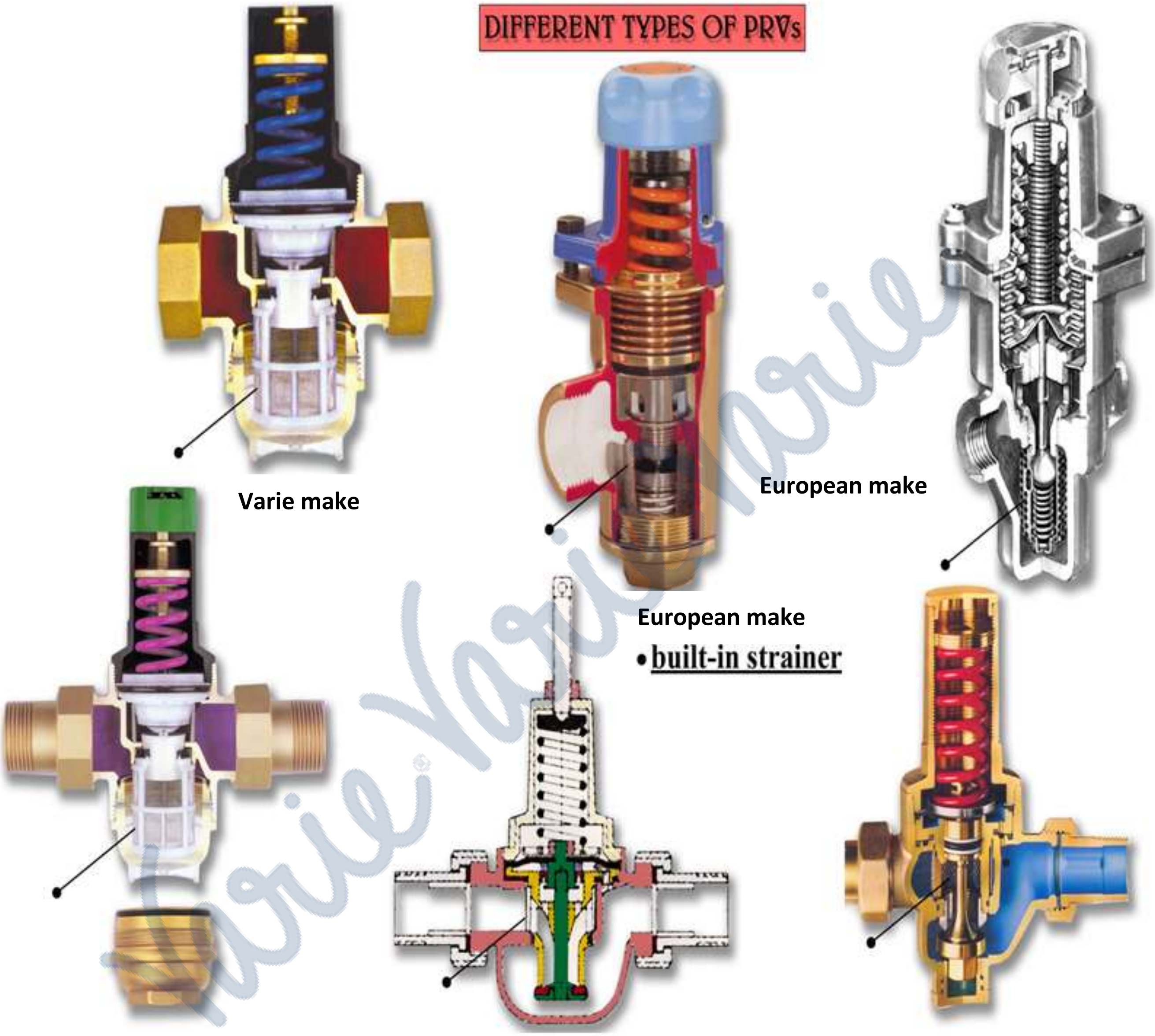


Crossover link from cold to hot water



Crossover link from hot water to cold water when hot water is heated

The most common cross link arises between an uncontrolled cold water supply and a pressure-reduced hot water supply (pressure reducing valve is fitted on the inlet to a Boiler). Somewhere in the system the cold and hot water supplies are connected. Sometimes it is in a centralized thermostatic mixing valve, but more usually is at the outlet fittings, such as single hole mixtures, hot water pipework, for example on thermostatic mixers. Non-return valve are fitted on hot and cold water inlets. If the non-return valve fitted to the hot water connection does not close off properly, then the cold water pressure can transfer over unhindered to the hot water pipework. If the cold water pressure is above the operating or set pressures of the safety valve fitted to hot water appliance, then this will result in a constantly dripping safety valve. In some circumstances this may arise only overnight when low consumption from the water circuit results in a rise in static pressure.
Mostly, however, it can be established that the higher pressure is indicated on the pressure gauge fitted upstream of the pressure reducing valve because non-return valves fitted after the pressure reducing valve seldom close off properly. Where the pressure reducing valve is centrally fitted directly after a water meter this problem cannot arise, because the cold water and hot water circuits are at the same pressure. However, even one take off branch before the pressure reducing valve, for example, for a garage or garden tap, may cause this problem to occur on a system with a centrally located pressure reducing valve. For the sake of completeness, it should also be noted that where an individual pressure reducing valve is fitted to control a hot water store, expansion of the water on heating will cause the pressure to rise above the set pressure and up to the operating pressure of the safety valve. This can also occur with centrally fitted pressure reducing valves and resulting in the crossover link described earlier occurring in the opposite direction.


DIFFERENT TYPES OF PRVs
Varie make
European make
European make
• built-in strainer

Although using the specially designed PTK-Pressure Testing Kit is ideal for pressure setting/ checking on PRV. The crude procedure to do same using an ordinary gauge is described below:

<u>Procedure / steps to adjust pressure setting on **PRV** with pressure gauge:-</u>

1) Shut off the line with ball valve / globe valve before PRV. If a ball valve is not there before PRV then shut off the ball valve provided on beginning of down take line on top of terrace, or near the outlet of the tank.

2) Open blanking plug with hand (use spanner only if needed) and allow all the water in the line to come out

3) After the line is emptied out, thread in the pressure gauge. The gauge should ideally be of 4" diameter/dial with range of 0 to 7 bar (kg/cm^2) if not then 0 to 10 kg/cm^2 and preferably back mounted rather than side mounted (though while setting on Varie prv sizes of 40 mm and 50 mm side mounted are required). Put 3 to 4 turns of Teflon tape on the thread and thread-in the gauge into the body. Tighten the gauge only half way, i.e. do not tighten fully. This is to allow the air to escape when the water supply of line is restarted again as sometimes air coming to the gauge directly at a pressure can cause faulty readings in the gauge and even damage same.

Back Mounted
Pr. gauge

4) Start supply again by opening ball valve/gate valve which closed earlier. Allow the air to escape through the threads until water starts dripping from the threads of gauge. Then tighten same with spanner (A small step is given after threads to grip the spanner).

The dial can be brought in desired position for easy reading.

<u>**Caution:**</u> DO NOT tighten the gauge by holding the dial or over tighten the gauge in threading slot, it may damage the pressure gauge.

5) In order to increase pressure turn the screw on PRV clockwise and to reduce pressure turn it anti-clockwise. Turn until desired pressure is shown on the gauge.

6) Open some tap below where the same PRV is supplying water to allow some flow for 5 seconds and shut it again. Check the pressure gauge again, while checking/setting the pressure on PRV always ensure that no water is flowing through PRV as sometimes residence may open the tap without our knowledge. This can be done by seeing the flow through the transparent filter cap (if provided).

7) This way the tap can be opened for a few seconds and again closed, and the pressure can be read on the gauge. Each time after closing the tap the reading should be the same. This way the pressure observed in static condition (i.e. No-Flow condition) is the correct pressure.

8) In case, if we can't open any tap in the flats below then open filter cap (transparent) or the other blanking plug (on opposite side) slightly till water starts flowing out then again close the cap till water leakages stop and then observe pressure gauge.

9) After setting is complete again shut off the supply valve.

A. Remove pressure gauge.
B. Allow water to escape.
C. Put blanking plug with its "O" ring and tighten it fully with hands (no spanner is needed
D. Start supply & check if any leakage is there. If needed tighten the plug fully

Note: Sometimes if the PRV has failed it will show the full static pressure