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Steam and pressure controls since 1951

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**Abstract:** Steam Control Specialist Mike Taillon discusses the potential energy savings using pneumatic versus electronic and digital control packages. He discusses features and solutions promoted. He argues that operating choices have important impact on outcome regardless of control package. He cautions choice based purely on potential energy savings promised by vendors.

**Keywords:** Pressure Reduction Valve, PRV Station, pneumatic valve, steam loss, enthalpy savings, steam transmission pressure

**Review of impact on Cost when choosing Control Systems for PRV Steam Station**

By Michael Taillon

Historically control systems of choice for a facilities main steam pressure reducing stations have been full pneumatic or “air” configurations, in part due to the practical benefits over other available systems. Air operated systems offered quicker response, high cycle life, and positive fail safe positioning. Pneumatic systems are often referred to as being “bullet proof” due to long-life expectancy and rugged durability in severe service conditions. However, following advancements in electronic control integration and increasingly competitive prices, digital controls packages have now become a viable substitute the pneumatic incumbent.

Digital control suppliers argue that their systems provide features not available with straight pneumatic systems. Despite these claims, it is still considered best practice to use air operated valves in conjunction with these systems. For example, a typical scenario is to fit air operated valves with I/P positioners which allows them to interface with a digital control package.

The choice between the two should ultimately “boil down” to customer preference. Each system has unique benefits and features which should be clearly understood before selection. It is the obligation of any competent vendor to educate the customers on the capabilities and features of each type of package so that an informed selection can be made that will best serve their needs.

Whether intentional or not, there is one sales argument which may be misleading to a buyer particularly when salesman attempt to promote an electronic package to replace an existing pneumatic system. This flawed argument often implies an immediate cost savings, in the form of lower steam usage by simply installing a digital control system.

On the contrary, simply replacing one control system with another does not affect steam consumption. For example, an on-demand water heater requires approximately 1,500 pounds per hour of steam to produce 30 GPM of hot water and will require that same amount of steam regardless of the PRV control system involved.

The implied saving is usually attributed to lowering steam pressures to some value under what was considered the normal operating range. Often this statement is not validated by any specific data other than a general belief that “If you lower steam pressure you will save 10 to 15 percent in steam costs”.

This premise is usually based on three main focal points.

1. **Enthalpy Savings**. Lower steam pressures have more available heat energy than higher pressures. Thus, by lowering delivered steam pressure overall steam consumption is lowered.

2. **Pipe Insulation Heat Loss.** Reducing the steam pressure lowers the condensate load which is a natural occurrence in steam piping. The result being less wasted steam.

3. **Steam Leakage Loss**. Steam loss to atmosphere through leaking fittings or failed traps is greater at higher pressure than lower pressures.

Before addressing each of these points it should be noted that the savings “argument” has now shifted away from the type of pressure control system in use and focuses more on finding an optimal operating pressure. System set point pressures can be manipulated regardless of the control mechanism, whether it be electric, pneumatic, or of a self-contained PRV configuration.

With the above in mind, we will address each point without bias to any particular pressure control mechanism.

Enthalpy Savings

Enthalpy in this context refers to the total heat content of one pound of steam at a given pressure and is expressed in BTU/Lb. In a heat transfer process involving steam, the term Enthalpy is used synonymously with latent heat of vaporization which in this case is used to determine how much energy can be extracted from a given quantity of steam before it condenses to liquid form. Simply put it is the amount of available energy in one pound of steam which can be used to heat another fluid. Although potentially counterintuitive, steam enthalpy will increase slightly as pressure decreases. It is therefore a false assumption that lowering steam pressures will reduce steam consumption and save energy.

So, how much savings can we expect to see by lowering the delivered pressure from our main steam PRV station? The practical answer is that overall savings will be negligible to non-existent. This answer can be validated by the following explanation, using the accompanying sketch for clarification.

Almost all of a building’s low pressure steam supply is used in heat transfer applications such as domestic water heaters, air handling coils, and perimeter heating heat exchangers. These applications use temperature control valves to regulate flow into the heat exchange and do not use the transmission pressure supplied directly from the main PRV station. In fact, it is likely that most heat exchangers operate with an internal steam pressure at or close to atmospheric levels as is evidenced by installed vacuum breakers found on most packaged units.

**Thus, simply lowering the steam transmission pressure to process temperature control valves has no effect on steam consumption taking place in the heat exchangers and therefore offers no enthalpy savings.**

Remember it is the heat exchangers that consume the steam *not* the transmission piping.

The only savings which might be attributed to the transmission side piping may be radiant heat losses which brings us to our second point of discussion.

**Pipe Insulation Heat Loss**

The implication here is that lowering steam pressures in transmission piping will reduce the inherent condensate load which naturally occurs in piping runs.

Radiant heat losses are generally affected by pipe size, surface insulation, surface temperature and ambient temperatures.  Using any number of available on-line calculators and/or published charts the estimated running condensate loads between two different operating pressures can be compared.

For example, a 100 ft length of well insulated 8 inch pipe operating at 15 psig saturated steam with an ambient temperature of 80°F has an estimated condensate load of 6.2 Lbs/Hr

The same pipe running at 5 psig has an estimated condensate load of 5.3 Lbs/Hr

Based on 24/7 operation and average NYC steam costs the savings could amount to under $30.00 per month.

To more accurately estimate potential heat loss savings facilitated by lowering transmission pressures a comprehensive piping analysis should be completed with a copy submitted to the facility detailing where and how the savings is being generated.

**Steam Leak Losses**

This area addresses steam lost to the atmosphere through leaking pipe connections and/or failed traps.

The most common type of steam waste attributable to leaks is failed steam traps. The amount of steam lost in this manner can be roughly calculated using a variant of the Napier formula

$\text{Lbs/Hr} = 24.24 \times Pa \times D^2$

Where:
Pa = Steam Pressure, Absolute
D = Diameter of the orifice, Inches

The amount of steam loss depends on the size, type and quantity of fail traps and can vary greatly between facilities.

It should also be stressed that this type of steam loss or “savings” should not be a determining factor in the decision to replace an existing pressure control system. Replacing a control system and/or lowering pressures to “manage” this type of steam loss is an ineffective answer to the immediate problem and not a solution. Any device or fitting found to be leaking constitutes a failed system component and should be repaired or replaced in a timely manner to eliminate unwarranted steam losses.

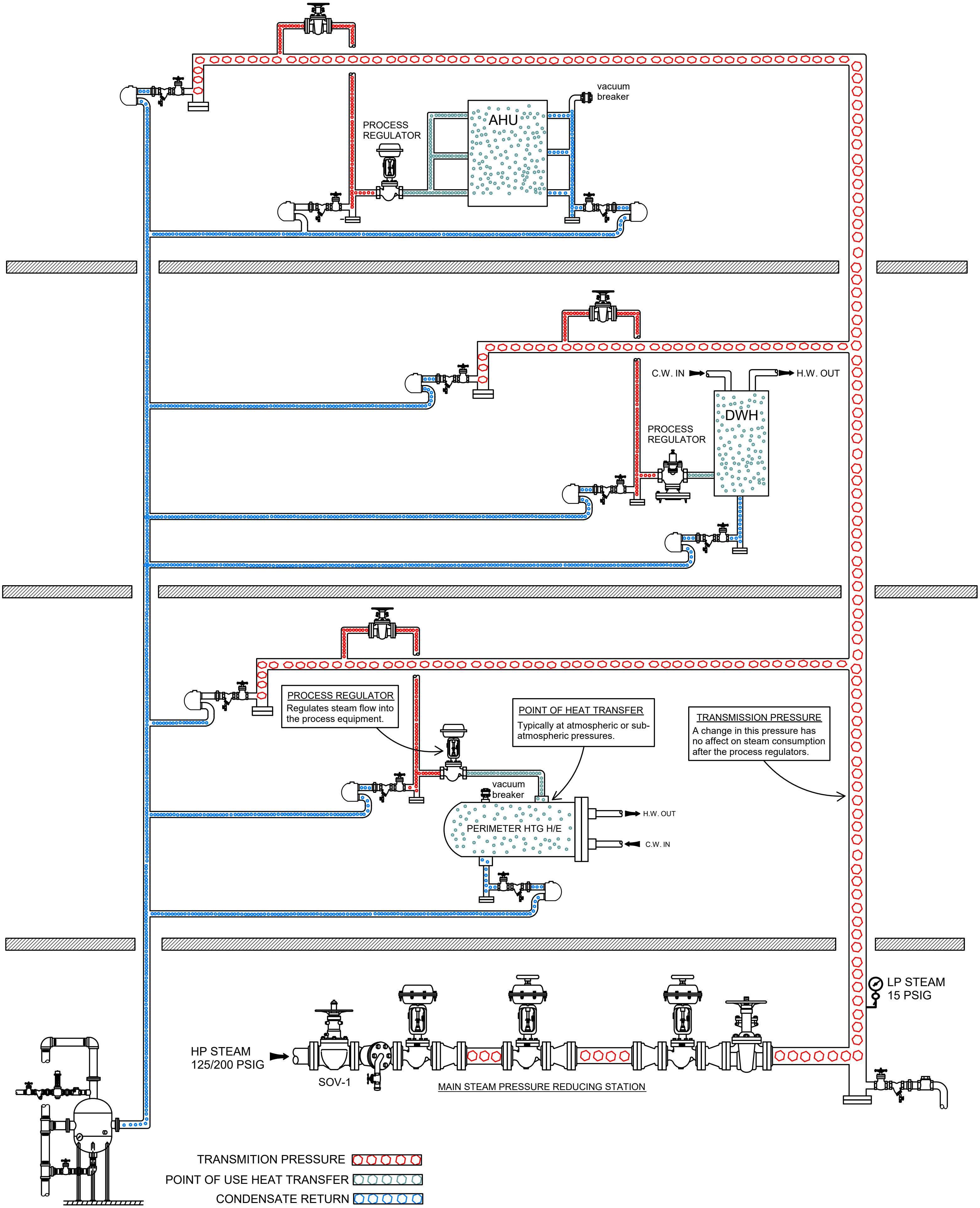
Of even higher importance is to consider what effect lowering set point pressures may have on system performance. Original system designs, sizing and equipment selection were based on specified flow capacities and pressures. Arbitrarily lowering pressures, especially if the change is significant, can have adverse effects, some of which could have severe consequences such as:

- **Excessive steam velocity**. By lowering steam pressures under those originally specified it can effectively result in the transmission piping now being undersized at design flow conditions. This can result in noise issues and accelerated erosion of piping and hardware.
- **Capacity issues**. Rated capacities of existing regulating equipment can be adversely affected by lowering steam supply pressures to a value under the original design parameters.
- **Steam Trap Function**. Steam traps installed to work at higher pressures may no longer function properly as the lower pressure may no longer be sufficient to evacuate condensate. This is an extremely important safety consideration as improper removal of condensate can lead to catastrophic equipment failure and/or personal injury.

## Summary

It would be highly advisable to consult with a licensed professional engineer before making a substantial investment to convert an existing pressure control system, particularly when such decision is to facilitate savings based solely on lowering steam pressures. A qualified engineer can provide both validation of any implied savings and analyze what effect the lower pressure may have on the overall system operation and equipment functionality.

We emphasize that the purpose of this brief is not to dissuade one from considering converting an existing pressure control package. To the contrary there are several legitimate reasons one might wish to do so. Rather the purpose of this brief is to emphasize that if such a conversion is being promoted with an implication that it will save money and offer a favorable return on investment the onus should be on the product supplier or vendor to “show the math” and detail where any actual savings will be generated.



vacuum breaker
AHU
PROCESS REGULATOR
C.W. IN
H.W. OUT
DWH
PROCESS REGULATOR
PROCESS REGULATOR
Regulates steam flow into the process equipment.
POINT OF HEAT TRANSFER
Typically at atmospheric or sub-atmospheric pressures.
TRANSMISSION PRESSURE
A change in this pressure has no affect on steam consumption after the process regulators.
vacuum breaker
PERIMETER HTG H/E
H.W. OUT
C.W. IN
LP STEAM 15 PSIG
HP STEAM 125/200 PSIG
SOV-1
MAIN STEAM PRESSURE REDUCING STATION
TRANSMITION PRESSURE
POINT OF USE HEAT TRANSFER
CONDENSATE RETURN