Design Guide
Steam Pressure Reduction Stations

For District Steam Systems and Large Commercial Buildings

Warren Controls - The Complete Solution

WARREN CONTROLS INC.
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WARREN CONTROLS INC.

Steam Pressure Reduction Stations

Introduction

The design of the Main Steam Pressure Reducing Stations in buildings that are being supplied steam from a central steam generating plant or other high pressure steam generating source, must take into consideration load characteristics, rangeability, noise, safety, reliability, long-term maintenance costs and overall control performance. This booklet will present basic design concepts and designs to achieve the optimum operating characteristics, safety and economy.

5800
Control Valve

System Load Considerations

Large buildings utilizing steam usually have complex multi-use, Multi-function application requirements. Applications including seasonal heating, air conditioning, domestic hot water, laundry and the like, as well as variations like time of day and outdoor temperature all play a critical role in load requirements. The difference between the maximum capacity, when the building is fully occupied during the day and at night when only minimally utilized, could be a factor of 100 to 1. Because the allowed for application loads often are variable or completely non-existent at night. The entire load on the steam supply at night might only be what is created by condensation and trap losses in the piping system.

Example:

A new office building is planned for a business complex with the following estimated steam requirements. All values are in pounds of steam per hour (Lbs/hr)

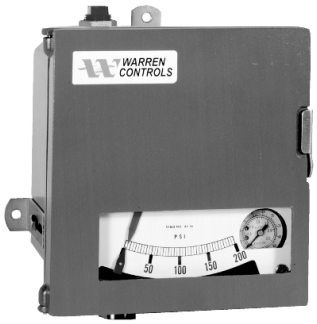
Heating	**12,000 (Winter)**
Domestic hot Water	**3,000 (All Year)**
Absorption Cooling	**20,000 (Summer)**
Kitchen/Pantry	**1,000 (All Year)**

Maximum load in summer = 24,000 Lbs/hr
Minimum load is not 4,000 Lbs/hr (DHW and Kitchen) but actually could be a little as 240 Lbs/hr.

Assume 500 feet of 12" low pressure insulated steam main which would have a condensate rate of approximately 27 Lbs/hr per 100 feet of pipe, for a total of 135 Lbs/hr.
The condensate load with the addition of a few steam traps would probably be no more than 240 Lbs/hr.

System turndown at 24,000/240 = 100 to 1

Pressure Reducing Stations must be designed to allow for the maximum system turn down. The best solution for the wide turn down ratios found in most buildings is a parallel transfer system.



8624
Indicating Controller

Noise

With steam there can be several aerodynamic noise producing mechanisms including turbulent mixing noise, shock waves, impingement, and shock turbulence interaction. Noise that exceeds specifications can either be controlled at the source or along the transmission path. The noise level at the control valves will automatically be calculated when using ValveWorks to size the valves and select the valves. Additional noise abatement and suppression techniques and equipment can be deployed when control valves exceed noise requirements so that overall system noise requirements can be met.

Safety

The final stage of a typical pressure reducing station is responsible for reliably supplying low pressure steam to the building header for its various users. Best practices of protection in managing failure of this final stage include an automated safety shut-off valve with manual reset. Alternately safety relief valves can be deployed but can be cost prohibitive in larger buildings due to logistics and length of the vent pipe, not to mention code constraints and testing requirements. Warren Controls offers the Non-Indicating Safety Pilot to first allow the primary stage to begin regulating to low pressure when two-stage reduction is employed. A separate pressure switch or safety alarm should be configured to trip the automated safety shut-off valve. Many building codes require an automated safety shut-off valve with manual reset in systems that use manual valves to bypass a PRV (for maintenance or manual recovery).

8351
Non-Indicating Controller (Pilot)

Transfer Systems are the best for stations with wide turndown ratios. Control valves are sized to have one valve large enough for approximately the first 25% of the load and the second parallel valve sized for the full load. The system will be designed to shut the small valve when it no longer provides sufficient capacity and transfer the entire load to the larger valve. This arrangement insures that the larger valve will not be throttling the plug close to its seat for when load requirements dictate modulating just near the transition region. The system will be stable and each valve will provide longer maintenance free service.

A Two-stage reduction system is shown in Figure 1. It provides all the best elements of a properly designed station for a high pressure reduction application that will experience wide turn down ratios. A single stage system (One control valve in each parallel line) can utilize the same control logic.

Features of the system

1. *Control Valves* that have been sized and selected for optimum performance by using the Warren ValveWorks sizing program (PRV-1A, 1B, 2A and 2B).

2. *Manual Override handwheel* on the Control valves that eliminate the need for a by-pass line.

3. *Automated shut-off valve* with manual reset (SSO-1) used in place of a relief valve and vent piping.

4. *Noise attenuation* thru the use of static restrictors (mufflers) after the control valves (M).

5. *Safety Limiting Pilots* (Warren 8351) that take control of the system should anything happen to cause the system pressure to exceed the setting of the low pressure indicating controller (Warren 8624).

6. *Indicating Pneumatic Controllers* (Warren 8624) with Gain and Integral Reset for accurate and dependable control. These units are capable of operating in environments that that would prohibit the use of electronic controls.

7. *Load Transfer Control*. Electric control that transfers the load from the Low-Flow loop to the High-Flow loop (LSL-2).

8. *Alarm Panel* (EP5-2X)

9. *Steam Traps* (T)

10. *Isolation Valves* (SOV 1 through 5)

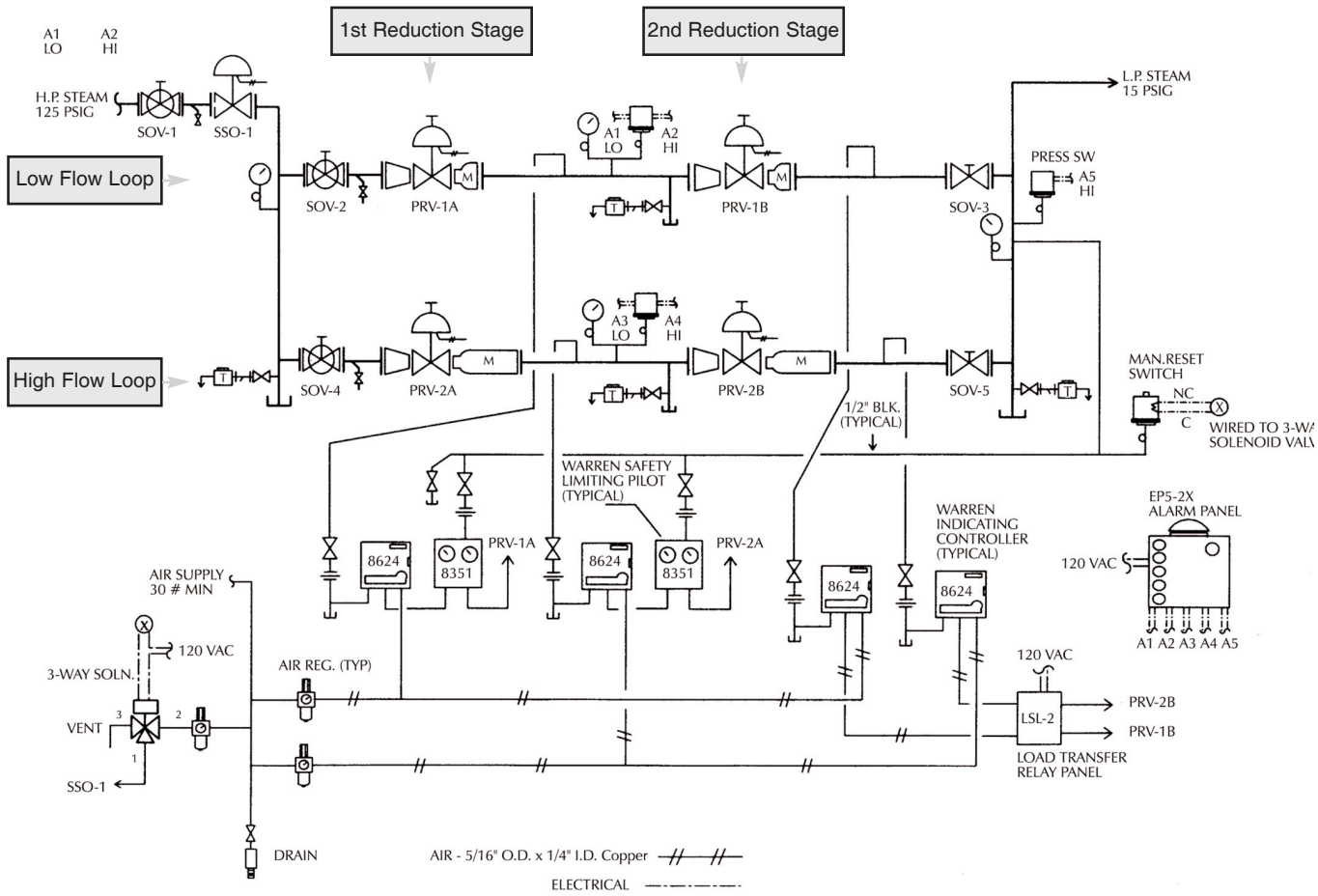


Fig 1 Typical Transfer System

WARREN CONTROLS

Application Considerations

1. *Single Stage Stations*: One control valve. Use when velocity through the control valve does not exceed 50ft/sec (Mach 0.1), capacity is below 10,000 Lbs/hr or less and specified noise levels are not exceeded.

2. *Two Stage Reduction*: Two control valves in series that divide the drop. Use when capacity is 10,000 Lbs/hr or less.

3. *Parallel Reducing Station*: Parallel Single or Two Stage reduction is used primarily when capacities are over 10,000 Lbs/hr, or when the ratio of maximum to minimum flow is greater than 1 to 25. Not recommended when load changes are rapid and frequent.

a. 1/3 – 2/3 Capacity Split: Control valves are sized to have one valve large enough for the first 1/3 of the load and the other parallel valve for the remaining 2/3. With this design the larger valve could become unstable and prematurely wear, as it will only begin to open after the smaller valve can no longer provide sufficient capacity. This practice while common is often unacceptable in many district or campus steam reduction stations.

b. Transfer System: See section titled Transfer System for more detailed information.

4. *Pneumatic vs. Electric Control*: Pneumatic controllers and pneumatically actuated control valves are preferred due to the harsh environment of these steam pressure reducing stations. Pneumatic controllers are capable of operating in moist ambient temperatures up to 180 Degrees F. Pneumatic diaphragm actuated control valves are simple, low maintenance and economical and also are not effected by moist high temperature ambient conditions. Warren Controls produces both Pneumatic controllers and pneumatically actuated valves.

5. *Control Valve Selection*: Oversized valves are one of the most frequent causes of unstable systems and energy waste. It is not recommended to attempt to control flow when operating a globe valve in the last 5% of valves travel to ensure the longest trim life and control stability. Choice of the correct station design and the use of the Warren ValveWorks program to select the optimum size control valve will insure a station that operates satisfactorily.

6. *Manual Bypass of the Control Valves*: It is normally desirable to provide a means of manually bypassing the automatic function of the control valves. A parallel bypass line with a manual shut off valve, or adding manual override handwheel to the control valves provide this feature. Either method is acceptable, with the handwheel option being the least expensive alternative. Both methods are only permissible under the following conditions.

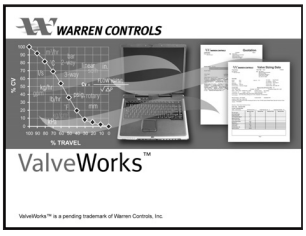
a. Safety shut down valve is located upstream of the reducing station. No manual bypass of this valve is permissible.

b. A safety relief valve is located on the downstream side of the reducing station. The relief valve must be sized to relieve the full capacity of the station.

7. *Isolation Valves*: Manual valves should be provided so that the control valves can be isolated for maintenance. These valves should have tight shut-off and not be capable of opening quickly.

8. *Steam Traps*: It is imperative that adequate trapping be provided before and after the reducing station, to insure that condensate cannot accumulate in the reducing station piping. Trap manufacturers should be consulted for proper trap sizing, selection and location.

Visit our website to get your *FREE* copy of the ValveWorks control valve selection program.



- **PRESSURE DROP** is calculated for efficient control
- **PRECISE Cv REQUIRED** is calculated for single or staged uses
- **WARNINGS PROVIDED** for cavitation or flashing
- **CALCULATES NOISE** level
- **GRAPHS CURVES** for selected valve, stroke vs flow
- **SELECTS CORRECT** actuator and accessories

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