VALVE SELECTION GUIDE

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FIGURES

SP-V.S.G.-98/09/23-1/12

CONTROL EQUIPMENT AND PERIPHERAL DEVICES FOR EFFICIENT ENERGY MANAGEMENT

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CONTROL VALVE SELECTION GUIDE

Valve selection is an important part of the design of a control system, and the proper choice will enhance performance while reducing costs. Often, valves are selected too large, impairing performance, requiring stronger operators, and needlessly escalating costs. This section describes how to properly size Spartan valves for best performance and for best value.

SIZING SPARTAN WATER VALVES

Obviously, the maximum operating pressure of the valve should be first considered. 125#, 225# or 600# class valves may be needed depending upon the maximum pressure the valve will encounter. When choosing this pressure class, allow for the addition of the circulating pump pressure if this pressure will or could be added to the static pressure.

Remember that 1 psi is equal to a head of 2.3' and that a building 230' high will have a water pressure at the bottom greater than 100 psig. This can be used as a guide, but it is always best to check with the consulting engineer for the project.

CALCULATING Cv

The Cv of a Spartan valve is defined as the amount of water at 60°F (15°C) which will flow through it in the wide open position with a differential pressure of 1 psi. A valve with a Cv of 10 will pass 10 gallons per minute with a 1 psi differential across the valve. But the pressure drop does not increase in **direct** proportion to the flow, rather it increases as the square of the pressure drop. Thus, if the Cv is 10 and the flow is 20 (double the Cv), the differential pressure will be 2 x 2, or 4 psi.

KvS

The Cv of Spartan valves is published in U.S. gallons, thus all Cv's are U.S. Cv's.

To convert U.S. Cv to Imperial Cv or to KvS (metric) divide U.S. Cv by 1.2

example:

U.S. Cv of 100 is selected as ideal for the application, then a KvS figure for the same valve would be 100/1.2 = 83.3 KvS (we have ignored the change in density of hot water as inconsequential.)

1 U.S. Cv = 0.833 Imp. Cv or 0.833 KvS
1 U.S. gallon = 0.833 Imperial gallons
1 Imp GPM = 1.2 U.S. GPM

CALCULATING DIFFERENTIAL PRESSURE

To find the pressure drop across a valve:

$PD = (F/Cv)^2$

Where PD = differential pressure in psi
F = flow in U.S. GPM

example:

The pressure differential (in psi) across a valve with a Cv of 5.5 and a water flow of 16.5 U.S. GPM would be (16.5/5.5)2 – 9 psi.

CALCULATING THE FLOW THROUGH A VALVE

To find the amount of water able to be passed by a valve:

$F = Cv \times \sqrt{PD}$

example:

The flow through a valve with a Cv of 2.5 and a pressure drop of 4 psi would be 2.5 x $\sqrt{4}$ = 5 U.S. GPM.

TAKING ADEQUATE PRESSURE DROP ACROSS THE CONTROL VALVE

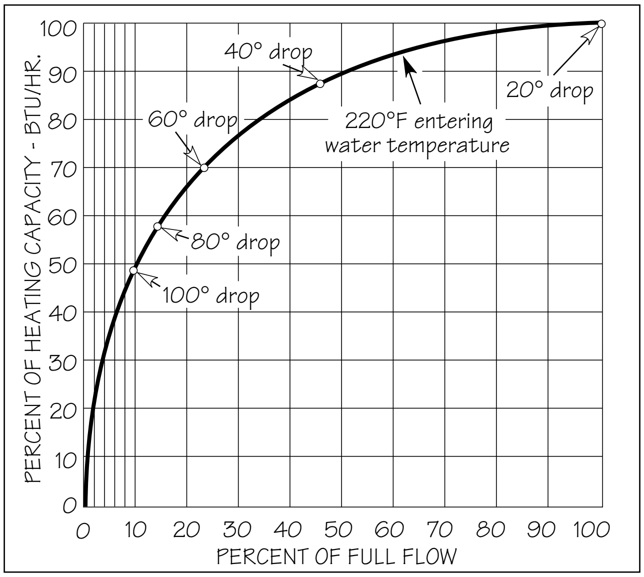
When selecting the differential pressure (DP) across the control valve in a standard heating system, remember that it is very difficult to undersize the control valve. The ASHRAE manual describes the effect of undersizing the control valve and the resultant reduction in heat transfer. At 50% flow, 90% heating is still effected. The most common error is oversizing the control valve.

Refer to ASHRAE guide chapter 30 (see Chart A)

Oversizing your Spartan control valve makes it very difficult for the temperature controller to function well unless it represents a goodly proportion of the total DP of the entire water circulating system (the total differential pressure generated by the circulating pump). As soon as the controller asks for a small amount of heating, the valve opens and passes too much water. Then the controller tries to back off the heating slightly, but a small amount of travel fully shuts the oversized valve. The resultant fluctuation, which is sometimes difficult to correct, is referred to as 'hunting'.

For this reason, general wisdom dictates taking 50% of the circulator DP across the open control valves. Many engineers mistakenly hesitate to accept this, but the control contractor should at least not accept less than the DP of the heating coil, otherwise stability of control may be difficult or impossible to achieve. Realize that cutting the flow by half only slows the water down in its flow through the coil. If full flow results in a water temperature drop of 20° (180° in and 160° out) then half flow results in about 180° in and 142° out, or a temperature drop of almost double. The coil face temperature has only dropped from a mean of 170 to a mean of 161, so the heat output is still over 90% even though only half flow.

CONTROL VALVE SELECTION GUIDE



See **Figure 1** which plots the heat output of a coil vs flow.

FIGURE 1 - Heat emission vs. flow characteristics of typical hot water heating coil

EXCEPTIONS TO A HIGH DIFFERENTIAL PRESSURE

Exceptions to taking a large DP when selecting a control valve are as follows:

- 2-position valves where it does not matter.
- Cooling tower control valves where the full circulating pump head is needed to provide adequate pressure for the spray nozzles. In fact, this is usually a 2-position application, for it is not possible to modulate the spray nozzles as they only dribble and become ineffective.
- 3-way valves used for mixing two streams of water to a common supply temperature. In this case, linear plugs may be used. A typical example would be in hot water boiler installations using indoor/outdoor type of control, but there still remain two schools of thought (see Page 8)

EQUAL PERCENTAGE PLUGS OR LOGARITHMIC PLUGS

Because of the peculiar characteristics of flow versus actual heat transmission, in heating applications it is advisable to use proportioning control valves equipped with equal percentage plugs (see Page 10 “proportioning plug valves”). Often referred to as logarithmic plugs, which are designed to offset the heat transfer effect, they open very gradually so that when in the half way position they only pass 10% of the flow, in the 90% position they pass 50% of the flow and in the full open position pass 100%. The idea is to compensate for the opposite curve to the heat transfer curve, and the equal percentage terminology means that for an equal percentage of valve stem travel there is a resultant equal percentage of heat transfer effect, not equal percentage of flow. Note that these equal percentage plugs will forgive an incorrectly sized valve, but with both correct sizing and equal percentage plugs, proper control can be maintained.

Where the two temperatures are closer together (the water temperature and the air temperature, as for example in a cooling coil), then cutting the flow has a greater effect at cutting the heat transfer. Study the ***Figure 2*** showing the heat transfer plotted against water flow for a coil working under the following conditions.

Air on at 78°F x 70% RH and off at 60°F at 90% RH. Water on at 48°F and off at 56°F

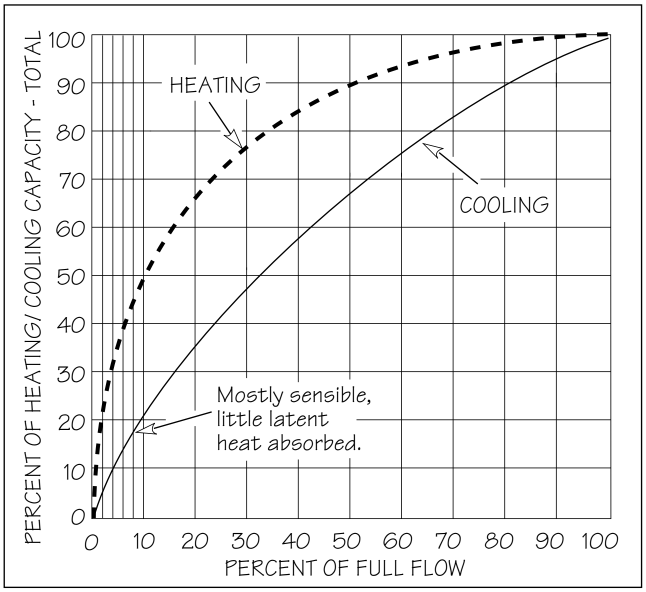


FIGURE 2
Percent of Full Flow

Now it is clear that the heat transfer vs water flow is a more linear relationship, and it would seem to be less important to select a valve with a logarithmic plug. This same analogy can be used when throttling the flow of water which has been reduced in temperature from an indoor/outdoor type of controller. In these applications, a linear plug could perform as well as a logarithmic plug.

All good engineering is a compromise, and Spartan has compromised as follows:

- All 2-way valves built for stock will be equipped with logarithmic plugs.
- All 3-way valves up to 2" will also be equipped with logarithmic plugs, as they are generally being used for heating coils, etc.
- All 3-way valves over 2" will be equipped with linear plugs, for they are generally being used on chilled water coils or on mixing applications as in indoor/outdoor control, etc.

Exceptions to these requirements will be handled on a build-to-order basis where delivery problems are of little concern.

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CONTROL VALVE SELECTION GUIDE

SIZING SPARTAN STEAM VALVES

Here the maximum operating pressure of a valve must be carefully considered. The maximum static pressure ratings of control valves are for water and steam, but only up to a given rated temperature. If the valve is rated to a maximum temperature of 100°C (230°F) then by checking the temperature/ pressure table at the bottom of steam chart 'C' it will be seen that this valve would be limited to 5 psig steam. Likewise, 130°C (266°F) = 15 psig and 135°C (275°F) = 30 psig.

Many valves rated at 6 psig steam (230°F) will operate for decades at 30 psig (275°F) without failure if properly sized. However, better life expectancy can be anticipated if valves used on high temperature mediums are mounted with the operator to the side of the pipe rather than on top of it. In this way, the valve operator is not located in the high temperature air directly above the high temperature steam pipe, and longer operator life can be expected. (Diaphragm life of a typical VP-2170 on 30 psi steam is shortened to 5 - 6 years when located above the pipe as in Fig. 'A'. Installed as shown in Fig. 'B' life expectancy can be measured in decades.)

STEAM IS A UNIQUE MEDIUM TO CONTROL FOR IT FOLLOWS UNUSUAL LAWS

1. First, steam flows through an orifice or control valve at an increasing rate until it meets a limit referred to as Critical pressure. At this point, flow cannot be increased.
2. A second factor is supersaturated steam which has less total heat than saturated steam at the same temperature, and this amount must be allowed for.
3. Finally, steam selection tables work on the absolute steam pressure as opposed to gauge pressure (absolute pressure is gauge pressure plus atmospheric pressure at 14.7 psi.)

Even more than water, it is imperative that steam valves not be oversized, for the steam can cut right through the valve materials of an incorrectly sized valve. The problem which can occur is caused by sizing the valve so large that it is always working at that almost closed position, with the disk just a few thousands of an inch off the seat. The resultant corrosion is called wire draw, because a small channel is cut out of the disc as though a wire has been embedded into it.

A valve with stainless trim such as Spartan V26 or 27 would alleviate the situation, but remember that hard seats do not close 100% tight. On steam supplying a convertor this can be a problem at no load because the valve will always be leaking a small amount. Even if this amount is less than 1%, if the convertor is well insulated it will not dissipate the resultant heat, and the temperature will slowly rise until the water reaches boiling point.

The correction is to size the valve so much smaller that it will need to be wide open to satisfy the design load, 50% open and modulating on its parabolic plug or skirt for average loads, and only under very light loads will it modulate on the disc. In this way, valves with bronze trim and composition discs will last for decades on steam service (under 25 - 30 psig).

If oversized, however, only valves with stainless steel trim will stand up and then there is a problem with minimal leakage of the seat (common with hard seated valves) as well as the extra expense of the larger size, the stainless trim and the larger actuator needed for the larger valve. Here, obviously, is an area where it pays to use a less costly device.

To calculate the Cv of a valve when using steam, use Figure 3.

Previously, we mentioned that steam will pass through a valve at increasing rate until the critical pressure drop is reached. At this point no further increase in flow will be noted and this is clearly shown on the chart.

General feeling, therefore, dictates that the point to size a valve is at the critical pressure drop so that on closing of the valve there will be immediate reduction of the flow. If the valve is larger and critical pressure drop has not been reached, then when the valve starts to close, the same amount of steam continues to flow until the valve is well closed. The exception to this rule is when the steam pressure is lower and at this point critical pressure drop would represent pressure after the valve lower than atmospheric. There would obviously be no pressure left to push the condensate through the steam trap at this point. For this reason, the recommended line curves to 0 psig.

Using ***Figure 3*** you can calculate the amount of steam which will pass through a valve with a Cv of 1.0. For other sizes of valves, multiply by the Cv. To calculate Cv, follow the example on the chart as follows:

example:

300# of steam is needed and the steam supply is 15 psig. (29.7 psia).

A modulating valve is needed so a line is taken vertically to the recommended pressure drop line and steam flow is read directly as 44#/hr/Cv. Actual Cv required is 300/44 - 6.82 and an ideal candidate would be a 3/4" V21 at 7.0 Cv.

Work backwards as a double check. 300# passing through a 7.0 Cv valve will require that 42.84# flow through each Cv and the differential pressure of this valve would in fact be 10 psi.

It is assumed that the steam will leave the steam trap at the lowest point of the heat exchanger and flow away unimpeded. Be wary of systems which require lifting the condensate, either before or after the trap. Such systems will mean a waterlogged coil at low load, potential stratification of the air stream and potential control problems. Check with the supplier of the steam traps or the consulting engineer.

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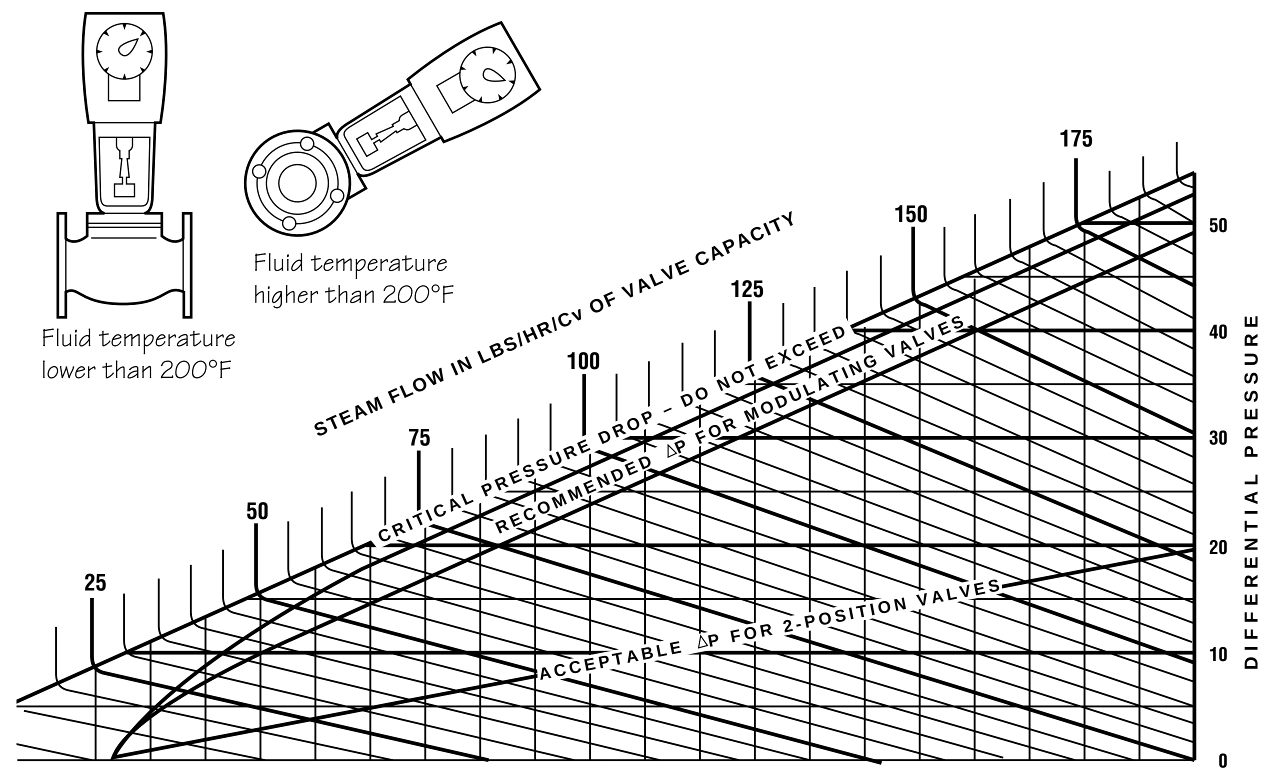
CONTROL VALVE SELECTION GUIDE



PSIG	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	PSIG
PSIA	15	25	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	105	115	PSIA
°F	212.0	227.0	240.0	250.0	260.0	268.0	275.0	281.0	287.0	293.0	298.0	303.0	308.0	312.0	316.0	320.0	324.0	328.0	332.0	335.0	338.0	°F
°C	100.0	108.3	115.6	121.1	126.7	131.1	135.0	138.3	141.7	145.0	147.8	150.6	153.3	155.6	157.8	160.0	162.2	166.7	166.7	168.3	170.0	°C

FIGURE 3 - Steam Valve Sizing

SUPERSATURATED STEAM:

Supersaturated steam has less latent heat than saturated steam at the same temperature and greater corrosion potential. Supersaturated steam is usually found after a high pressure steam reducing valve. Steam might be supplied at 400 psig through a steam distribution network and reduced to a working pressure of 30 psig for use in a local building or area of a building. Immediately after the reducing valve, supersaturated steam can be suspected, although it will be difficult to estimate how much.

At any rate, the additional size of the control valve is little, and furthermore, 10 or 20' of uninsulated pipe is often enough to reduce the temperature of the steam to saturation (the superheat actually contains little total heat in comparison to the heat given off by condensation of the steam). The formula for the increase in Cv necessary is 12.5% per hundred Celsius degrees of superheat (7% per hundred Fahrenheit degrees) so the calculation after selecting the Cv by one of the above formulae would be:

Cv (correct) = Cv (calculated) x 1.00125 x superheat in Celsius

or

Cv (correct) = Cv (calculated) x 1.007 x superheat in Fahrenheit.

Example:

The Cv of a valve was calculated at 100 and superheat of 100°F is suspected. The actual Cv needed has to be 107.

Another solution might be to locate the valve further away from the PRV where the steam will have lost its superheat and its resulting wear and tear on the valve.

ESTIMATING CONTROL CONTRACTS

When quoting a job, it is too time consuming to size each valve and for that reason many estimators quote on valves one size smaller than pipe size.

Often when the job is engineered, the valves will work out at one or two sizes less than pipe size (be careful on chilled water – you may come unstuck. Furthermore, cooling towers are best provided with full flow butterfly valves for least pressure drop particularly if the engineer is using a single butterfly valve in the bypass as opposed to a three-way diverting valve).

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CONTROL VALVE SELECTION GUIDE

VALVE PIPING

It is a normal requirement that the control valves have a bypass for use during failure of the controls, and isolating valves for removal of the valve during repair. Additionally, a strainer will be required to keep pipe shavings and debris from entering the valve.

Many Spartan control valves are available with manual override features which allow the operator to override the automatic controls, but still, isolating valves will be required.

When installing the control valve, it will usually be found that the valve will be one or two pipe sizes smaller than the coil and the system piping, and this fact will require that the plumbing contractor install reducing couplings just before and just after the control valve. This reduction is normal, however, the connecting piping, the isolating hand valves, bypass, etc. should be **full pipe size.**

The same applies to the strainer which should be placed ahead of the control valve to prevent pipe shavings and other debris from getting under the seat of the valve and preventing it from closing off tightly.

Under no circumstance should all this piping and paraphernalia be installed in less than the same size pipe as the coil or the piping serving it. Only the control valve should be reduced, even though the plumbing contractor may press to save on his installation costs.

Another point should be made about the installation of the valve with respect to direction of flow. The water or steam should always enter the valve opposing the plug, never forcing the plug onto its seat. The flow media always has to be forcing the disc off its seat. It should never force the disc down onto the seat. Read the section under three-way valves.

For this reason, care must be taken to study the construction of the valve. A typical example would be the Spartan V-11 and V-12 valves. Both these valves use a common outer body. The V-11 is direct-acting. It closes with the stem down.

The V-12 is reverse-acting. It closes when the stem is up. The water then obviously enters the V-11 by the female port under the plug and seat, while it must enter the V-12 from the male coupling port to force the plug down off its seat. But the same rule applies; always install so that the media forces the disc off the seat. Fortunately, most plumbers know this rule, but it pays to be sure.

Note:

While V-11 is a normally-open valve body, it could be used as a normally-closed control valve when used with a reverse-acting actuator.

A V-11 with an ME-21 operator becomes a VE-1121 valve. Since ME-21 is direct-acting, the assembly becomes normally-open. Contrarily, a V-11 with an ME-11 operator becomes a VE-1111 valve. Since ME-11 is reverse-acting, the assembly becomes normally-closed.

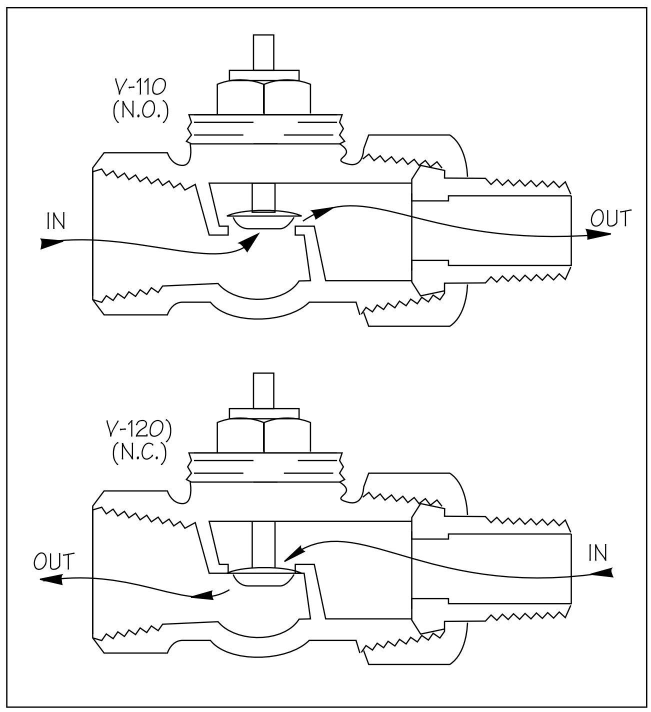

FIGURE 5 - V-11 (N.O.) & V-12 (N.C.) Valve Bodies

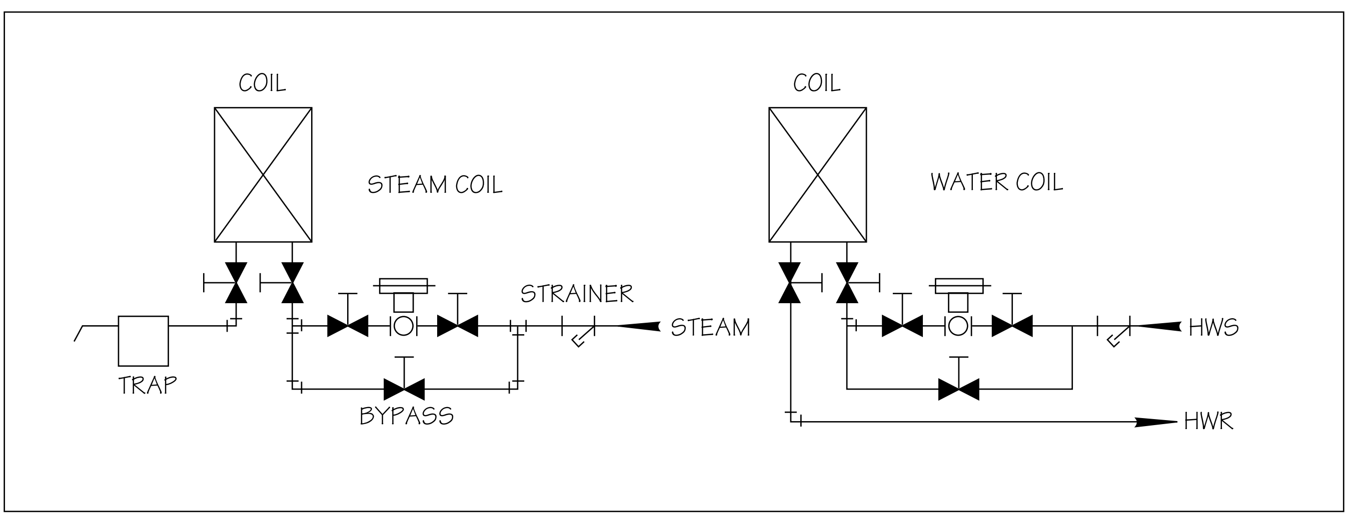

FIGURE 4- 2-way Valve Piping

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CONTROL VALVE SELECTION GUIDE

TYPICAL BYPASS PIPING

THREE-WAY VALVE PIPING:

Three-way valves require a bit more complexity of installation, but the same requirements remain. Isolating valves, a bypass valve, and strainers are all still required. The assembly looks like the following:

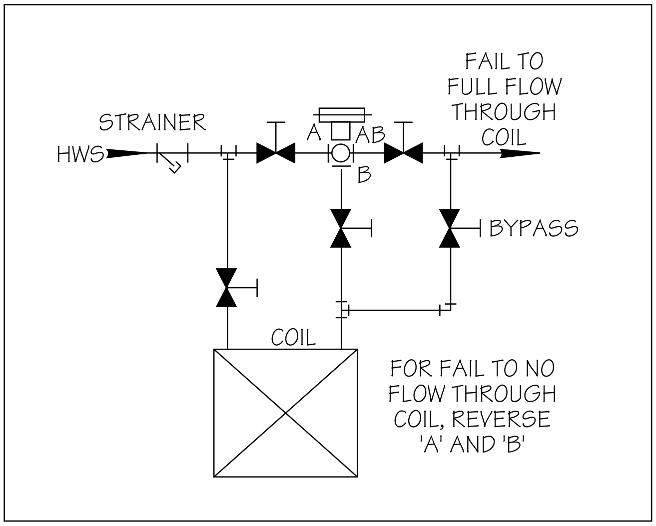

FIGURE 6 - 3-way Valve Piping

In this installation, flow through the coil varies with the heating load, but flow through the piping circuit remains constant.

TYPICAL THREE-WAY PIPING

THREE-WAY MIXING VALVES:

The three-way valve requires other considerations for its installation, namely the flow through the coil. Most three-way valves are mixing valves, and cannot be used in diverting application because all globe valves must have the pressure applied under the seat. They must never be applied with pressure from the top of the seat, for on close-off the valve will shut with an audible and annoying “thunk”.

More than this, once the valve does shut with a “thunk”, there is no longer any velocity pressure, and the differential pressure alone may not be enough to keep the disc against the seat when it will lift off and this process will repeat itself like machine gun fire which reverberates throughout the system when only the client is in the building – never when your serviceman is present.

When your serviceman arrives, the valve has taken a new position under slightly different loads, and the noise cannot be found. Even when the serviceman IS in the building, the noise seems to be coming from the piping all over the building. It can sometimes take months to locate the problem unless you have been warned (consider yourself now warned!) Don’t use mixing valves as diverting valves, or vice versa, and don’t install two-way globe valves in the line backwards.

THREE-WAY DIVERTING VALVES

Diverting valves are more common in Europe. In the Americas, mixing valves are the norm. Diverting valves are only required in cooling tower or open tank applications, and then butterfly type valves are usually more prevalent. In closed loops, three-way mixing valves are installed on the return line while a diverting valve would have to be installed on the supply line. The result is the same either way. In these applications, the flow through the coil varies as the load, but the flow through the circuit is constant.

Diverting valves are equipped with double plugs, making disassembly and repair more difficult for the owner, requiring longer delivery times because they are non-stock items, and costing slightly more at time of purchase.

CONSTANT FLOW SYSTEMS:

In some cases, the consulting engineer requires that there be constant flow through the coil with varying temperature on the face. In this case, the mixing valve is installed on the supply as a mixing valve, and a small in-line circulating pump retains constant circulation. In this application, Figure ***7***, flow through the coil remains constant while the flow of water in the system varies as the load. This type of installation is most common in face and bypass preheat coils to prevent coil freezing, but in very northern climes it can still be dangerous even with the use of freezestat, in-line safety thermostat and flowswitch (if it can freeze, it will freeze!). In these climes, glycol coils and face and bypass coils are favoured by many for fresh air makeup systems (see ASHRAE journal).

Another common application is the indoor-outdoor application, shown on ***Figure 8*** (next page). A common error in the installation of these three-way valves (usually in an effort to save a circulating pump) is putting the return water into the common return from numerous loads. If the common return is hotter than needed by one particular valve, then that zone will always overheat. This error most often occurs in hot water heating systems with more than one indoor-outdoor loop. The excess heat from the working loop overheats the loop not requiring heat.

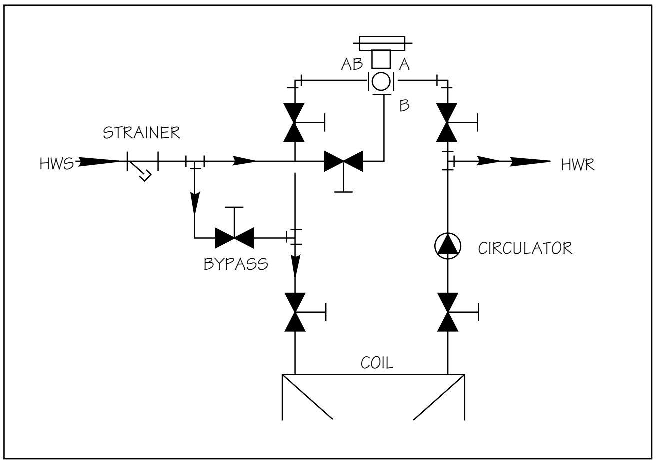

FIGURE 7 - Constant Flow Systems

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CONTROL VALVE SELECTION GUIDE

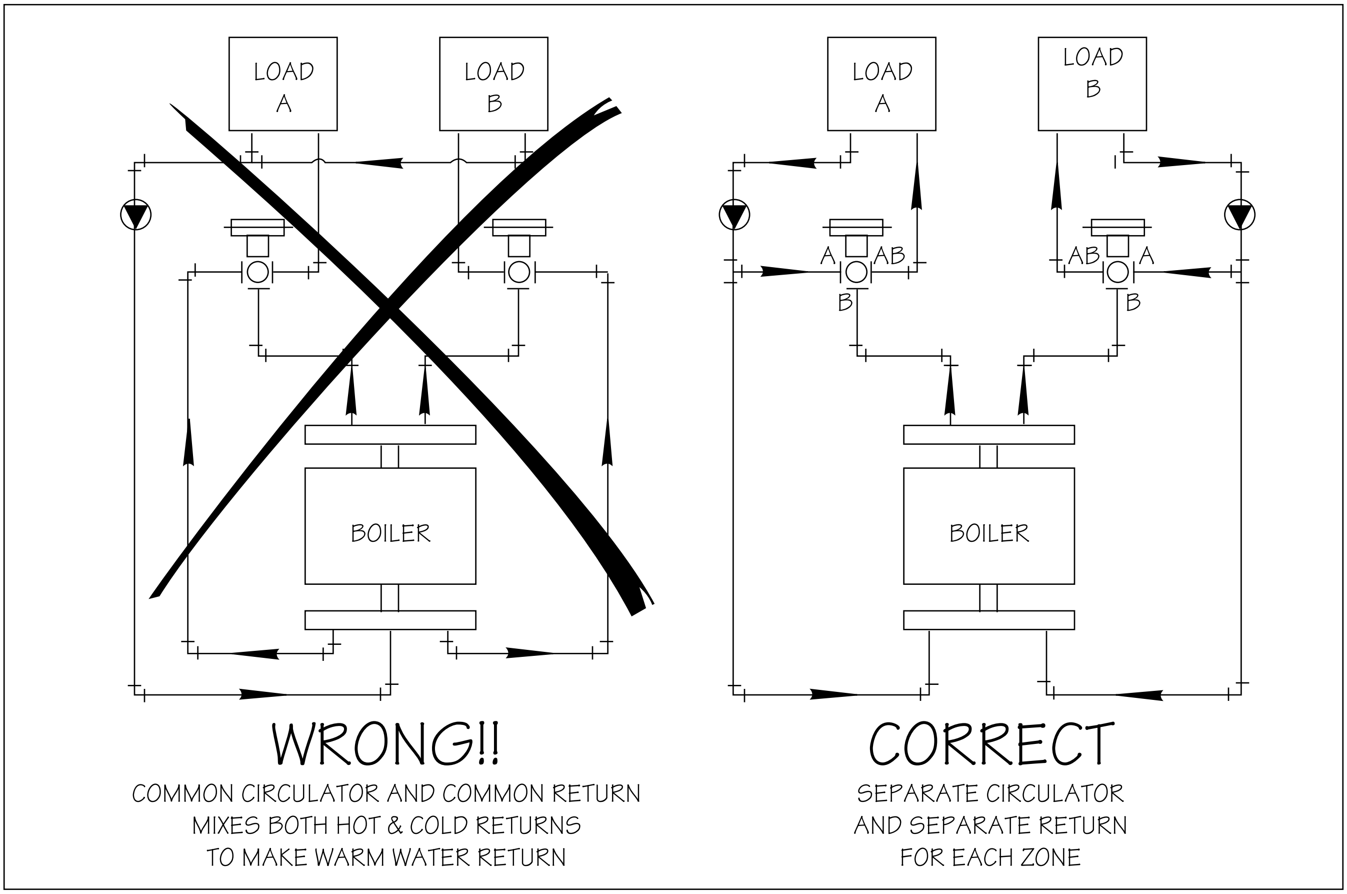

FIGURE 8- Common Piping Errors

SPARTAN FOUR-PORT VALVES:

Spartan supplies 4-ported valves for the OEM accounts who are concerned with installation costs as well as space within limited cabinets, see ***Figures 9*** **& 14**. For them, 3-way valves are produced with the bypass built into the valve body, thus simplifying the installation, reducing space requirements and reducing factory costs. Spartan also supplies manifolds, piping kits, close-off or isolating valves, and all fittings as a package kit, made to the exact dimensions of the OEM account and repeatable from order to order from year to year.

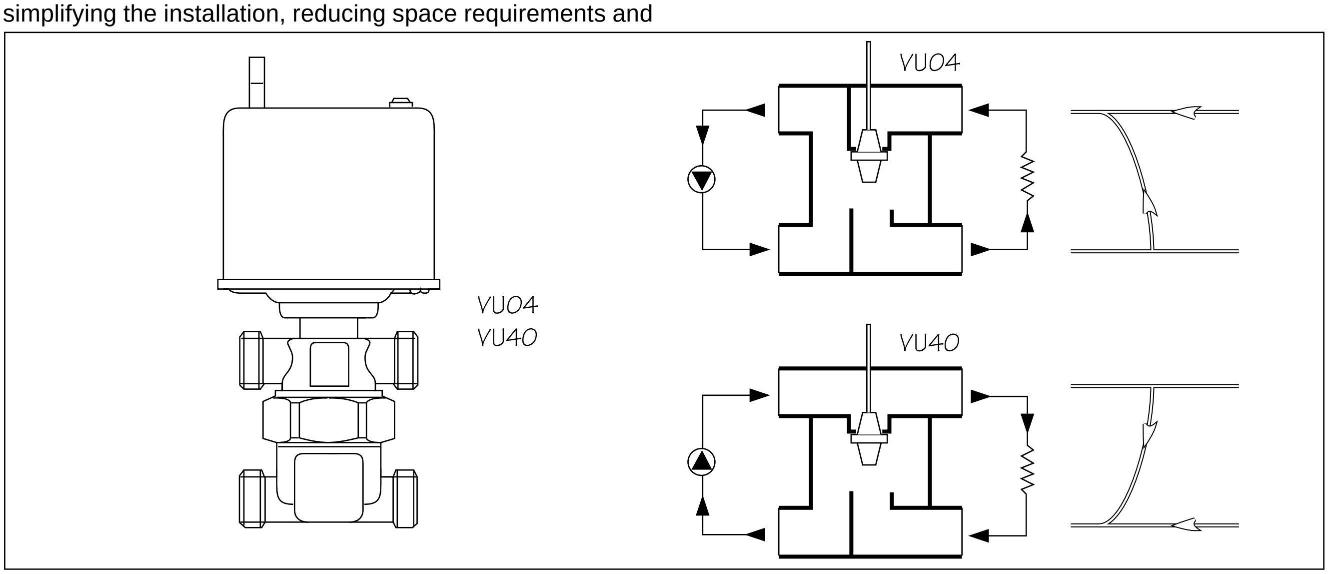

FIGURE 9 - Four-port Valves

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CONTROL VALVE SELECTION GUIDE

SPARTAN PROPORTIONING PLUG VALVES:

Parabolic plugs or V-fluted skirts are installed on control valves to provide a proportional reduction in flow with valve stem movement. Characterized plugs are available to provide equal percentage or linear flow reduction. Valves without these characterized plugs provide a quick opening.

Note the graph, **Fig. 13**, in the ASHRAE guide, copied below.

TURNDOWN RATIO:

Turndown ratio is defined as the ratio between maximum flow with the valve wide open to the minimum controllable flow, assuming no change in differential pressure across the valve.

For this reason, a valve with 50:1 turndown ratio which is incorrectly sized so that it can handle the full load when only 50% open, now has an effective turndown ratio of only 25:1.

Furthermore, if the pressure drop across the valve should increase from, say, 1 psi DP to 10 psi then the effective turndown ratio diminishes to 25:1 over the square root of (10-1) or 8-1/3:1. Compare this with a valve with 50% DP when wide open and you will see that the effective turndown ratio remains at 50:1 √10-5 = 22.4:1.

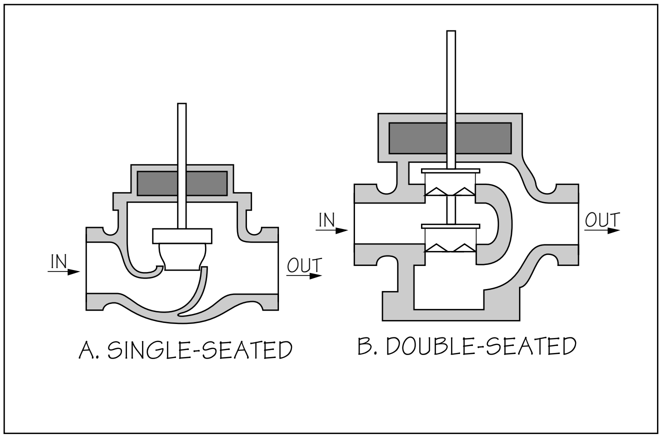

FIGURE 10 - Typical single- & double-seated valves

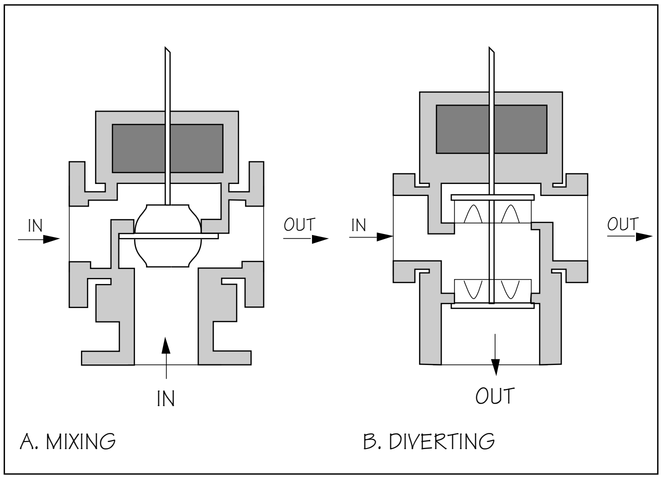

FIGURE 11 - Typical 3-way mixing & diverting valves

DOUBLE SEATED VALVES:

Where the DP across a large control valve would require an enormous topworks or actuator, a double-seated or balanced pressure valve is used: Spartan type V24 or V27. In this application, one plug opposes the other so that the stem force caused by the DP is almost cancelled out, and a smaller actuator can accomplish the job. The nature of the construction of this valve does not assure tight close-off, however, and between 0.05% and 0.5% leakage should be allowed for.

Remember that a valve rated at 0.05% leakage is rated at constant DP. Obviously, if the DP should increase from 20 psi to 100 psi as the valve closes, the leakage will increase as the square root of the DP changes.

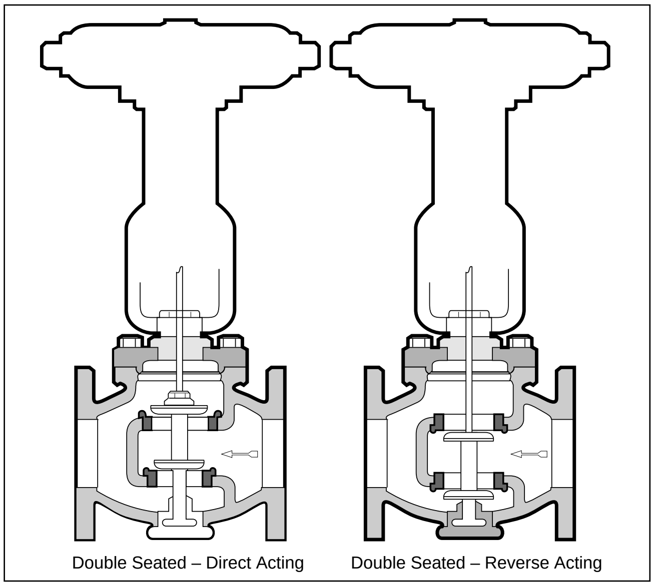

FIGURE 12 - Double Seated Valves, Reverse/Direct Action

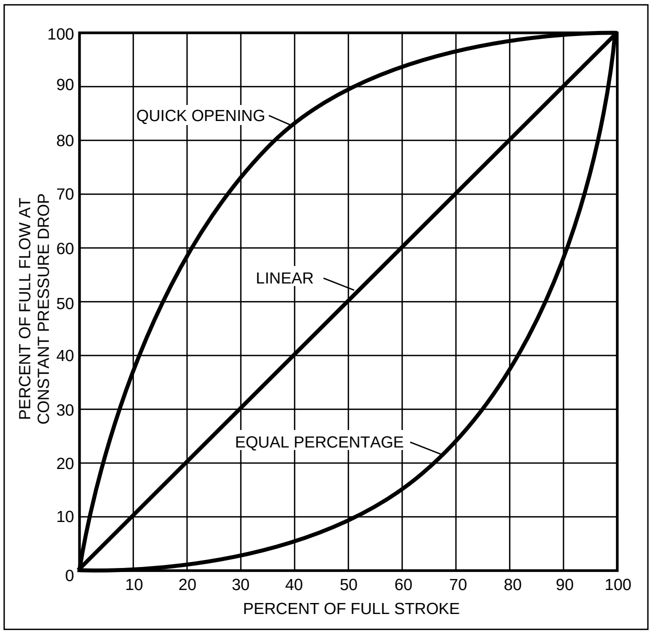

FIGURE 13 - ASHRAE Valve CharacteristicsGraph

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CONTROL VALVE SELECTION GUIDE

SELECTING SPARTAN VALVE TOPS

A complete line of Spartan valve actuators is available including self-acting, electric, electronic, pneumatic, in 2-position, proportional, and normally-open, normally-closed, or fail-in-last-position configurations.

SIZING PNEUMATIC TOPS

Pneumatic topworks vary their force with the air pressure applied; the higher the pressure, the more force they develop. This force can be calculated.

The published literature for Spartan topworks provides the effective operating area in square inches. The effective square inch area of the disc of the various valve sizes is as follows:

Size	Plug Area	Size	Plug Area
.5"	0.25	2.5"	5.0
.75"	0.4	3.0"	7.2
1.0"	0.8	4.0"	12.8
1.25"	1.3	5.0"	20.0
1.5"	1.8	6.0"	28.8
2.0"	3.2	8.0"	51.2

The air pressure drives a Spartan normally-open valve closed when it builds up to the closed end of the spring range. But it will not close the valve tightly until it also builds up enough additional pressure to oppose the force of the fluid trying to push the seat off the disc. Therefore, a normally-open valve with a nominal spring range of 3 - 6 psi might easily have an effective spring range of 3 - 8 psi, because it might take an additional 2 psi to seat the valve against the circulating pump pressure.

Similarly, a Spartan normally-closed valve uses the spring pressure to close the seat, and if a normally-closed valve had a nominal spring range of 9 - 12 psi, it might have an effective spring range of 7.5 - 12 psi for the additional 1.5 psi reduction in pressure might be needed in order to allow the valve spring to seat the valve.

Because of this fact, low spring ranges are usually used for normally-open valves, and higher spring ranges are usually used for normally-closed valves.

A common application of normally-closed and normally-open valves is to sequence the two from one thermostat. Usually the chilled water valve is normally-closed with 9 - 12# range, and the hot water valve would be normally-open with a 3 - 6# range. If the example above applied, then the effective ranges would be 3 - 8# and 7.5 - 12#. At the control point, the thermostat might be satisfied and controlling at 7.75 psi, but at this point both heating and cooling would be on (if slightly) at the same time. In this case, it is obvious that the topworks of the valves would have to be larger, so as to oppose the seating pressure without as much shift of spring range. Alternatively, a pilot positioner would have to be applied, or the spring adjuster (if the actuator is so equipped) would have to be tightened or slackened off as the case may be.

Spartan type MP50 tops have only 4 sq.in. of area, type MP60 tops have only 5.6 square inch effective area and the spring ranges are fixed, whereas Spartan type MP70 topworks have 12 square inch effective area and their spring followers allow readjustment of the spring range by + or – 2 psi.

NORMALLY-OPEN VALVES:

Normally-open control valves require pressure to close, so additional pressure will be needed to oppose the seating pressure. The following formula will calculate the additional pressure needed:

(Note that this does not apply to double-seated valves)

P = (SA x PH) / TA

where P equals psi needed,

SA equals seat area from the chart above,

TA equals topwork area,

PH equals the pump head or pressure to be opposed in psi.

example 1:

A circulating pump with a 70' head (70/2.3 - 30 psi) and a valve with a 1" body and an MP61 or MP66, 5.6" top would be as follows:

P = (0.8 x 30) / 5.6 = 4.4 psi.

Adding the 4.4 to a 3 - 6# spring gives us a 3 - 10.4 effective spring range which would be quite satisfactory by itself, but not good enough if it were to sequence with a cooling valve or VAV box with a 9 - 12# range. What might be done would be to use an MP71, 12 sq.in. top on a 3/4" valve (which has the same Cv as the 1" with the 5.6 top. Check the data sheets). The picture is now as follows:

example 2:

P = (0.5 x 30) / 12 = 1.25 psi.

The MP71, 12" top has a spring starting adjustment and so we would be able to adjust the effective spring range from its nominal of 3 - 6# to 1.75 - 6#, or even leave it at 3 - 7.25# where it would sequence without overlap with the VAV box or perhaps a cooling valve. Let's check!

NORMALLY-CLOSED VALVES

If a cooling valve also had to close against a circulating pump head of 70 feet (about 30 psi), was also 3/4", and also used a 12" top, then it would need the same force to close it and the pressure to close it would have to be equal to 1.25 psi. But this valve is normally closed with a spring range of 9 - 12 psi, so the spring will have to oppose the seat, and so the effective spring range will be 9 – 1.25 = 7.75 to 12 psi spring range. At this point there will only be 0.5 psi dead band between the heating valve above, and it might be prudent to tighten the cooling valve range adjuster by 1.25 psi and to loosen the heating valve spring range adjuster by 1.25 psi so as to leave the full 3 psi dead band intact.

CONTROL VALVE SELECTION GUIDE

If the same exercise was done using two valves with MP61 or MP66, 3 - 6# ranges and MP63 or MP68, 9 - 13# ranges then their effective spring ranges would be 3 - 10.4# and 4.6 - 12# respectively. At this point, they could overlap, and some of the time the unit could pass both hot and cold water simultaneously. The above scenarios are a bit extreme, because in fact the full close-off differential pressure would not be felt unless all of the valves closed at the same time. In this case, a bypass control valve across the circulating pump would be a wise decision. (There is a good description of this application in the ASHRAE journal, Chapter 30). Furthermore, 1/2" valves would not require as much force and can handle most terminal units.

Another solution to this problem would be to use 3-way valves, whereupon there is always flow through one port or the other and little DP across the valves. Some engineers use 3-way valves for 10 - 20% of the coils and 2-way on the rest of the job. In this way there is assurance that there will always be some flow, and further assurance that the DP would never be greater than the DP of the coil.

See the Spartan engineering report, "ΔP Control of Riser Pressures."

Typical kit supplied to major OEM manufacturer of fan coil units comprising:

- **Hand valves**
- **Control Valves (3-way, 4-port heating and cooling)**
- **Preformed piping kits**
- **Fittings.**

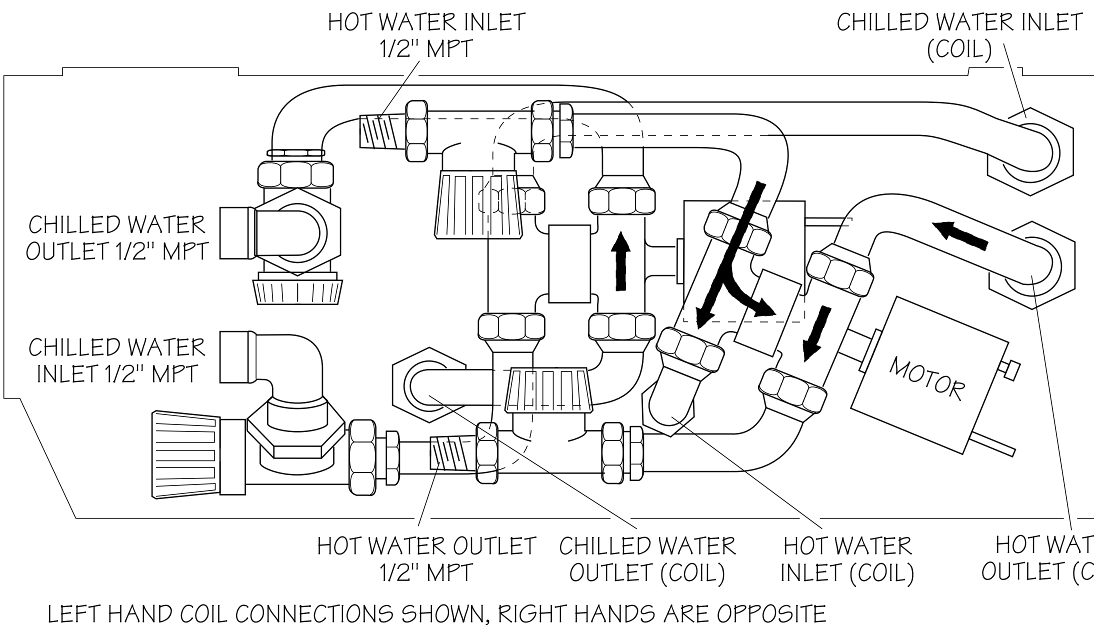

FIGURE 14 -View from Side of a Typical Fan Coil Unit.

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