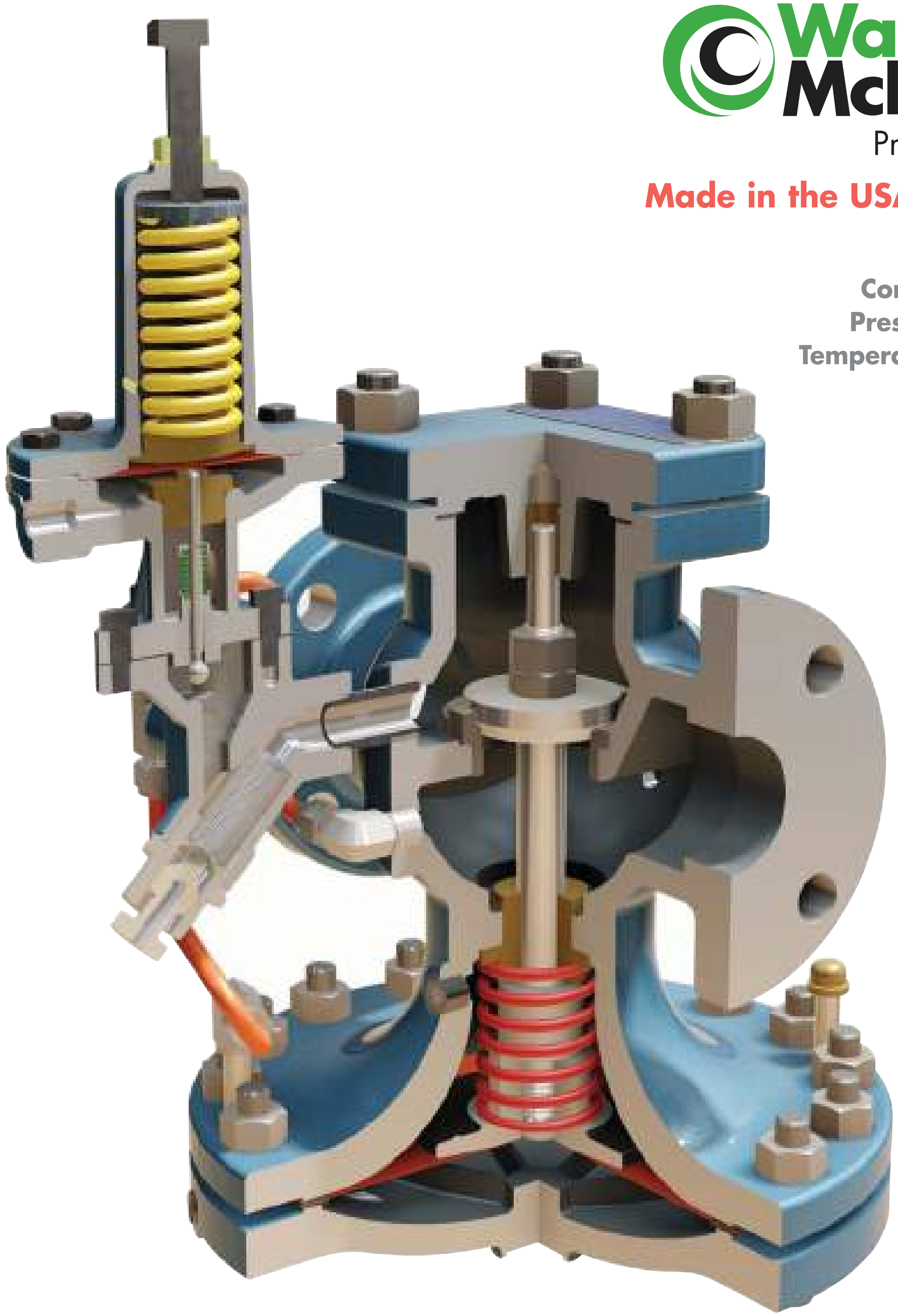
Watson McDaniel

Product Catalog

Made in the USA Since 1878

Steam Traps
Condensate Pumps
Pressure Regulators
Temperature Regulators
Control Valves
Relief Valves
Liquid Drainers
Check Valves



Manufacturing High-Quality Steam & Fluid Specialty Products for Industry

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For over 135 years, **Watson McDaniel** has been manufacturing a wide range of steam specialty and fluid products for the industrial marketplace. These time-tested products have made the operation of steam, compressed air, heat transfer and fluid systems substantially more effective and efficient.

In 1995, **Watson McDaniel** received its **ISO 9001** Quality Certification as industry recognition of our continued commitment to world class manufacturing, assembly and quality control procedures. This level of quality certification assures our customers unequaled dependability of our products. Our manufacturing facilities, with over fifty computer numerical controlled (CNC) machining centers, is considered the most modern in the industry.

Watson McDaniel serves the global marketplace with a network of Manufacturers, Representatives, Distributors, Manufacturing Plants and Sales Offices located throughout the world. In 1997, a Manufacturing Plant and Sales Office was opened in Shanghai, China to fulfill the growing demands of steam specialty products in the Far East. The success of this operation has allowed us to quickly deliver products with competitive prices to our customers throughout this region.

The structure of our operation affords us the ability to give highly personalized attention to each and every customer. We continually strive to provide ultimate customer service and product reliability while responding immediately to our customers' requests and detailed needs. Watson McDaniel welcomes the opportunity to work with your company so that we may help to make all of your steam system and fluid applications the best that they can be.

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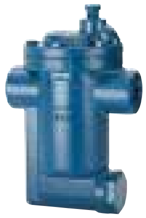
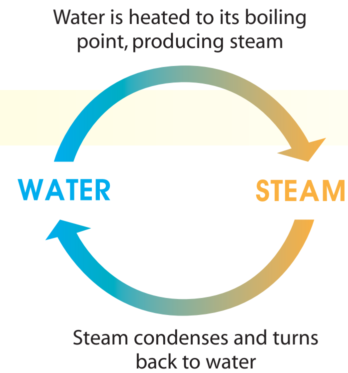
STEAM TRAPS



Steam & Condensate

Introduction



What is Steam?

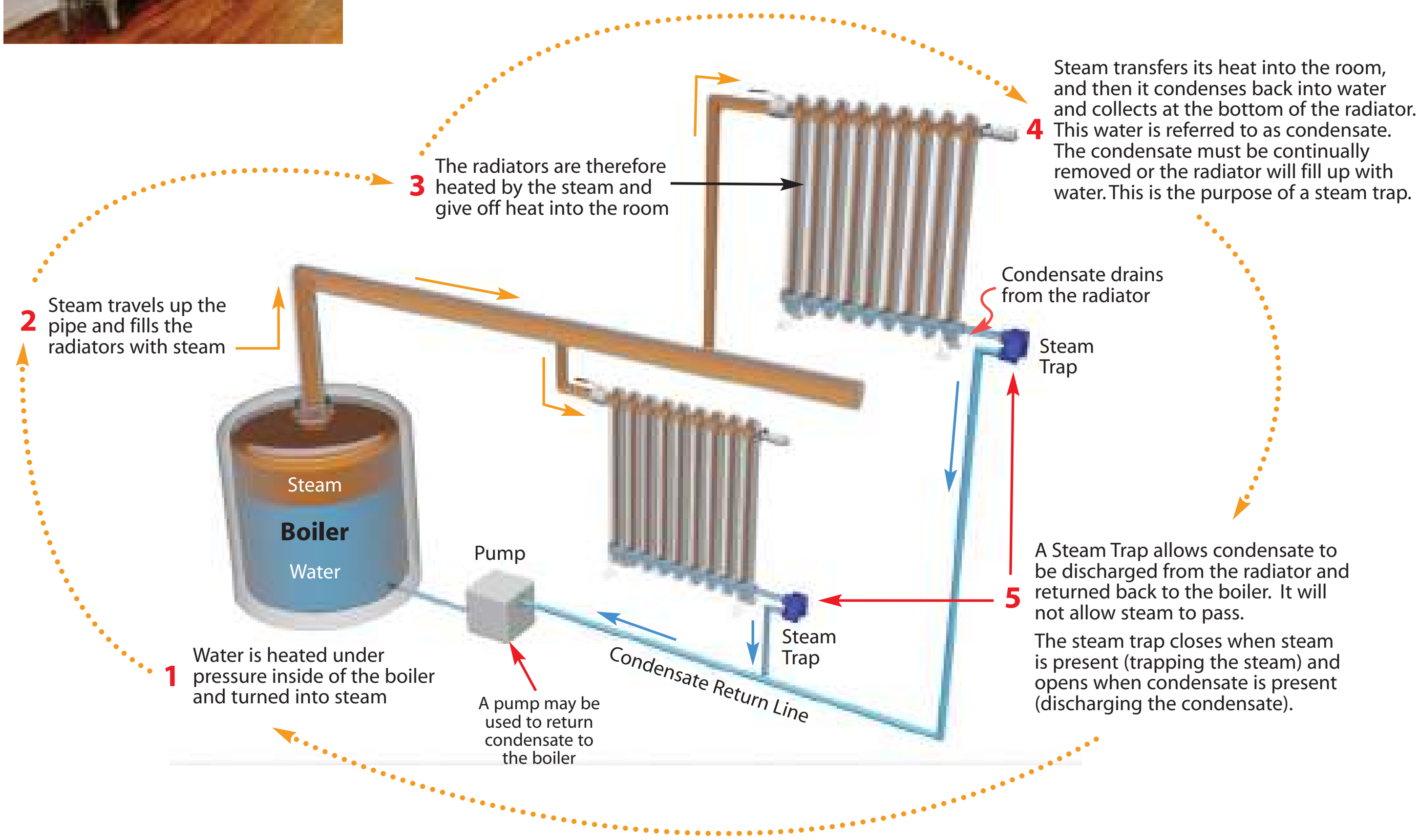
Steam is simply the gas that is formed when water is heated to its boiling temperature at a given pressure.

A tea kettle is the most common example of producing steam by heating water to its boiling temperature (212˚F). In this case, the steam does not develop any pressure and is released into the atmosphere. A boiler will generate steam under pressure by heating a large quantity of water in a contained system. This pressurized steam will travel throughout the pipes in the system to where it is needed. In addition to being created from water, which is readily available and relatively inexpensive, steam has many other advantages that make it easy and efficient to work with.

What makes steam desirable to use for heating?

Another benefit of using steam is that steam temperature is directly related to the pressure of the system. Therefore, by increasing or reducing pressure, it is easy to increase or reduce the temperature.

The Steam & Condensate Loop



Pressure / Temperature Relationship of Steam

Steam is created when water is heated to its boiling temperature until enough heat energy is absorbed to transform the water from a liquid to a gas. The temperature at which water boils is 212˚F; however, this is the boiling point of water at 0 psig, or atmospheric pressure. A unique property of steam is that there is a direct relationship between the pressure at which it is generated and the temperature at which it boils. The boiling temperature increases as steam pressure increases. If steam is generated at a pressure higher than 0 psig, the temperature at which the water boils will be higher than 212˚F. An abbreviated version of the Saturated Steam Table is included to show the exact boiling temperature at various steam pressures. (The complete steam table is available in Engineering Section.)

Steam Pressure (psig)		Temperature (˚F) Steam	Temperature (˚F) Boiling Water
0 psi	=	212˚ F	212˚ F
1 psi	=	215˚ F	215˚ F
4 psi	=	224˚ F	224˚ F
10 psi	=	239˚ F	239˚ F
50 psi	=	298˚ F	298˚ F
100 psi	=	338˚ F	338˚ F
150 psi	=	366˚ F	366˚ F
200 psi	=	388˚ F	388˚ F
300 psi	=	421˚ F	421˚ F

Steam Supplies Heat at a Constant Temperature

Steam does not reduce its temperature when it releases its heat; it just simply changes from a gas back into water at the same temperature. For example, steam at 50 psig (is at 298˚F; refer to steam chart above) will condense back to water at 298˚F when it releases its heat energy. In contrast to steam, water reduces in temperature when it gives up its heat.

What is saturated steam?

Steam that is generated under pressure inside the boiler, while in the presence of boiling water, is referred to as **Saturated Steam**. If additional heat is later added to the saturated steam to increase its temperature, it is then referred to as Superheated Steam. Superheated steam is used in power generation and saturated steam is used for heating. When saturated steam releases its energy, it condenses back to water. This hot water at or near boiling temperature is referred to

Heating Properties: The energy absorbed by water at its boiling point to transform it from a liquid to a gas is known as **Latent Heat**. This Latent Heat is then released by the steam when used for heating. Steam is very efficient in transferring heat to other processes. Steam, being a gas, allows it to surround any surface it needs to transfer its heat energy into. When steam transfers its heat, it condenses back into water, which will be drained away and sent back to the boiler in order to be used again (referred to as Condensate Recovery).

Where else is steam used?

Hospitals and pharmaceutical manufacturers may use steam for the sterilization of medical instruments and production of medicines, while the petrochemical industry may use steam for processing gasoline from crude oil. Steam is essential in large scale food processing & manufacturing applications. Large cities, such as New York, have centralized steam systems for heating large apartment complexes.

Steam Turbines in Power Plants

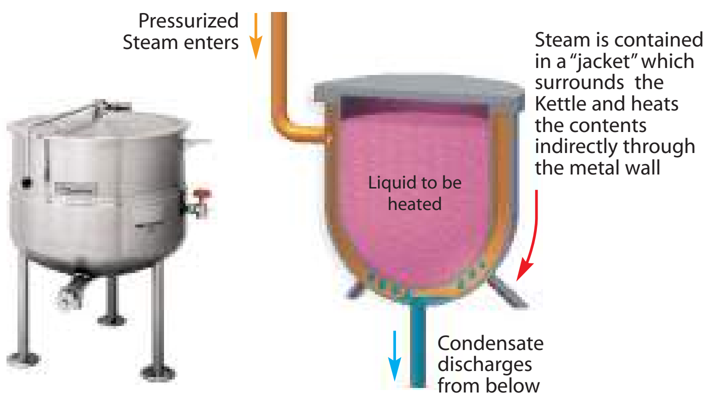
Steam exhaust from power plants

Steam used in cities for heat

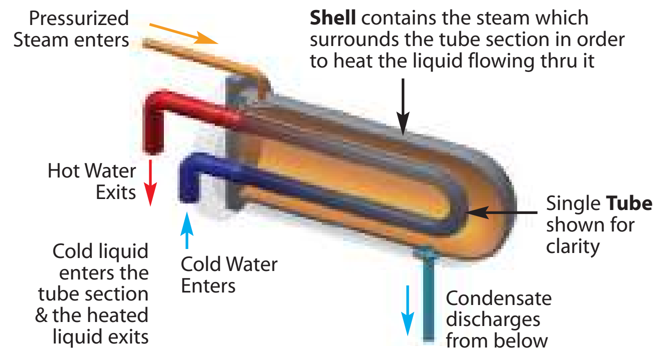
Typical equipment used for process heating in steam systems

A steam jacketed kettle contains a liquid to be heated surrounded by an isolated jacket containing the steam (steam does not contact the fluid). They are typically found in commercial food processing facilities. The Shell & Tube Heat Exchanger is used for continuous processes where a liquid to be heated (such as water), continually flows through the tubes surrounded by the steam.

Steam Jacketed Kettle



Shell & Tube Heat Exchanger
(Single tube shown for clarity)



Typical pieces of equipment used to control, protect and optimize steam systems

Now that a basic understanding of steam has been provided, let's introduce some components of the system and their general purposes:

Steam Traps

Since steam is created from water, it will condense back to water after releasing its energy during heating. This water, or condensate, must be removed to not only ensure proper heat transfer, but system safety as well. Removing condensate without the loss of live steam is the primary function of Steam Traps. Steam traps also discharge air that is present in the system prior to system start-up.

Pressure Regulators & Control Valves

Steam is generated at the boiler at pressures sufficient to ensure travel throughout the entire piping system. Pressure Regulating Valves and Control Valves may be used for temperature control or to reduce the steam pressure generated at the boiler down to more usable levels.

Condensate Return Pumps

When condensate does not have sufficient pressure to return to the boiler on its own, mechanical or electric pumps are required to pump the condensate back to the boiler.

Introduction

How does steam flow in a system?

Steam coming from the boiler is distributed throughout the system by pipes referred to as steam mains or steam supply lines. Since steam is generated under pressure at the boiler, it will travel on its own through the system. Steam may travel in pipes at velocities exceeding **90 mph**; for this reason, care should always be taken to open and close valves slowly.

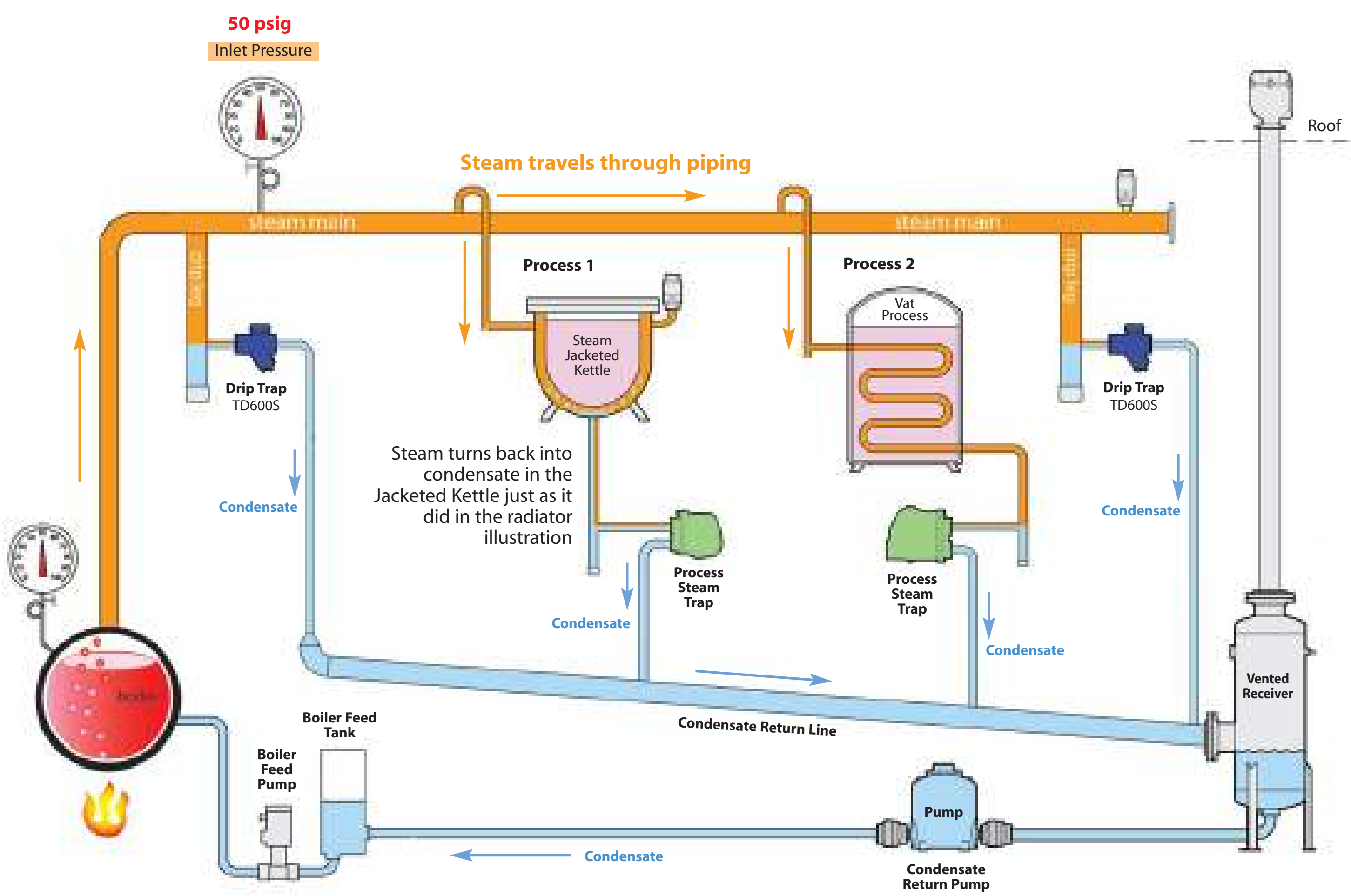
What is condensate and why must it be removed from a system?

When steam releases its heat energy, it condenses from a gas back to a liquid. This “condensed” steam is referred to as **condensate**... which is nothing more than extremely hot water. As previously discussed, steam at 50 PSIG condenses back into water at 298˚F. Steam Traps were specifically designed for the removal of unwanted **Condensate** and **Air**.

Condensate will form in steam pipelines due to radiation losses through the pipe walls. Drip Traps remove condensate from steam pipelines. However, the bulk of the condensate formed in the system occurs in the heat exchangers and other processes, and must be removed or the system would fill with water and impede the heat transfer process. In contrast to drip traps, Process Traps remove condensate from the actual process application (such as a heat exchanger).

System showing use of Steam for Heating in two different Process Applications:

Steam Jacketed Kettle & Tank with Steam Coil (Vat Process)



Note the process steam traps draining condensate from the Steam Jacketed Kettle and the Vat Process, discharging into a condensate return line. Condensate is then drained into a vented receiver which is used to release flash steam from the hot condensate in order to neutralize the pressure in the condensate return line. Also note the drip traps used for draining condensate from the steam supply lines. Other components, such as control valves and pressure regulating valves that would be required to control steam pressures and product temperatures, have not been included for simplification purposes.

WHY ARE STEAM TRAPS REQUIRED?

The purpose of the steam trap is to allow Condensate (water that is formed from the condensed steam) and air, to be discharged from the steam system while preventing the loss of live steam. The steam trap is a special type of valve which opens when condensate and air are present and closes when steam tries to pass.

CONDENSATE: (condensed steam or water): Any time steam releases its heat energy (latent heat), the steam condenses back to water. This water is therefore referred to as condensate. This transformation of steam back to liquid condensate will occur in a radiator heating a room, in a heat exchanger making hot water, in a pipe transferring the steam over long distances, or in any process that uses steam. If this condensate is not continuously removed, the radiators, heat exchangers and piping will fill with condensate (water). The removal of condensate from the steam system, while preventing the loss of live steam, is therefore the primary function of the steam trap.

AIR: Before the steam is turned on and the system is cold, air will exist in all the steam pipes and process equipment, such as radiators and heat exchangers. This air must be bled from the entire system to allow the steam to enter and reach its intended designated process. The air is actually pushed thru the system by the incoming steam and automatically bled thru the process traps at the end of the steam lines or special air vents at the high points in the system. This bleeding of air from the system allows the steam to enter.

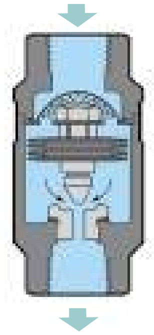
GENERAL APPLICATION CATEGORIES for STEAM TRAPS:

DRIP APPLICATIONS: Drip applications refer to removing the condensate that forms in the steam main and steam supply lines as opposed to condensate that forms at the actual process (heat exchanger, jacketed kettle, radiator, etc.). When steam loses its heat energy due to radiation losses through the pipe walls, condensate forms in the pipes. This condensate needs to be continuously removed, and it is therefore common to have steam traps placed 150–300 feet apart throughout the piping system. Traps used for this application are referred to as drip traps and have small condensate capacities as opposed to process traps. Drip traps are not normally relied upon to discharge the air from the system. Air removal is performed by the process traps and air vents located throughout the system. The most common trap choices for drip applications are the **Thermodynamic** style for line pressures over 30 PSIG, and Float & Thermostatic style for line pressures up to 30 PSIG. **Inverted Bucket** (IB) style traps are also commonly used for drip trap applications. The orifice of the IB is mounted at the top of the trap which makes them less susceptible to failure from dirt and pipe scale when compared to other trap types.

PROCESS APPLICATIONS: Process applications refer to removing condensate and air where the actual process using the steam is taking place. This process could be a heat exchanger making hot water, or a radiator heating a room, or anything else that requires the use of steam. Traps used for process applications require larger condensate handling capability in contrast to steam traps that are used for drip applications. Traps used in Process applications also need to be able to discharge large amounts of air present in the system at start-up. The most common trap choice for process applications are **Float & Thermostatic** traps since they do an excellent job of discharging condensate and air. **Thermostatic** traps make a good choice for process applications since they also do an excellent job of discharging air and condensate. In contrast, the lack of air venting capability of the Thermodynamic and Inverted Bucket traps, make these trap types a less desirable choice for most process applications.

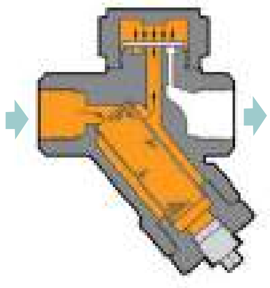
Common Types of Steam Traps

Shown below are some of the most common types of steam traps; Float and Thermostatic, Thermodynamic, Thermostatic, as well as a Thermostatic Air vent. Other common steam trap types are the Inverted Bucket and the Bi-Metal. In the following diagrams, other system components such as control valves and regulating valves are often required to control steam pressure and process temperatures. (Some piping components may not be included in the diagrams for simplification purposes.)



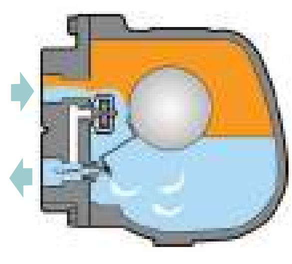
Thermostatic Trap

Contains a thermostatic element which allows air and condensate to be discharged, but closes when steam is present.



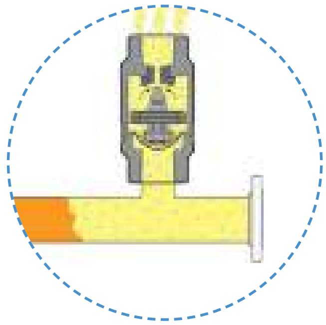
Thermodynamic Trap

Contains a disc and seat arrangement which allows condensate to be discharged, but will close when steam tries to pass through.



Float & Thermostatic Trap

Contains a float-operated valve to discharge condensate, and a thermostatic air vent which discharges air, but will close when steam is present.



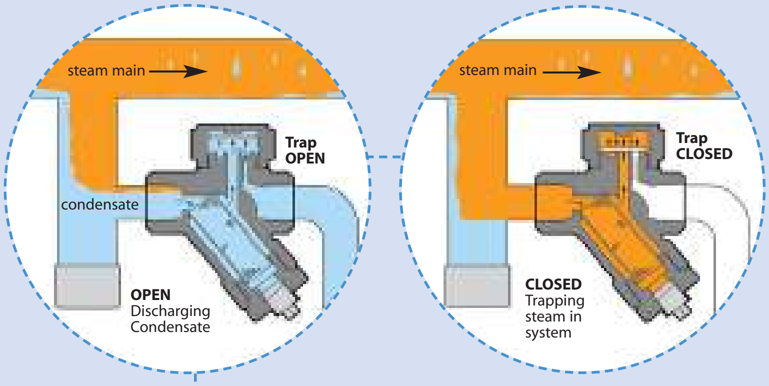
Thermostatic Air Vent

Air Vents are used in steam systems for the removal of air and other non-condensable gases. They are placed at the end of steam mains and directly on process equipment.

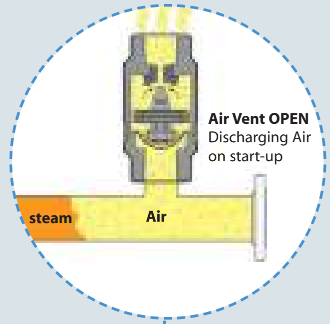
Diagram of a Steam System

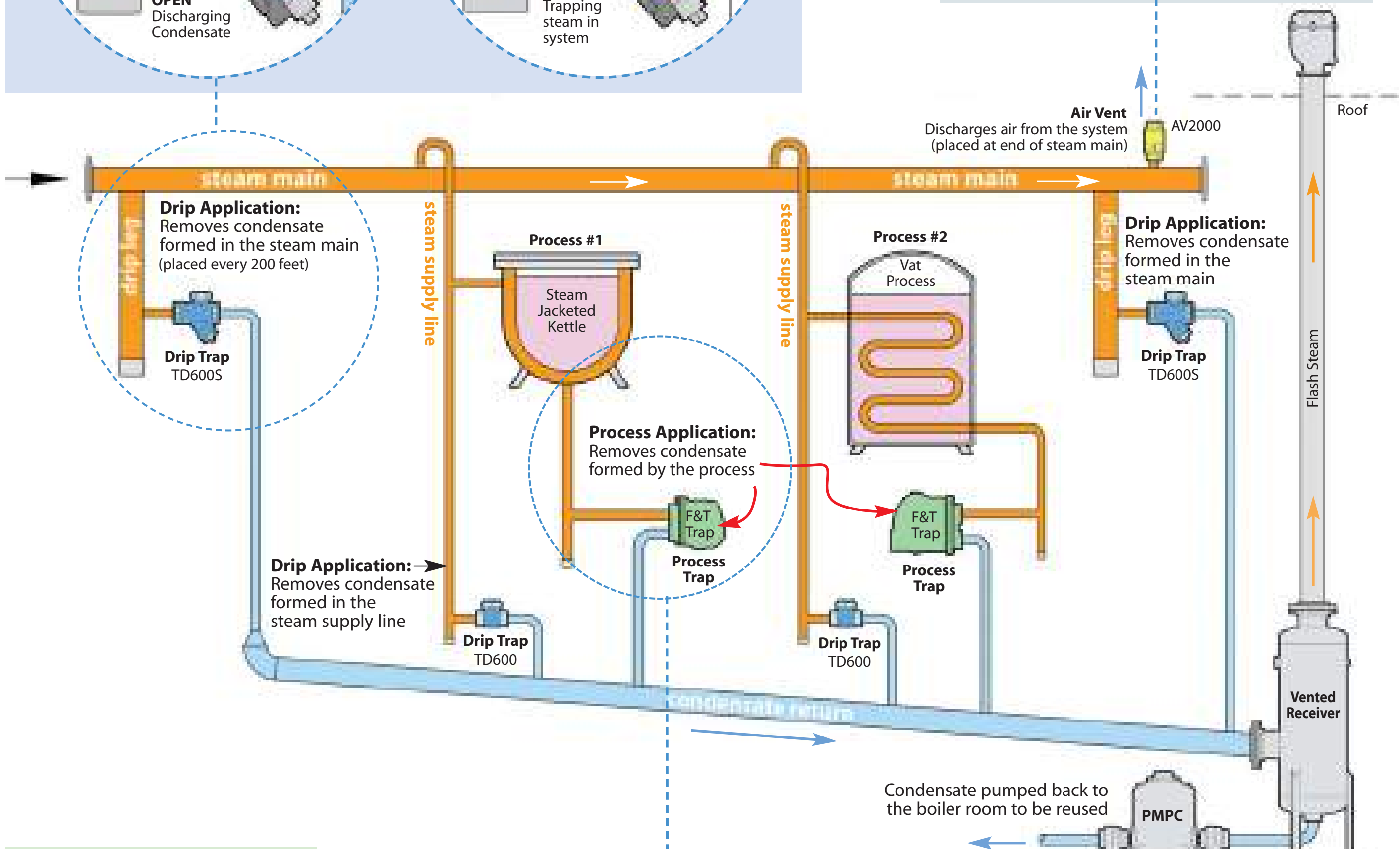
DRIP APPLICATION:

Drip applications refer to **removing the condensate that forms in the steam pipes** as opposed to condensate that forms at the actual process. It is appropriate to have steam traps (drip traps) placed 150 to 300 feet apart.

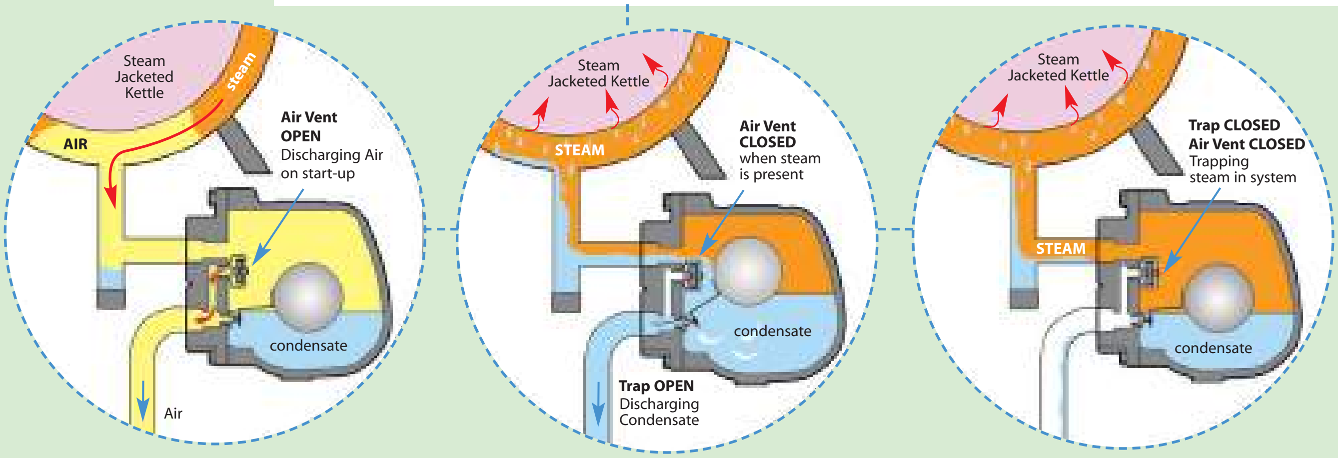


AIR VENT: Placed at the end of steam mains and other high points in order to remove air from the system.





PROCESS APPLICATION:



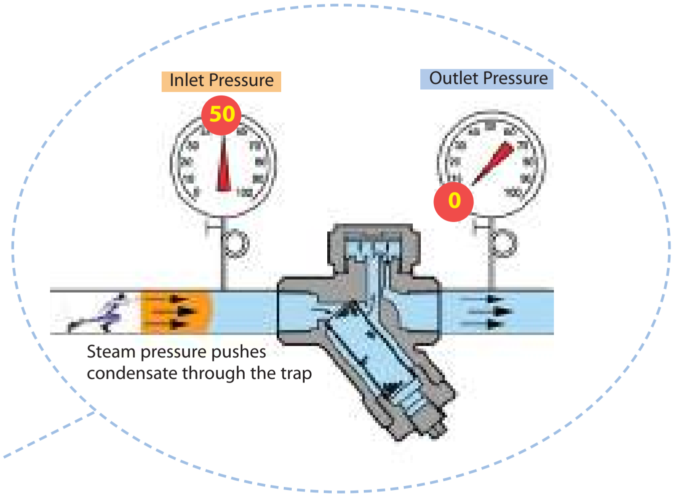
Process Applications refer to **removing condensate and air from the actual process** where steam is being used. This process could be a heat exchanger making hot water, or a radiator heating a room, or anything else that requires the use of steam. Traps used for process applications require larger condensate handling capability than steam traps used for drip applications and also need to be able to discharge large amounts of air.

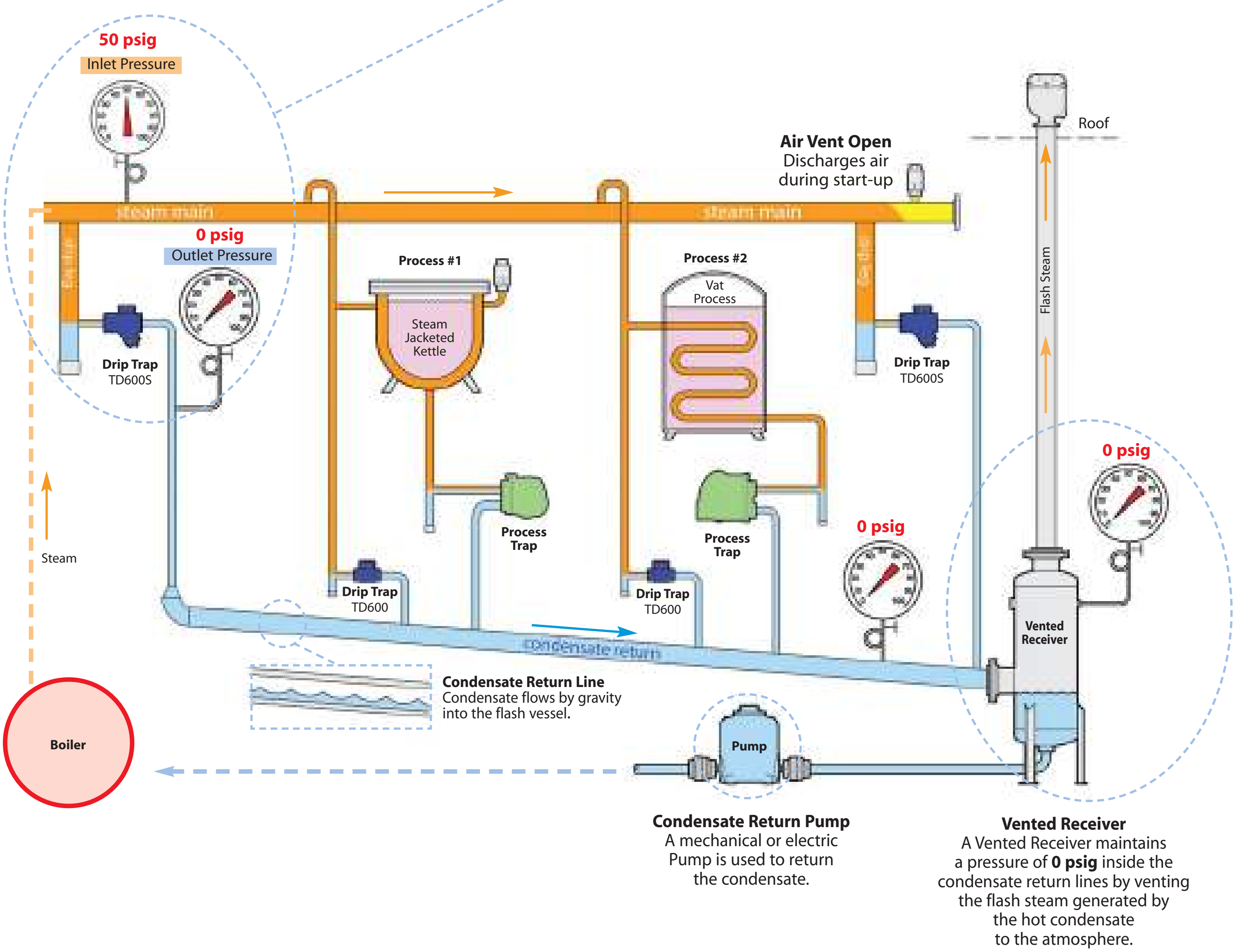
How does condensate flow through steam traps? Steam Pressure *pushes* the condensate through the trap.

Every steam trap has an **Inlet Pressure** (Steam Supply Pressure) and an **Outlet Pressure**. The difference between inlet & outlet pressure is referred to as the **Differential Pressure**. When the Inlet Steam Pressure is higher than the Outlet Pressure (Positive Differential Pressure), the steam will *"PUSH"* the condensate through the steam trap.

Differential Pressure is an important factor for sizing steam traps as well as other components, such as regulators and control valves. The higher the Inlet Pressure in relation to the Outlet Pressure, the more condensate the trap can remove from the steam system. The trap capacity is therefore a function of the differential pressure across the trap.

Inlet Pressure (Steam)	–	**Outlet Pressure** (Condensate)	=	**Differential Pressure**
50 psig	–	**0.0 psig**	=	**50 psi**



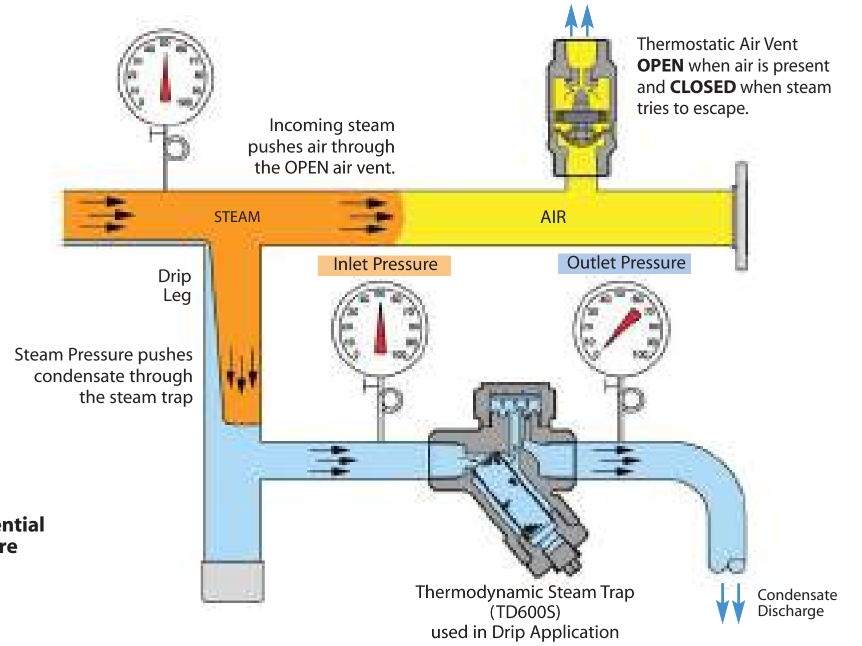


Operation of a Steam System

DRIP APPLICATION using a Thermodynamic Trap: Removing condensate from steam mains & steam supply lines

Drip applications refer to removing the condensate that forms in the steam pipes (due to heat losses) as opposed to condensate that forms at the actual process. It is appropriate to have "Drip traps" placed 150 to 300 feet apart in the steam pipe line, and at any abrupt changes in direction or elevation. Air discharges through the separate air vent located at the end of the steam line.

The Steam Trap discharges the Condensate & the Air Vent purges the air.



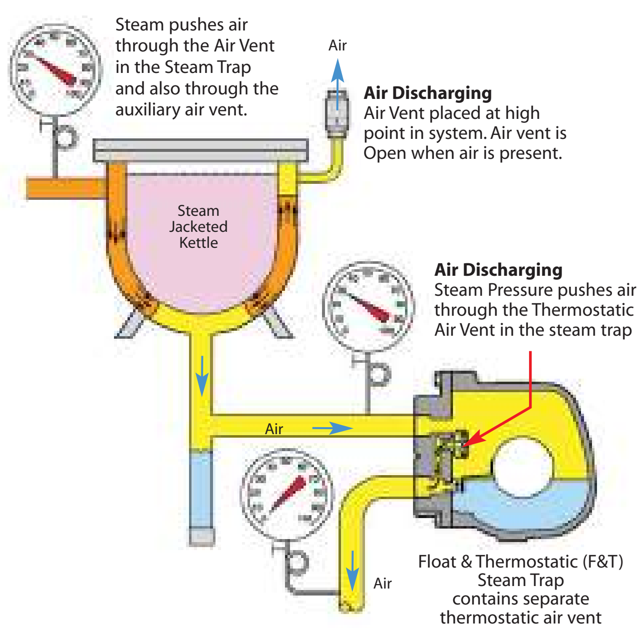
Inlet Pressure (Steam)	–	Outlet Pressure (Condensate)	=	Differential Pressure
50 psig	–	**0.0 psig**	=	**50 psi**

PROCESS APPLICATION using a Float & Thermostatic (F&T) Trap: Removing condensate and air from a steam jacketed kettle

Start-Up – Air discharging from system

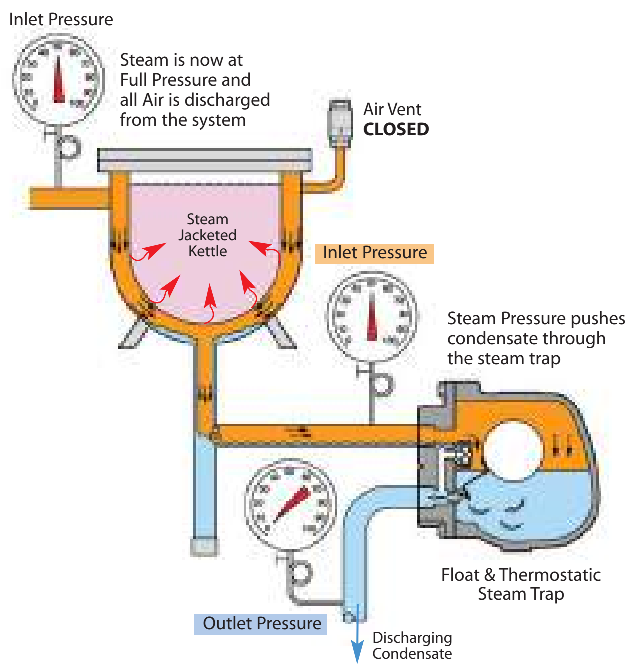
Air that entered the system during system shut-down must be purged so that steam may enter. Float & Thermostatic steam traps contain a separate thermostatic air vent for discharging air during system start-up.

Note: Additional air vents may be installed on the process or other high points in the system.



Operation – Condensate discharging from system

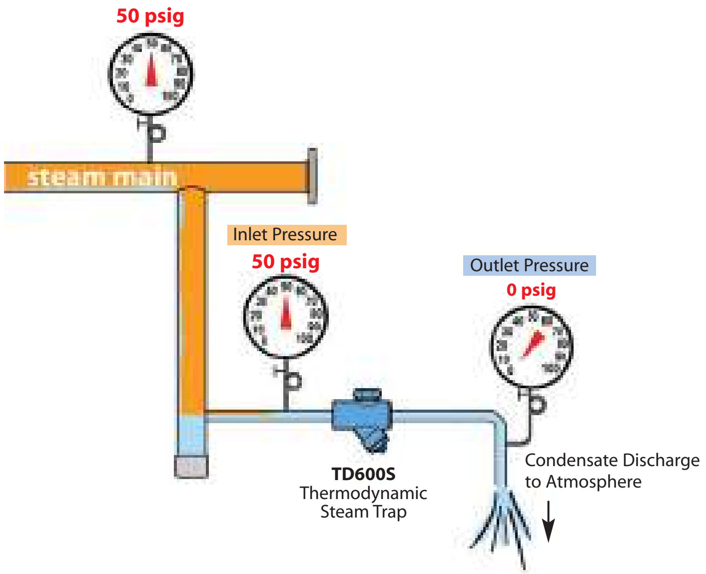
Steam now fills the jacket at full operating pressure, heating the contents of kettle. Steam is condensing and the steam pressure in the kettle is being relied upon to push the condensate through the steam trap and into the condensate return line.



Typical Ways Steam Traps are Installed ... and how this affects the differential pressure.

Depending on the installation of the steam trap, the pressure at the outlet of the trap can vary significantly. It is important to understand the trap Outlet Pressure as this will affect the differential pressure used for sizing and selecting the appropriate steam trap. Furthermore, there could be instances where steam supply pressure to the inlet of the trap is insufficient to "push" the condensate into the return line. The following diagrams show: **1)** discharging condensate to atmosphere, **2)** discharging condensate into gravity return line, and **3)** discharging condensate into an elevated and/or pressurized return line.

1) Discharging Condensate to Atmosphere:



Steam Pressure "pushes" the condensate through the steam trap allowing it to discharge out of the system (0 PSIG)

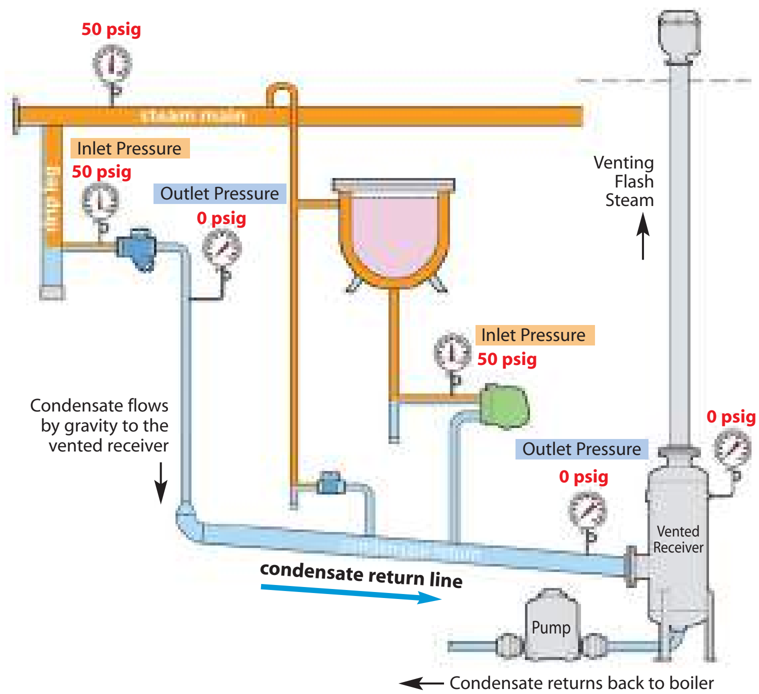
Discharging condensate to atmosphere is often done in larger facilities when it may not be cost-effective or practical to install long lengths of condensate return lines back to the boiler.

Inlet Pressure: The Pressure in the steam main. In our case, **50 psig**

Outlet Pressure: Since we are discharging steam trap to atmosphere, **0.0 psig**

Inlet Pressure (Steam)	–	**Outlet Pressure** (Condensate)	=	**Differential Pressure**
50 psig	–	**0.0 psig**	=	**50 psi**

2) Discharging Condensate to Gravity Return Line (Connected to Vented Receiver):



Steam Pressure "pushes" the condensate through the steam trap allowing it to discharge into gravity return line (0 PSIG)

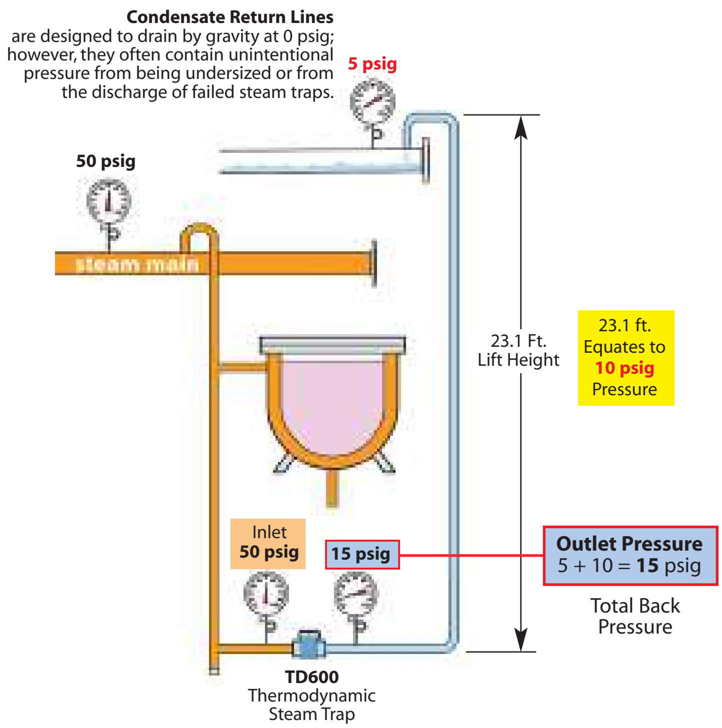
It is always preferable to drain condensate in the direction of gravity to a condensate return line which leads into a vented receiver for condensate collection. In most situations the vented receiver vents to atmosphere, and is therefore at a pressure of 0.0 psig.

Inlet Pressure: The Pressure in the steam main. In our case, **50 psig**

Outlet Pressure: Since the steam trap is being discharged to a properly sized condensate return line that leads to a vented receiver, we assume **0.0 psig**

Inlet Pressure (Steam)	–	**Outlet Pressure** (Condensate)	=	**Differential Pressure**
50 psig	–	**0.0 psig**	=	**50 psi**

3) Discharging Condensate into an Elevated and/or Pressurized Return Line:



Steam Pressure "pushes" the condensate up through an Elevated return line (15 PSIG)

Total Back Pressure (Outlet Pressure) is the Sum of Condensate Return Line Pressure + Equivalent Lift Height Pressure

Discharging condensate upward against gravity is the least desirable scenario; however, in certain instances, it may be the only solution possible. Since condensate must be "lifted" to an elevation, it adds additional back-pressure to the discharge (outlet) side of the trap. For this example the condensate return line pressure is **5 psig.** We first need to calculate Lift Height Pressure :

Lift Height Pressure = **Height x 0.433**
= 23.1 Ft. X 0.433
= **10 psig**

Inlet Pressure: Pressure in the steam main.
= **50 psig**

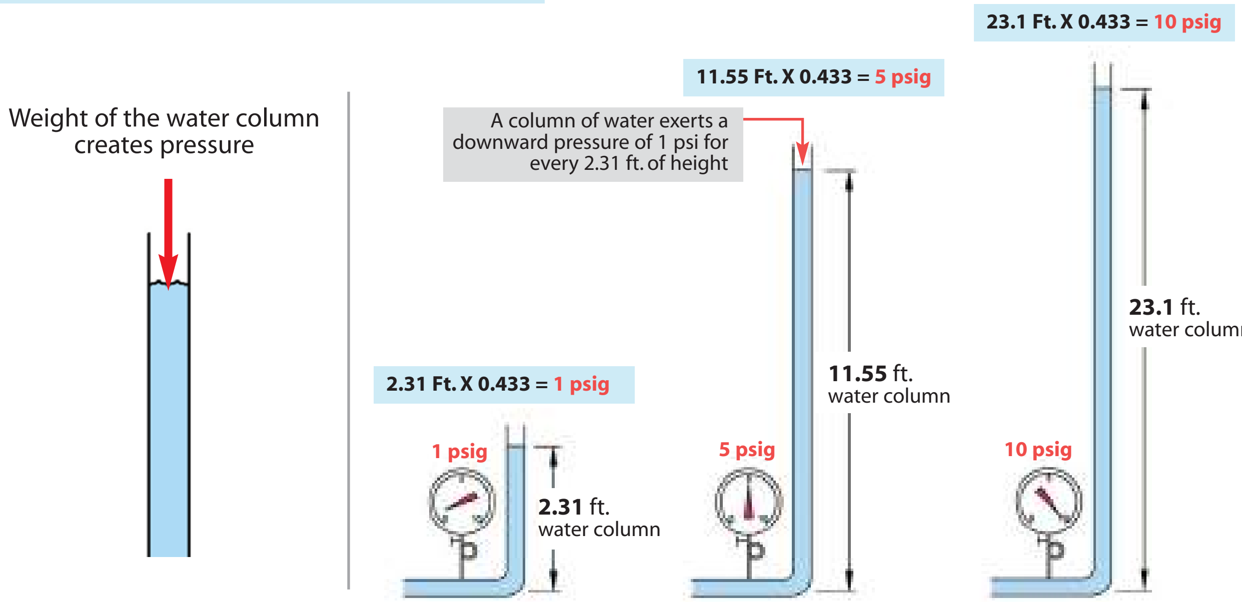
Outlet Pressure: Since we are discharging steam trap to a pressurized and elevated condensate return line, we need to add condensate return line pressure (5 psig) to lift height pressure (10 psig)
= **15 psig**

Inlet Pressure (Steam)	–	**Outlet Pressure** (Condensate)	=	**Differential Pressure**
50 psig	–	**15 psig**	=	**35 psi**

Calculating Lift Pressure

A column of condensate in vertical piping results in additional pressure at the outlet of the steam trap.
By knowing the height of the condensate return line, the pressure of this column can be easily calculated as follows:

Lift pressure (psig) = **Lift height** (ft) **x 0.433** (psig/ft)

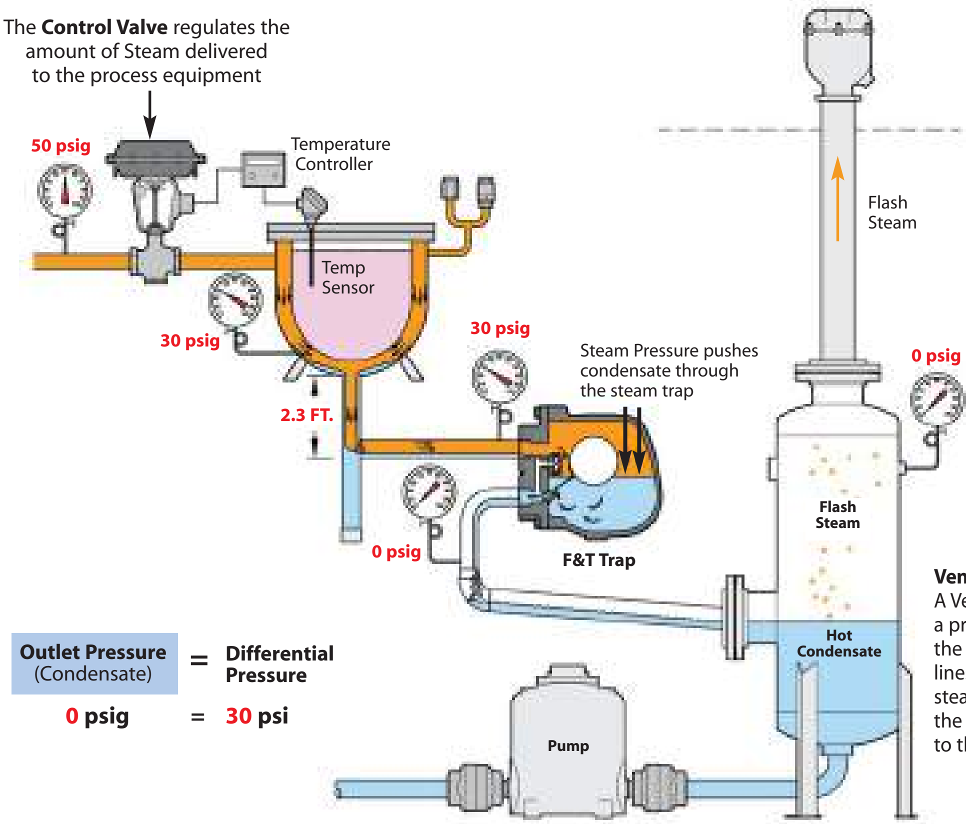


Steam Trap Installed after a Control Valve ... which can cause wide variations of trap inlet pressures and condensate loads.

The flow rate and the steam pressure in the jacketed kettle is determined by the temperature control valve. When the process fluid in the jacketed kettle reaches the desired set temperature, the control valve reduces the flow of steam which, in turn, reduces steam pressure. The Steam pressure can drop down to 0 psig or below (to sub-atmospheric pressures) to maintain just the correct amount of steam flow to keep the kettle at the exact set temperature.

With the varying amount of steam that is sent to the process, the amount of condensate that is generated also varies. If the steam demand is high for a given period, more condensate is generated after the steam is used. When there is a low steam demand, less condensate is generated.

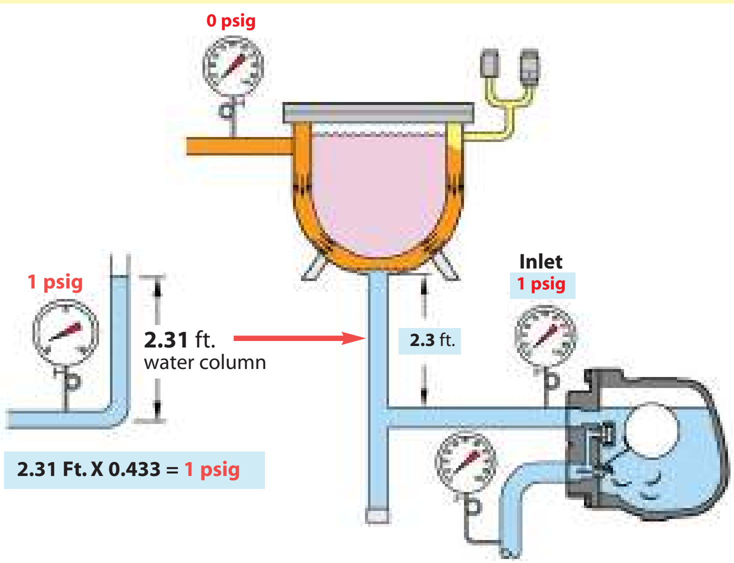
The appropriate steam trap selected for process applications must be able to adjust to varying condensate loads without oversizing, and have the capability to remove air from the system.



Inlet Pressure (Steam)	–	Outlet Pressure (Condensate)	=	Differential Pressure
30 psig	–	**0 psig**	=	**30 psi**

Vented Receiver
A Vented Receiver maintains a pressure of **0 psig** inside the condensate return lines by venting the flash steam generated by the hot condensate to the atmosphere

Why the Steam Trap needs to be placed a minimum distance below Jacketed Kettle



When set temperature of the process fluid is reached, the steam pressure inside the jacketed kettle may reduce to 0 PSIG or even go into Vacuum. To promote condensate drainage, the steam trap is placed a certain distance below the process equipment.

2.3 ft. will provide **1 psig** of condensate head pressure. As long as the trap discharges into a gravity return line (at 0 psig), there will be **1 psi** differential pressure and condensate may freely drain.

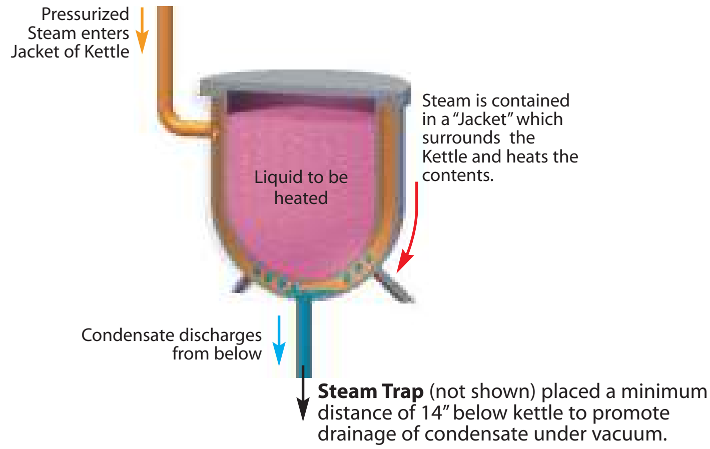
Pressure = Column Height x 0.433 $\frac{\text{psi}}{\text{ft}}$

1 psig = 2.31 Ft. x 0.433

Typical Process Equipment Which Use Steam for Heating

Batch Processes: Steam Jacketed Kettle

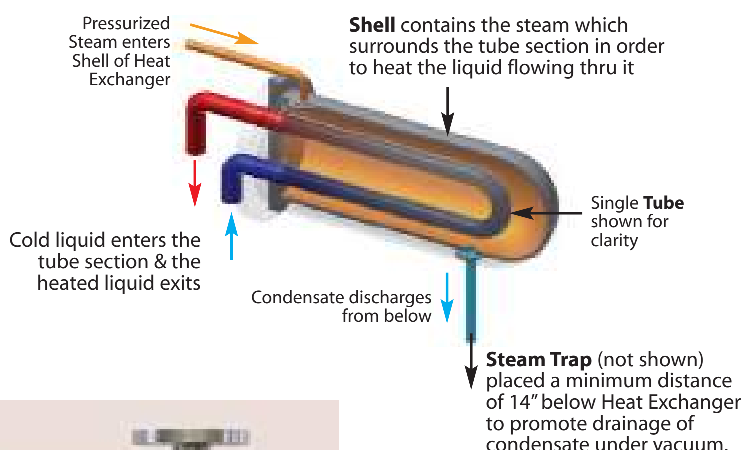
Steam jacketed kettles are used for batch processing and are typically found in commercial food processing facilities. A steam jacketed kettle contains a liquid to be heated surrounded by an isolated jacket containing the steam (steam does not contact the fluid). Steam enters the kettle and its heat is then transferred to the liquid through the jacket wall and the condensate is discharged out the bottom. Steam Pressure to the kettle is controlled by the Steam Supply (Control) Valve. The steam trap is placed a minimum distance below the kettle to promote condensate drainage when low pressure or partial vacuum exists in the jacket of the kettle (14" is equivalent to 1/2 psi of head pressure).



Continuous Process: Shell & Tube Heat Exchangers

Shell & Tube Heat Exchangers are used for continuous processes such as heating a continuous flow of water or other liquid. The Shell & Tube heat exchanger contains multiple tubes inside to optimize heat transfer to the process. In the majority of applications, the process liquid goes through the inside of the tubes and the steam surrounds the outside of the tubes and is contained within the shell area. The condensate that is formed from the condensed steam is discharged out of the bottom through a steam trap. Steam Pressure to the heat exchanger is controlled by the Steam Supply (Control) Valve. The steam trap is placed a minimum distance below the heat exchanger to promote condensate drainage when low pressure or partial vacuum exists in the shell of the heat exchanger (14" is equivalent to 1/2 psi of head pressure).

Tube Bundle of a Shell & Tube Heat Exchanger



Shell & Tube Heat Exchanger

Batch Process Application: Jacketed Kettle ... from Start-Up to Reaching Temperature Set Point

Let's take a detailed look at a **batch process** application using a control valve to heat the contents of a Jacketed Kettle to a specific temperature. Steam will enter the jacket to indirectly heat the kettle contents through a metal wall.

The condensate load and pressure drop across the steam trap varies because the control valve will open and close in response to the temperature of the contents inside of the kettle. As the valve opens and closes, the **steam pressure and steam flow in the jacket** will vary, affecting the differential pressure across the steam trap and condensate load requirements. A Float & Thermostatic steam trap is the primary choice for the majority of process applications because of its ability to quickly adjust to changing condensate loads, as well as having the capability to discharge air from the system.

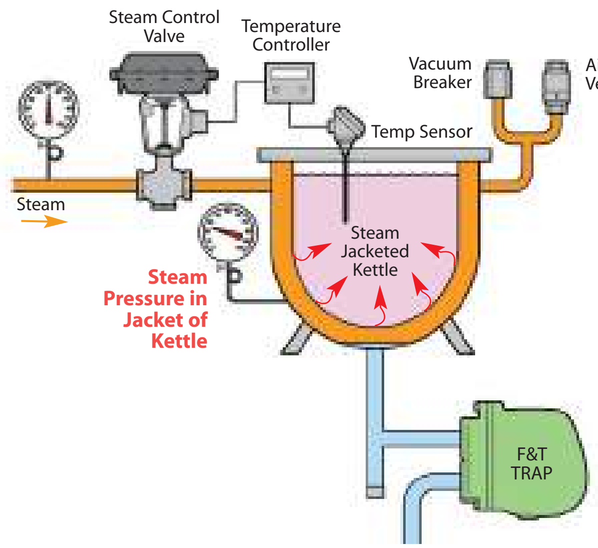
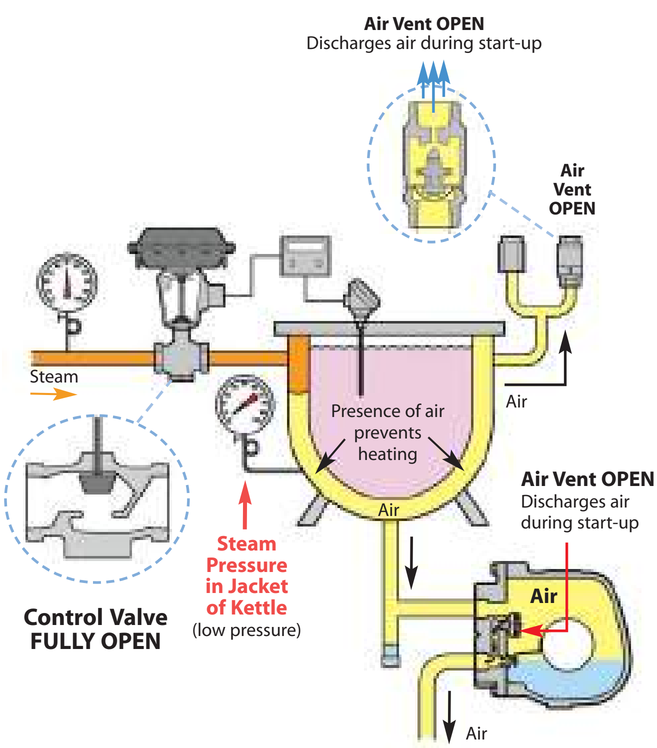


DIAGRAM 1:

Start-Up (Air Vents Open)

On start-up, jacket is filled with air which must first be discharged by the Air Vents to allow steam to enter for heating. Float & Thermostatic steam traps contain a separate thermostatic vent, and can discharge large volumes of air present during system startup. Additional air vents may be installed on the kettle. The faster air is expelled, the faster steam can enter and heating can begin.

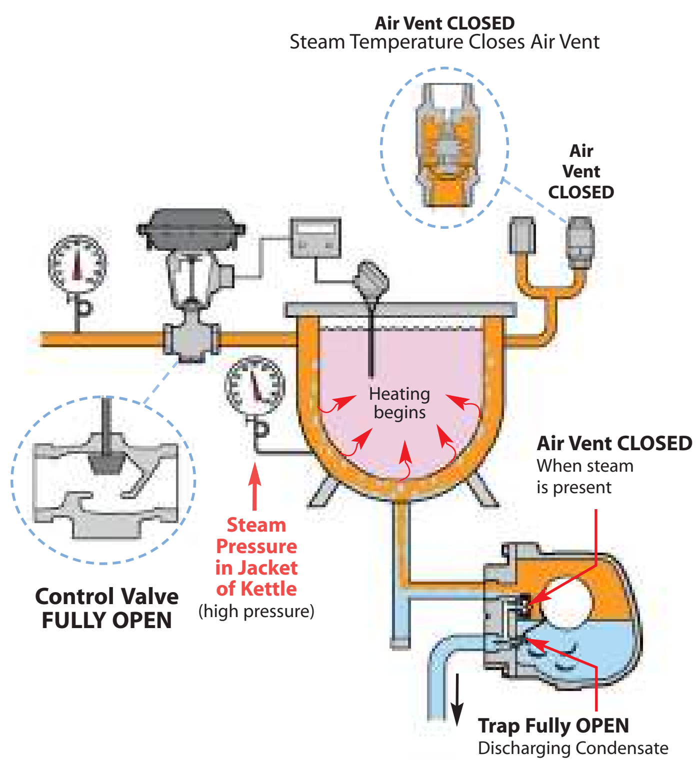


Air Discharging from Process on Start-Up

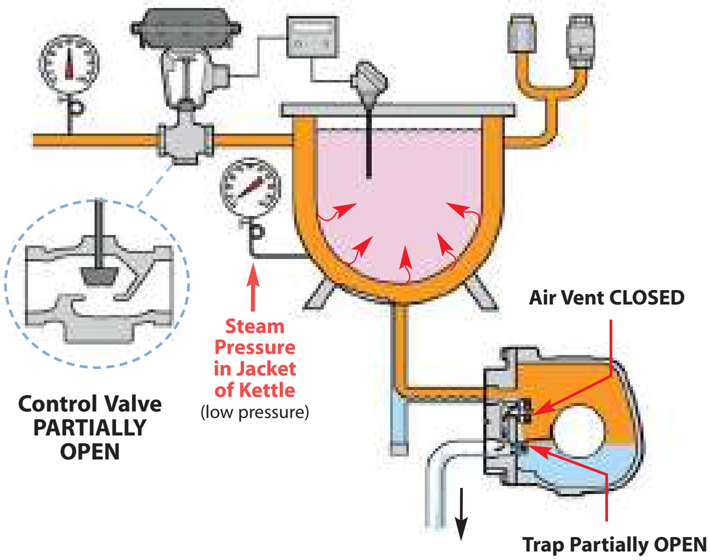
DIAGRAM 2:

Steam Enters (Trap Fully Open; Air Vents Closed)

Once the air has been discharged, steam can fill the jacket. Since the kettle is cool, the control valve will open to allow as much steam as possible to fill the jacket and begin heating the contents in the kettle. The steam trap must adjust to the high condensate load as the steam is entering and building pressure.



Temperature of Steam causes Air Vents to Close



Process Liquid is nearing Set Temperature

DIAGRAM 3:

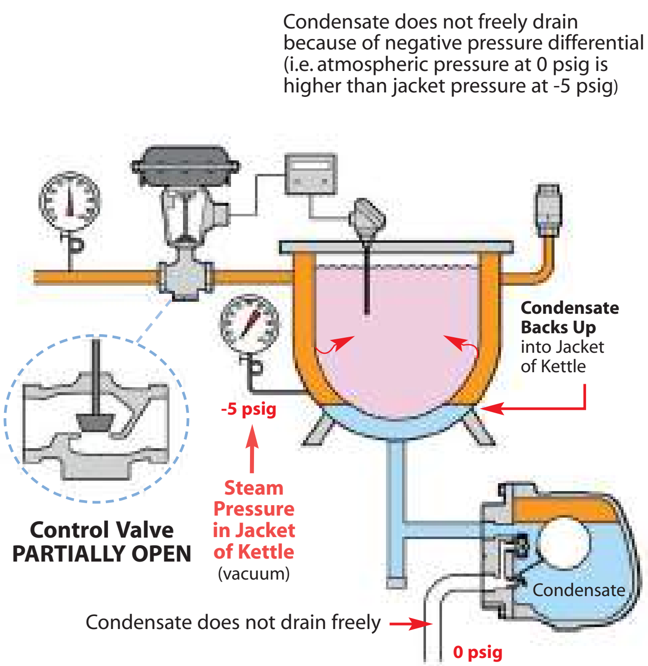
Nearing Set Temperature
(Trap Partially Open)

As the temperature of the kettle contents nears set point, less steam will be required and the control valve will modulate toward a partially open position. As this happens, steam pressure decreases in the jacket and therefore the pressure differential across the steam trap will likewise decrease. The steam trap will then adjust to the lower condensate flow generated.

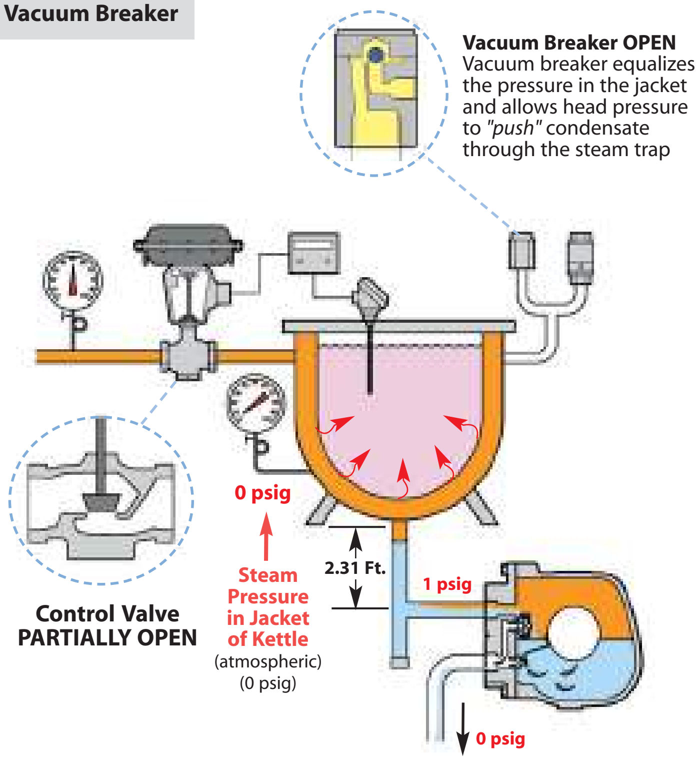
DIAGRAM 4:

Temperature Set Point Achieved **(Steam Flow Reduced; Since Only Required to Maintain Temperature)**
Once the set temperature is achieved, a significantly less amount of steam is required to maintain the temperature of the product inside the jacketed kettle. The steam supply valve will modulate to a near shut-off condition, dropping the pressure, and the kettle may be operating in vacuum. This action will impede the discharge of condensate as the pressure in the jacket will be less than atmospheric. Therefore, a vacuum breaker is required to allow air to enter the jacket and equalize the pressure. This then allows drainage of condensate through the steam trap by gravity.

System *without* **Vacuum Breaker**



System *with* **Vacuum Breaker**



Continuous Process Application: Shell & Tube Heat Exchanger

Let's take a detailed look at a **continuous process** application using a control valve on a Heat Exchanger to heat a variable flow rate of water to a constant temperature. Cold water enters the Heat exchanger and hot water is discharged at an elevated temperature.

The condensate load and pressure drop (differential pressure) across the steam trap are not constant. Therefore, it is important to select a steam trap that can handle high condensate loads at very low pressure drops, without significantly oversizing the steam trap during normal operation.

A temperature control valve will modulate between an open and closed position to deliver the proper amount of steam to a heat exchanger to maintain the outlet water at a desired temperature. During this process, the steam pressure in the heat exchanger will vary depending on the flow rate of heated water produced. *The higher the flow rate of water – the higher the steam pressure in the heat exchanger will be. Conversely, when water flow is reduced, steam pressure is reduced.*

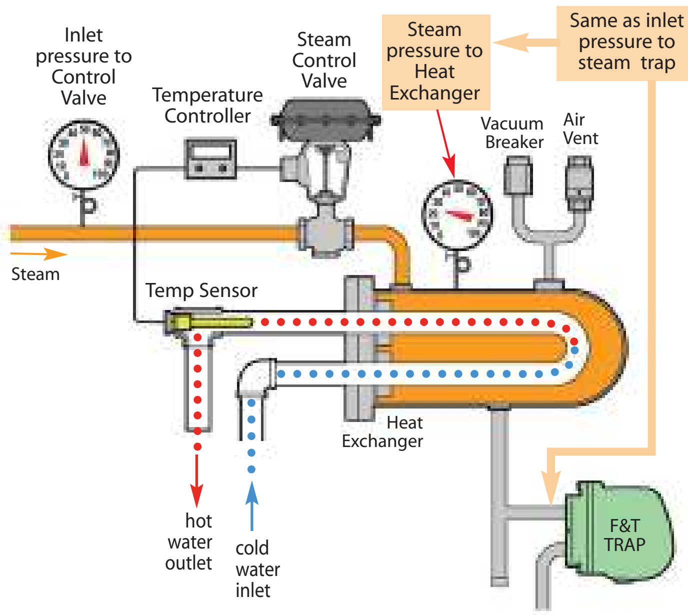


DIAGRAM 1:

Start-Up (Air Vents Open)
On start-up, heat exchanger is filled with air which must first be discharged by the Air Vents to allow steam to enter for heating. Float & Thermostatic steam traps contain a separate thermostatic vent, and can discharge large volumes of air present during system startup. Additional air vents may be installed on the heat exchanger. The faster air is expelled, the faster steam can enter and heating can begin.

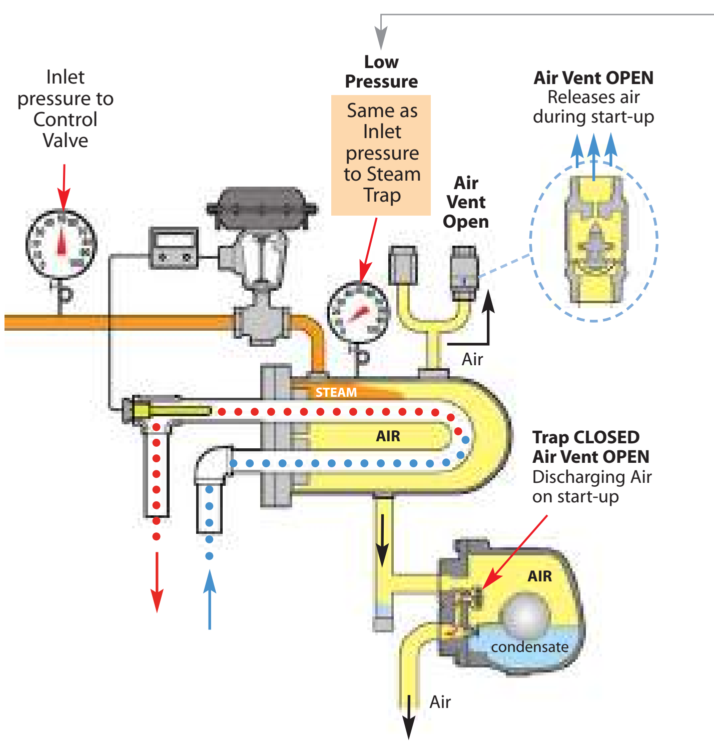


DIAGRAM 2:

Steam Enters (Trap Fully Open; Air Vents Closed)
Since the water temperature is cold, the control valve is fully open to allow as much steam as possible to fill the heat exchanger. The steam trap must adjust to the high condensate load as the steam is entering and building pressure. This steam pressure in the shell of the heat exchanger pushes the condensate through the steam trap and into the return line.

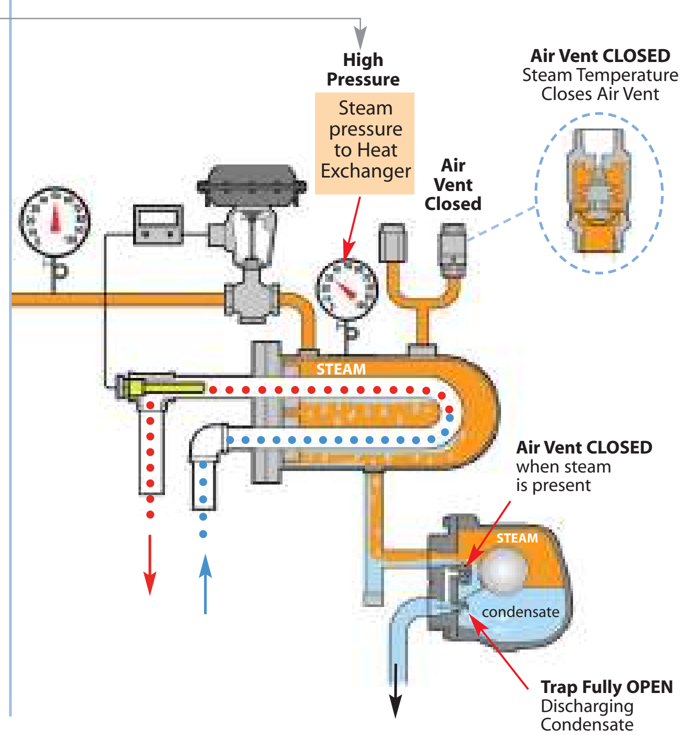


DIAGRAM 3:

Typical Running Load

The temperature control valve will automatically adjust the flow of steam (lbs/hr) to coincide with the flow rate of heated water (GPM). The higher the flow rate, the higher the steam pressure will be. The steam pressure in the shell of the heat exchanger is indirectly determined by the amount of water flowing through the heat exchanger. The steam (lbs/hr) turns into condensate (lbs/hr) and is discharged through the steam trap.

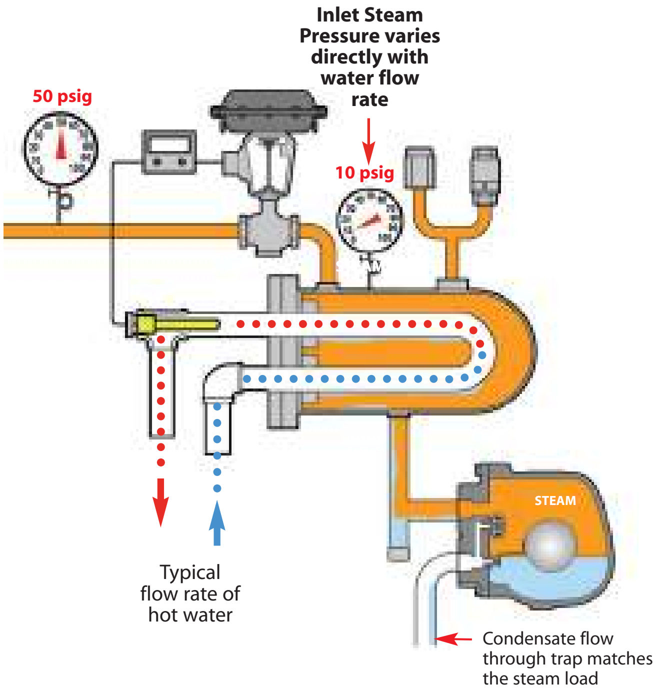


DIAGRAM 4:

High Running Load

When a high flow rate of heated water is required, the control valve will open accordingly to allow more steam (lbs/hr) and steam pressure (psi) to enter the heat exchanger. During times of high water usage, there will also be a significant increase in the condensate load (lbs/hr), as well as higher steam pressure in the shell of the heat exchanger. This high pressure steam will push the condensate through the steam trap.

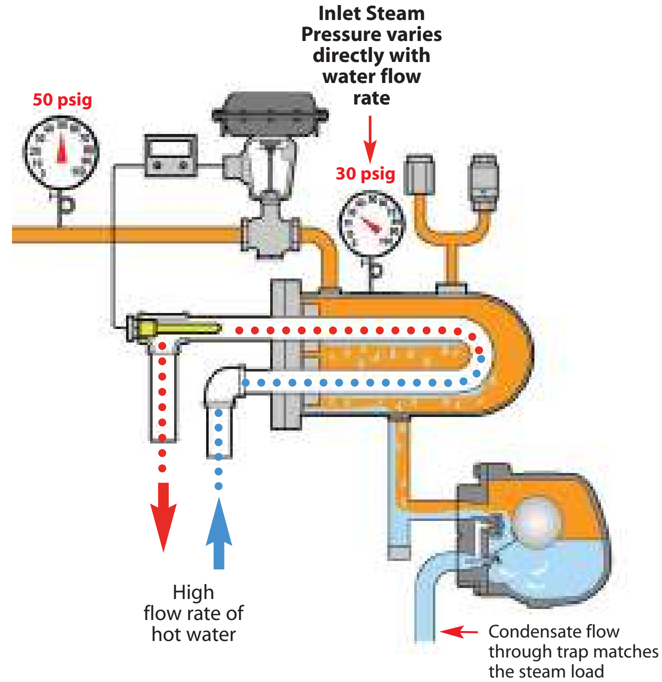
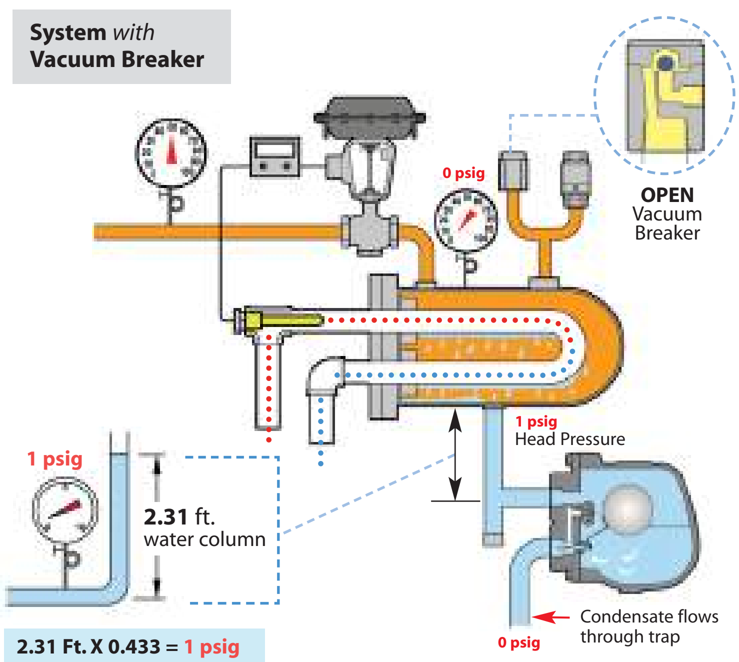


DIAGRAM 5:

Low Running Load

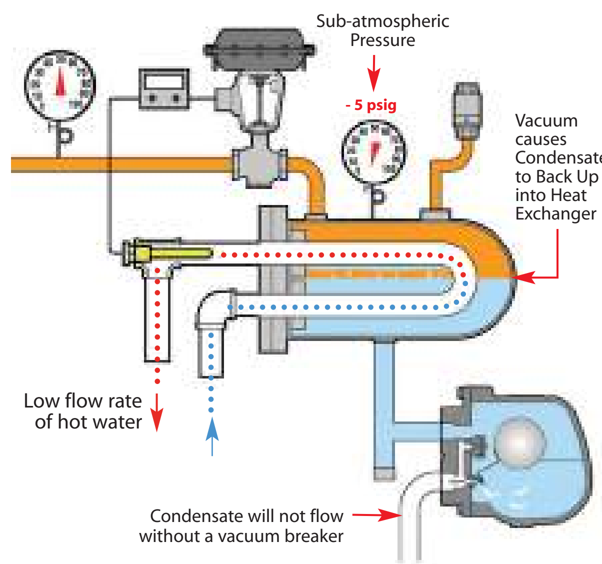
When the demand for hot water is low, the steam control valve will adjust accordingly, allowing just enough steam to heat the reduced flow of water. The pressure in the shell of the heat exchanger will go into vacuum, preventing discharge of condensate. Therefore, a vacuum breaker is used to allow air to enter the shell and equalize the pressure, allowing drainage of condensate through the steam trap by gravity.

System *with* Vacuum Breaker



2.31 Ft. X 0.433 = 1 psig

System *without* Vacuum Breaker



Steam Traps

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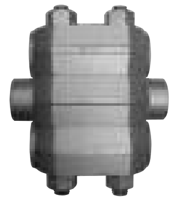
TD600


TD600S


TD700S


TD900S

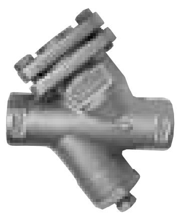

TD3600

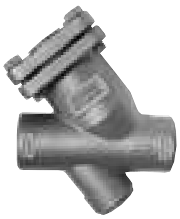
Thermodynamic


WT1000


WT2500


W2000


WT3000

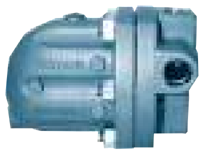

WT4000


WT5000

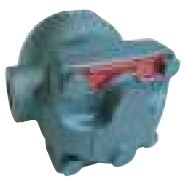

TA/TS

Thermostatic


FT


FT600 & FT601


FTE & FTES


FTT


WFT

Float & Thermostatic

Steam Traps
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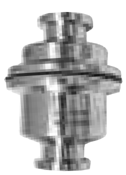
Stainless Steel


Cast Iron





The **FM / FSM Series Manifolds** are used for steam distribution to the tracing system and for condensate collection.

Steam Trap Selection Guidelines

Steam Traps for Drip Applications: "Drip traps"

Drip applications refer to draining condensate that forms in distribution piping as steam is transported from the boiler to where it is to be used. Eliminating this condensate protects valves and piping from wiredrawing and water hammer Because condensate loads tend to be low, steam traps with smaller orifices are typically selected for extended service life. It is reasonable to consider a single trap that can operate over a wide pressure range in order to simplify selection and reduce inventory. Other factors to consider when selecting drip traps: materials, repairability, efficiency, reliability, installation orientation, personal preference/experience, as well as the trap's ability to handle freezing climates, superheated steam, or pipe scale and debris.

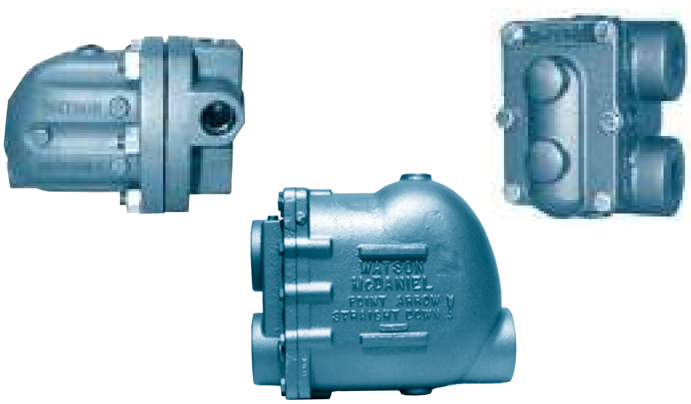
Steam Traps for Tracing Applications: "Tracing Traps"

Tracing Applications refer to using steam to elevate the temperature of a product, process, or piece of equipment by using tubing or some type of jacketing device filled with steam. These applications are commonly used to promote flow of heavy fluids or prevent pipelines and equipment from freezing. The relatively small traps used for these applications are referred to as "Tracing traps". A Non-Critical Tracing application may benefit from a thermostatic steam trap which sub-cools and backs up some condensate - an adjustable bimetal trap offers additional temperature control. Thermodynamic traps are ideal for Critical Tracing applications where condensate back-up is not permitted.

Steam Traps for Process Applications: "Process Traps"

Process applications refer to draining condensate from the actual process using the steam. These require steam traps with relatively high condensate capacity. In the majority of process applications, it is important to discharge air present in the system during start-up so the steam can quickly enter the system. Although separate air vents can be used for this purpose, it makes sense to select a trap which has air venting capability, in addition to discharging varying condensate loads. The trap must have enough capacity to discharge the condensate even when the differential pressure across the trap is low. These low pressure conditions commonly occur in process heating applications where control valves are used to regulate the flow of steam into the equipment. However, if the trap is significantly oversized it may cause it to wear out more quickly and allow steam to pass into the condensate return. The most common trap type for process applications is the Float & Thermostatic style.

Most Common Types of Steam Traps



Most Common Use:

Process Applications from low pressure HVAC models for residential heating to Industrial cast steel and stainless steel models for Chemical and Petro-Chemical plants up to 450 PSI. Suitable alternative for drip applications to 200 psig.

F&T (Float & Thermostatic) Traps:

Float & Thermostatic Steam Traps contain a float-operated valve to continually discharge condensate and a thermostatic air vent which discharges air. Body materials available are Cast Iron, Ductile Iron, Cast Steel, & Stainless Steel for pressures up to 450 psig. *(F&T traps are referred to as mechanical traps.)*

Typical Applications: F&Ts are the most commonly used trap for both batch type processes and continuous process applications with rapidly changing pressures and loads.

Advantages: F&Ts quickly respond to load and pressure changes, discharge large amounts of air present at start-up which allow steam to quickly enter the system, continuously discharge condensate as it forms and offer a wide range of capacities for any process application.

Other Factors to Consider: F&Ts narrow operating pressure ranges require more care during selection. Since they are not self-draining, they are subject to freezing. Trap body must be installed vertically for proper operation.

Steam Trap Selection Guidelines

Most Common Use:
General service drip & tracing applications above 30 psig, as well as high-pressure drip applications with superheat.

Thermodynamic Traps:

The Thermodynamic Trap is simple and compact with a single moving part (disc) which opens to discharge condensate and closes in the presence of steam. Body materials available are Stainless and Alloy Steels for pressures up to 3,600 psig.

Typical Applications: Widely used on higher pressure drip applications and critical tracing applications (where condensate back-up is not permitted).

Advantages: Rugged design, operation is easy to check due to distinct cyclic operation, relatively small with lower capacities, single model operates over wide pressure range in contrast to mechanical traps, excellent for superheated steam, self-draining when mounted vertically to prevent freezing.

Other Factors to Consider: Limited air venting, wet climates can increase cycle rates, sensitive to excess back pressure, blast discharge may not be preferred in some systems

Most Common Use:
Industrial style Thermostatic Traps are extremely versatile. Their use can range from general service drip & tracing applications to small-to-medium batch process heating applications.

Thermostatic Traps:

A Thermostatic Trap contains a heavy-duty, industrial-purpose welded stainless steel thermal element designed to control condensate discharge by sensing the temperature difference between steam and cooler condensate. Body materials available are Cast Iron, Stainless and Alloy Steels with thermal element designs available for pressures up to 650 psig. The WPN Series Bi-metallic design will handle presssures up to 2,260 psig.

Typical Applications: Extremely versatile and energy efficient, these traps are suitable for a wide range of applications. Thermal element designs are suitable for applications ranging from general service drip and tracing applications to small-to-medium batch style processes. Bi-metal designs can be used in high pressure, superheated drip applications or in lower pressure tracing applications.

Advantages: Self-draining when mounted vertically to prevent freezing, single model operates over wide pressure range in contrast to mechanical traps, small and compact with similar capacities to larger mechanical traps (F&Ts & IBs), superior air venting capabilities, welded stainless steel thermal element and bimetal elements are extremely rugged, moderate discharge due to reduced flash steam, choose between fail-open or fail-closed bellows.

Other Factors to Consider: Some condensate back-up can be expected, thermal element design not recommended for superheated applications.

Most Common Use:
Used on drip applications where excessive dirt and debris may be of significant concern. They can serve as alternatives to F&T's in process applications where air venting is not required by the steam trap.

Inverted Bucket Traps:

The Inverted Bucket Trap uses an inverted bucket as a float device to control the opening and closing of the plug and seat to discharge condensate. Body materials available are Cast Iron and Stainless Steel for pressures up to 450 psig. *(IB traps are referred to as mechanical traps.)*

Typical Applications: These traps have a discharge orifice positioned at the top of the trap body which make them ideal for drip applications on systems containing excessive pipe scale and debris. They may be considered for process applications where air venting is less of a concern or handled by a separate air vent.

Advantages: Rugged and simple design, top-mounted discharge orifice less susceptible to failure from dirt and debris, service life often exceeds other style traps.

Other Factors to Consider: Limited air venting capabilities, can lose its prime causing it to fail, narrow operating pressure ranges require more care during selection, not self-draining therefore subject to freezing, single position installation, fixed orifice on bucket allows small steam leakage, physical size can be large and require additional support.

DRIP Applications • Sizing a Trap for Draining a Steam Main

Drip applications refer to the removal of condensate formed in steam lines due to the radiant heat loss of the hot steam pipes to surrounding air and are required for the protection of the steam system. (Drip Traps remove the condensate from the steam lines where the process traps remove condensate being generated by the actual process.) Drip traps should be placed 150 to 300 feet apart on straight runs of piping, before elevation changes, and before critical equipment such as Regulators and Control Valves. See description below of typical drip leg configurations.

Why Condensate Safety Load Factors and Warm-up Loads need to be considered:

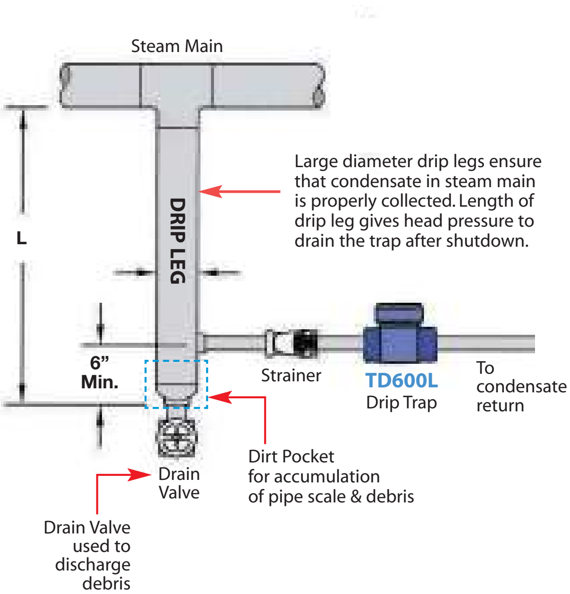
During start-up, when the piping system is cold and steam begins to flow thru the pipes, steam is condensing very quickly because of the energy required to heat all the cold surfaces. Furthermore, the steam pressure in the system which is required to push the condensate through the steam trap into the return line, is low before the system comes up to full pressure. Therefore, condensate is being generated at a maximum rate and the steam pressure used to push the condensate out of the system is at a minimum. If the traps are sized for the normal running loads and normal system pressures, then they would be undersized for the start-up condition.

In a supervised start-up, condensate drain valves located throughout the system, are manually opened to drain excessive condensate generated by the cold piping system; relying less on the steam traps. Therefore, the steam traps selected for a system with a supervised start-up can be more closely sized for the actual normal running load.

Drip Leg in a Steam Main

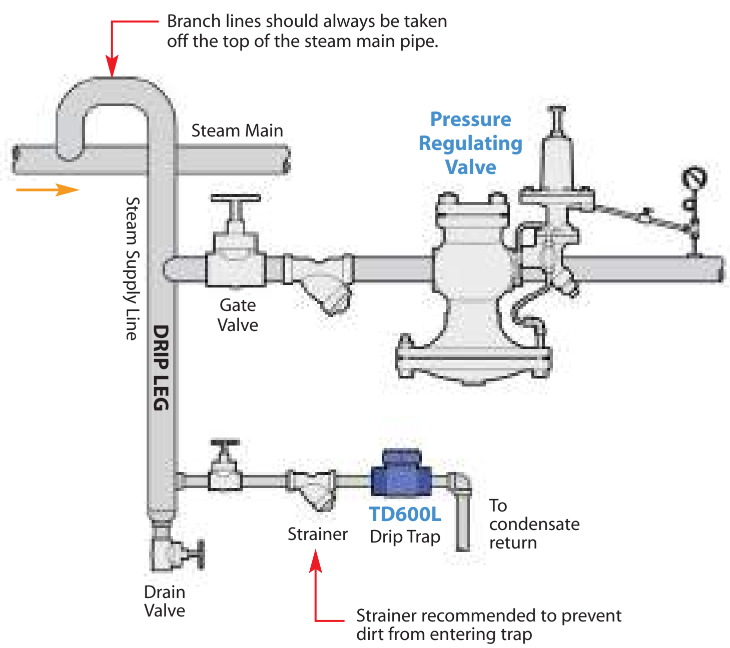
Drip Leg Design Criteria:

- For systems with automatic start-up, L to be 28" minimum (= 1 PSI minimum head pressure)
- Drip leg diameter should be equal to steam main diameter (up to 4" in size)



Drip Leg Before Regulator or Control Valve

Drip Legs should be installed directly ahead of regulators and control valves to minimize erosion to valve trim and flooding of valve bodies.



Steam Trap Selection Guidelines • DRIP Applications

Sizing Example: Size a drip trap for an 8” steam main with 100 psig steam pressure. Traps should be placed every 200 ft. A 2x safety factor based on Warm-Up load will be used.

- Based on Warm-Up Load Chart: **100 lbs/hr** of condensate is generated per 100 feet length of pipe.
- Warm up load for 200 ft. length is therefore, **200 lbs/hr** (2 x 100 lbs/hr)
- If a 2x safety factor based on warm-up load is used, we require a trap with a capacity of **400 lbs/hr**
- Actual running load for 100 ft. length = 41 lbs/hr
- Actual running load for 200 ft. length = **82 lbs/hr**

Warm-Up Loads in Pounds of Condensate per hour per 100 ft. of Steam Main

Outside Temperature at 70˚F

Steam Pressure (PSIG)	Pipe Size 2”	2 1/2”	3”	4”	5”	6”	8”	10”	12”	14”	16”	18”	20”	24”	0˚F Correction Factor †
20	8.4	13.4	17.5	24.9	33.8	44	66	93	124	146	191	241	284	396	1.37
60	11.0	17.5	22.9	32.6	44	57	86	122	162	192	250	316	372	518	1.29
100	12.8	20.3	26.6	37.8	51	67	100	142	188	222	290	366	431	600	1.26
125	13.7	21.7	28.4	40	55	71	107	152	200	238	310	391	461	642	1.25

Running Loads in Pounds of Condensate per hour per 100 ft. of Steam Main

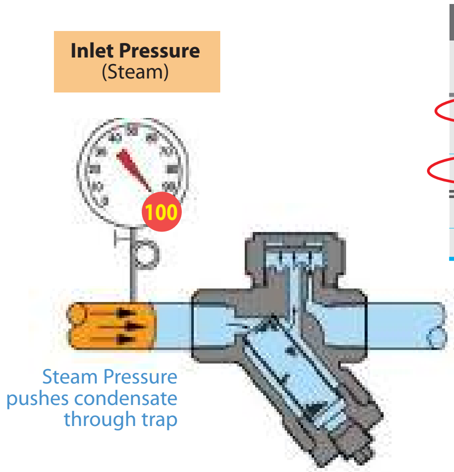
Outside Temperature at 70˚F

Steam Pressure (PSIG)	Pipe Size 2”	2 1/2”	3”	4”	5”	6”	8”	10”	12”	14”	16”	18”	20”	24”	0˚F Correction Factor †
20	8	9	11	14	17	20	26	32	38	42	48	51	57	68	1.50
60	10	12	14	18	24	27	33	41	49	54	62	67	74	89	1.45
100	12	15	18	22	28	33	41	51	61	67	77	83	93	111	1.41
125	13	16	20	24	30	36	45	56	66	73	84	90	101	121	1.39

† For outdoor temperatures of 0˚F, multiply load value selected from table by correction factor shown.

Trap Selection: Reference the TD600S Series Capacity Chart below based on inlet steam pressure. Enter the chart under 100 psig inlet pressure to compare the capacities of different models.

The 1/2” TD600LS will be capable of discharging 375 lbs/hr of condensate at 100 psig steam pressure. The capacity is slightly less than the load calculated based on warm-up load with 2x safety factor, however, this trap selection would be a suitable choice since its capacity is well in excess of what is actually required. These loads are indicative of drip applications and lend support as to why only reduced capacity 1/2" TD600L or 3/4" TD600L traps are required for the majority of drip applications.



CAPACITIES – *Condensate (lbs/hr)*

Size	Model Code	Steam Inlet Pressure (PSIG) 3.5	5	10	15	20	25	30	40	50	75	100
1/2”	TD600LS-12-N	180	185	190	195	200	215	220	230	250	310	375
1”	TD600LS-14-N											
3/4”	TD600LS-13-N	300	315	350	380	415	440	470	515	580	710	825
1/2”	TD600S-12-N	300	315	350	380	415	440	470	515	580	710	825
3/4”	TD600S-13-N	415	430	475	520	565	610	650	720	825	1020	1185

Drip Applications

The trap models in the chart below are for drip applications for the protection of steam mains and steam supply lines. When traps listed below are installed every 200 feet, they will have adequate capacity to handle typical warm-up loads in properly insulated 8" steam mains. See Warm-up Load Chart in Engineering Section. Several models listed will handle steam mains considerably larger than 8". Steam pipe size, the distance between traps, insulation quality, ambient temperatures and start-up conditions should all be considered. Consult factory if additional guidance is required.

Thermodynamic

Model	Size

30 PSIG

30 to 150 PSIG

Non-Repairable	
TD600L & TD600LS	1/2" 3/4"

Repairable	
TD700S	1/2" • 3/4"

Universal Quick-Change	
UTD450LSM	

150 PSIG

150 to 600 PSIG

Non-Repairable	
TD600L & TD600LS	1/2" 3/4"

Repairable	
TD700HS	1/2" 3/4"

Universal Quick-Change	
UTD600LSM	

600 PSIG

600 - 900

Repairable	
TD900S TD900LS (Light Loads)	1/2", 3/4"

900 PSIG

Float & Thermostatic

Model	Size

0 to 125 PSIG

Parallel Pipe Connection (Cast Iron)	
WFT-125 PMO=125	3/4"

In-Line Pipe Connection (Ductile Iron)	
FTT-145 PMO=145	1/2" • 3/4"

Universal Quick-Change	
UFT450-145 PMO=145	

125 PSIG

125 to 225 PSIG

In-Line Pipe Connection (Ductile Iron)	
FTT-225 PMO=225	1/2" • 3/4"

Universal Quick-Change	
UFT450-225 PMO=225	

225 PSIG

NOTE:
The WFT-125, FTT-145 and FTT-225 have adequate capacity for draining steam mains and steam supply lines.

For pressures below 65 PSI, the WFT-075 or the FTT-065 can be used if a larger discharge orifice and increased capacity is required.

Thermostatic

Model	Size

0 to 650 PSIG

Repairable (Cast Iron)	
WT2501 (Limited to 250 PSI)	1/2" 3/4"

Non-Repairable (Stainless Steel)	
WT2001	1/2" 3/4"

Repairable (Stainless Steel)	
WT3001	1/2" 3/4"

Universal Quick-Change	
UT450 (Limited to 450 PSI)	

650 PSIG

Inverted Bucket

Model	Size

0 to 150 PSIG

Cast Iron	
IB1031-150 PMO=150	1/2" 3/4"

Stainless Steel	
SIB150 PMO=150	1/2" 3/4"

Universal Quick-Change	
USIB450-150 PMO=150	

150 PSIG

125 to 250 PSIG

Cast Iron	
IB1032-250 PMO=250	1/2" • 3/4"

Stainless Steel	
SIBH-250 PMO=250	1/2" • 3/4"

Universal Quick-Change	
USIB450-250 PMO=250	

250 PSIG

NOTE:
IB Models up to a PMO of 250 shown above, have adequate capacity for draining steam mains and steam supply lines.

On lower pressure systems, models with lower PMO ratings can be used if a larger discharge orifice and increased capacity is required.

Steam Trap Selection Guidelines • DRIP Applications

Thermodynamic

The Thermodynamic Disc (TD) Steam Trap is simple and compact and one of the primary choices for drip applications over 30 psig. The TD600 Series with integral one piece body-seat design, are the most economical and commonly used for pressures up to 600 psig. The 1/2" & 3/4" TD600**L** will meet the capacity needs of most drip applications ("S" models have integral strainers). The TD600 Series cannot be welded in-line. The TD700S & TD900S Series are both in-line repairable and can be welded into the pipeline.

TD600L

TD600LS

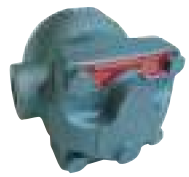
TD700S

TD900S

Fully In-line Repairable

Float & Thermostatic

The Float & Thermostatic (F&T) Steam Trap is the primary choice for process applications. However, for drip applications, they can be effectively used for pressures up to 125 psig on the WFT Series & 225 psig on the FTT Series; for higher pressures, the larger body sizes required make F&T traps a less economical and desireable solution for drip service. The 3/4" WFT-125, or 1/2" & 3/4" FTT-225 will meet the capacity needs of most drip applications. Other PMO (maximum operating pressure) ranges available. For drip applications, select a PMO that meets or exceeds the maximum pressure in the main steam distribution piping.



FTT
In-line Pipe Connection

WFT
Parallel Pipe Connection

Thermostatic

Thermostatic Steam Traps are extremely versatile and can be used on a wide variety of applications from general service drips to small-to-medium batch type processes. Using a welded stainless steel thermal element to control condensate discharge, these traps allow condensate to subcool, making them extremely energy efficient. As a result, the condensate discharged generates less flash steam which reduces back pressure build-up in condensate return lines. A single model will operate from 0 to 650 psig which simplifies selection. The WT2001, with stainless steel body and non-repairable design, is the most commonly used. The WT3001 and WT2501 have the same internals as the WT2001, however, their 4-bolt cover allows them to be in-line repairable. The WT3001 has a stainless steel body while the WT2501 is cast iron.

The WPN Series (not shown), uses a bi-metal element suitable for pressures to 2,260 psig, and will handle superheated steam.

WT2501
Repairable
(Cast Iron)

WT2001
Non-Repairable
(Stainless Steel)

Inverted Bucket (IB)

Inverted Bucket Traps are extremely rugged and have a discharge orifice mounted at the top of the trap body, making them less susceptible to failure from dirt and debris when compared to other trap types. The IB models selected are suitable choice for most drip applications.

Stainless Steel

Cast Iron

Universal Quick-Change

The all stainless steel universal style steam traps feature a permanent installation of the universal connector with a 2-bolt mounting arrangement for the universal steam trap module, allowing the steam trap to be removed and replaced in minutes. These Quick-Change Steam Traps should be considered for all drip applications.

- Thermodynamic
- Float & Thermostatic
- Thermostatic
- Inverted Bucket

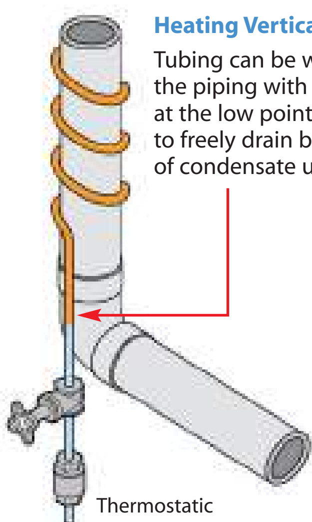
Tracing Applications

Steam tracing refers to using steam to indirectly elevate the temperature of a product or process by using tubing or some type of jacketing device filled with steam. In a typical steam tracing application, stainless steel or copper tubing is filled with steam and is coiled or wrapped around the outside of a pipe or tank containing material that requires heating. The steam inside the tubing transfers its heat to the material in the pipe or tank; to stop it from freezing or to lower its viscosity to allow it to flow more easily. A steam trap is required for tracing to remove the condensate and air from the system. The most common trap choice for tracing applications is the Thermostatic type. Depending on the particular tracing application, it is often desirable to have some amount of condensate backup in the tubing.

Steam Tracing Applications:		Primary Trap Choice	Special Notes
Typical Service:	Some condensate back-up preferable	• Thermostatic	Thermostatic traps are suitable for the majority of steam tracing applications; for critical steam tracing applications, where no back-up of condensate can be tolerated, thermodynamic traps should be used.
Critical Service:	No back-up of condensate permitted	• Thermodynamic	

Heating Vertical Pipelines

Tubing can be wrapped around the piping with a steam trap installed at the low point to allow condensate to freely drain by gravity. Partial back-up of condensate using thermostatic trap.

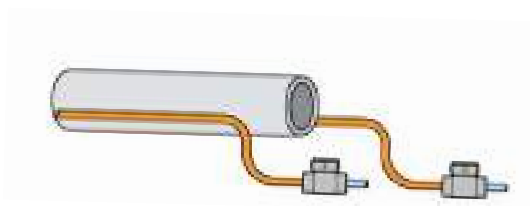


Thermostatic Trap

WT2000 Thermostatic
(5˚F - 10˚F subcool)

Heating Horizontal Pipelines

Tubing should not be wrapped around horizontal pipelines or condensate will collect at low points. After shutdown, condensate retained in the system could potentially freeze. Therefore, tracing tubing should be run parallel to any piping and sloped slightly towards the steam trap to promote condensate drainage.

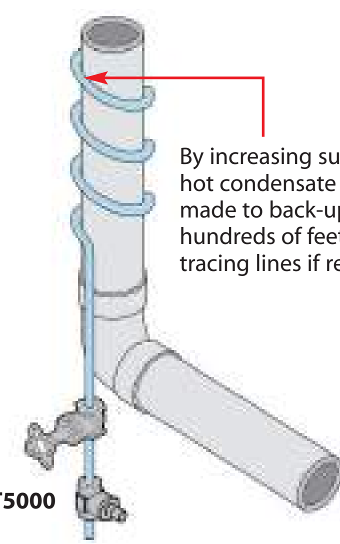


Thermodynamic Traps

TD600

Bi-Metal Steam Trap with Adjustable Discharge Temperature (WT5000)

For applications where overheating of product fluids in a pipeline may be a concern, an Adjustable Bi-Metal Steam Trap, such as the WT5000 (shown), should be considered. The discharge temperature of the condensate can be manually adjusted to control the amount of condensate back-up in the tracing tubing. This technique can be used to control the temperature of the product in the pipeline.



By increasing subcool, hot condensate can be made to back-up into hundreds of feet into tracing lines if required.

WT5000

WT5000 Bi-Metal

Process Steam Trap Selection Guidelines

This guide is intended to provide the user with a "starting point" for the selection of Watson McDaniel steam traps. Steam trap selection can appear to be overwhelming given the range of applications and trap choices available. Selection criteria for a specific application may include pressure & temperature ratings, capacity, physical size & weight, and materials.

Batch Process - Steady Demand

Batch type processes typically have steady demand as a batch of products is heated to a certain temperature. They tend not to experience rapid changes in steam pressure and steam flow. Common examples of such processes are: • **Unit Heaters** • **Storage Tank Coils** • **Jacketed Vessels** • **Pipe Coils**

The primary steam trap type for process equipment is a Float & Thermostatic. The **WFT** & **FTT** Series in Cast Iron and Ductile Iron are the most cost-effective solutions to most applications. The **FTE** Series is for higher capacity applications. The **FT600/601** Series traps are available in Cast Steel or Stainless Steel which may be specified for refineries and higher pressure applications. Since rapid pressure changes do not typically occur with batch processes, Thermostatic Bellows traps can also be selected. The **WT2000**, **WT3000** & **WT4000** Series have Stainless Steel bodies and may be preferred for outdoor applications to Cast Iron F&T traps, particularly when a potential for freezing exists.

Continuous Process - Varying Demand • Heating Processes (high to ultra-high capacity)

These applications use steam to heat a continuous flowing product. The modulation of the control valve results in rapid change in steam pressure and flow. Common examples of such processes are:

• **Heat Exchangers** • **Air Handling Coils** • **Instantaneous Water Heaters**

The primary steam trap type for process equipment is a Float & Thermostatic. The **WFT** & **FTT** Series in Cast Iron and Ductile Iron are the most cost-effective solutions to most applications. The **FTE** Series is for higher capacity applications. The **FT600/601** Series traps are available in Cast or Stainless Steel which may be specified for refineries and for higher pressure applications.

Safety Load Factors (SLF's) and appropriate rules to size steam traps

The largest condensate load occurs when the maximum steam pressure is present in the Heat Exchanger (HX). However, if the steam trap is selected based on the maximum condensate load at maximum pressure, it will not be adequately sized at lower differential pressures. This is because the capacity of a steam trap depends on the differential pressure across the trap (less pressure means less capacity) and trap capacity decreases **at a significantly faster rate** than condensate load when the steam pressure drops. When temperature control valves are used to control steam flow to a HX, the pressure may reduce to 0 psig or less. The pressure available to discharge condensate would then be based on head pressure of the drop leg. A drop leg length of 14" will produce a head pressure of ½ psig.

Use the following rules and safety factors for the three categories of process applications. This should assure the trap has adequate capacity at lower differential pressure and not be drastically oversized when operating at full pressure.

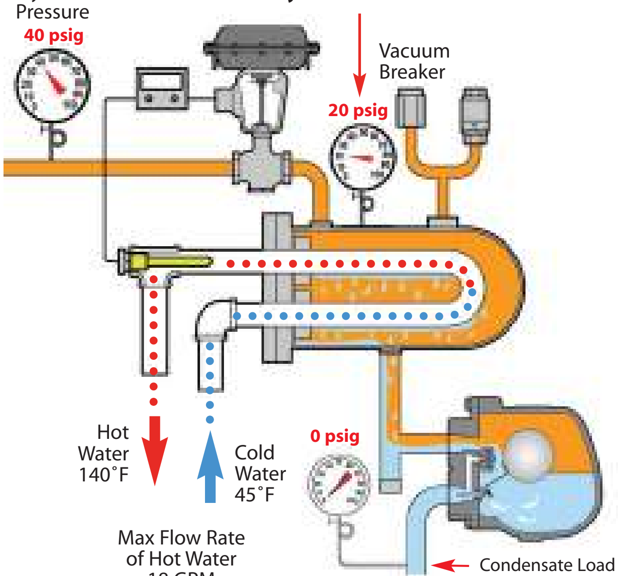
I For applications **NOT** <u>containing a Temperature Control Valve</u> and operate at fairly constant steam pressures; select a steam trap that will handle **2X the maximum condensate load at the maximum differential pressure**.
For Example: if a process will generate 5,000 lbs/hr at 50 psi differential pressure, then choose a trap that can handle 10,000 lbs/hr at 50 psi.

II For applications **WITH** <u>a Temperature Control Valve</u> and steam pressures **OVER 30 PSI**; select a steam trap that will handle **2.5X the maximum condensate load at the maximum differential pressure**.
For Example: if a process is expected to generate 5,000 lbs/hr at 50 psi differential pressure, then choose a trap that can handle 12,500 lbs/hr at 50 psi.

III For applications **WITH** <u>a Temperature Control Valve</u> and steam pressures **UNDER 30 PSI**; calculate the maximum condensate load at the maximum differential pressure; select a steam trap that will handle this **maximum amount of condensate at ½ psi differential pressure**. *For Example:* if a process is expected to generate 5,000 lbs/hr at 15 psi differential pressure, then choose a trap that can handle 5,000 lbs/hr at ½ psi differential pressure. The purpose of the ½ psi differential pressure is to allow condensate to properly drain when system pressure goes into vacuum. This assumes the installation of a vacuum breaker and a drop leg of at least 14" in length (for ½ psig) below the HX to give proper condensate head pressure to the steam trap, and trap discharge to atmospheric pressure (0 psig).

PROCESS Applications • Sizing a Trap for Heat Exchanger Application

Goal: Select appropriate model and size steam trap for Process Water Heating application using a Shell & Tube Heat Exchanger in which a maximum of 18 GPM of water is being heated from 45-140˚F. Steam Pressure to the control valve is 40 PSI. The trap is discharging to a condensate return line at atmospheric pressure (0 psig back pressure)



Example: Conditions of Service at Max Load

- Maximum water load to be heated = **18 GPM**
- Temperature Rise: (140˚F - 45˚F) = **95°F**

1 Calculate Maximum Condensate Load

Using the formula below, to approximate steam load based on water flow rate (GPM) and temperature rise, a Steam Flow of 855 lbs/hr is required; therefore, 855 lbs/hr of condensate will likewise be generated.

$$\text{Steam (lbs/hr)} = \frac{\text{GPM} \times \text{Temp. Rise (˚F)}}{2}$$

$$= \frac{18 \times 95˚F}{2} = 855 \text{ lbs/hr}$$

Steam Flow (lbs/hr) = Condensate Load (lbs/hr)

Condensate (lbs/hr) = 855 lbs/hr

2 Determining the Differential Pressure (ΔP) Across the Trap at the Maximum Condensate Load

In order to size the steam trap, we must first know the pressure in the HX at the Max Condensate Load. This steam pressure is determined by the physical size of the HX. (*note that a larger HX uses lower steam pressure while a smaller HX requires a higher steam pressure to heat the same flow of water*). If the pressure of the HX is not known, assume 50% of the Pressure at the inlet of the control valve is required in the HX to heat the maximum flow of 18 GPM of water. We therefore have (40 psig x 0.5 = 20 psig) **20 psig steam pressure at 855 lbs/hr.**

3 The Condensate Load at 0 psig Steam Pressure and Conditions at other Water Flow Rates

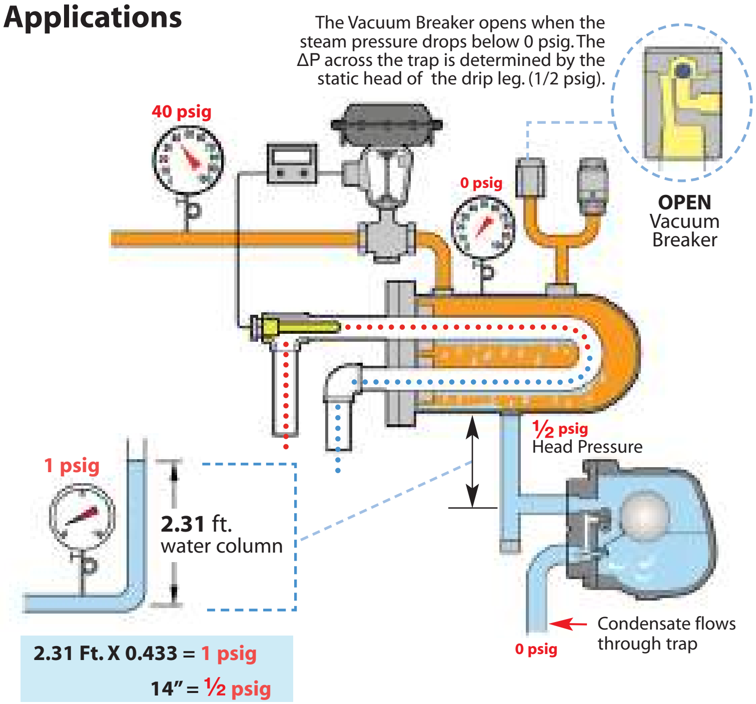
The steam trap cannot be selected solely based the condensate load at the maximum steam pressure because it will be undersized at lower steam pressures (when there is much less force to push the condensate thru the trap). Lower steam pressures occur when less water is being heated. If the steam pressure and condensate load is known at the lowest pressure, the trap can be selected based on that operating point, and it would be adequately sized at higher pressures. In this particular application, we have a gravity return line at 0 psig back pressure.

Load Chart Based on HX Size to Heat 18 GPM of Water using 20 psig Steam Pressure

	Flow Rate Water (GPM)	Steam Flow (required) (lbs/hr)	Steam Temperature (required) in HX (°F)	Steam Pressure (required) in HX (PSIG)	Actual Pressure in the HX (PSIG)	Trap Differential Pressure (PSI)	Condensate Flow (lbs/hr)
At maximum Flow Rate of 18 GPM	**18**	**855**	259	20	**20** steam	**20**	**855**
Flow Rate of Water at 0 psig Steam Pressure	**12.9**	**614**	212	0	**0** steam	**1/2** psi 14" drip leg	**614**
At Flow Rate of 10 GPM of Water	**10**	**475**	185	-6 vacuum	**0** steam & air mixes together	**1/2** psi 14" drip leg	**475**

For this size HX, when water flow rate is 12.9 GPM, the steam temperature required is 212˚F, therefore, the steam pressure is 0 psig. At flow rates below 12.9 GPM, the steam pressure would need to go into vacuum or mix with air drawn in thru the vacuum breaker in order to achieve the proper temperature.

Steam Trap Selection Guidelines • PROCESS Applications



4 Using Safety Load Factors to size Steam Traps

The largest condensate load occurs when the maximum steam pressure is present in the HX. However, if the steam trap is selected based on the maximum condensate load at maximum pressure, it will not be adequately sized at lower differential pressures. This occurs because the capacity of a steam trap decreases *at a significantly faster rate* than condensate load when the steam pressure drops. When temperature control valves are used to control steam flow to a HX, the pressure may reduce to 0 psig or less. The pressure available to discharge condensate would then be based on static head pressure of the drip leg. A drip leg length of 14" will produce a static head pressure of 1/2 psig.

In this application, 614 lbs/hr of condensate is being generated at 0 psig steam pressure. See Load Chart.

The appropriate safety load factor for this application is 2.5X the maximum condensate load of 855 lbs/hr. Therefore, select a steam trap based on:
2.5 x 855 = 2,138 lbs/hr at a differential pressure of 20 psi.

5 Selecting the Steam Trap

The steam trap should be sized for a condensate load of 2.5 x 855 = **2,138 lbs/hr at 20 psi differential pressure.** The HX is assumed to have **20 psig** steam pressure at the maximum water usage of **18 GPM**. However, when selecting the PMO (maximum operating pressure) for the trap, assume the actual pressure could reach nearly the full line pressure of **40 psig**. Therefore, select a trap with a PMO of at least **40 psig**.

Referring to the WFT Capacity chart below, we must select a **WFT-075** model with a PMO of 75 psig. Enter the **20 psi** column inside the **WFT-075** section and scroll down until a condensate load greater than **2,138 lbs/hr** is found. The capacity of **3,850 lbs/hr** is the first condensate load greater than **2,138 lbs/hr**.

For this application, the **WFT-075-15-N** will be capable of discharging the calculated condensate loads of **2,138 lbs/hr** at **20 psi ΔP** and 614 lbs/hr at **½ psi ΔP**.

CAPACITIES – *Condensate (lbs/hr)*

Model Code	PMO (PSIG)	Pipe Size	Orifice Size	Differential Pressure (PSI) 1/4	1/2	1	2	5	10	15	20	30	40	50	75
WFT-015-13-N	15	3/4"	0.250	390	490	620	780	1050	1320	1500					
WFT-015-14-N	15	1"	0.250	390	490	620	780	1050	1320	1500					
WFT-015-15-N	15	1¼"	0.312	610	770	960	1210	1630	2040	2330					
WFT-015-16-N	15	1½"	0.500	1420	1910	2570	3460	5120	6890	8190					
WFT-015-17-N	15	2"	0.625	2260	2950	3860	5040	7170	9360	10930					
WFT-030-13-N	30	3/4"	0.228	330	420	530	670	930	1180	1350	1500	[illegible]			
WFT-030-14-N	30	1"	0.228	330	420	530	670	930	1180	1350	1500	[illegible]			
WFT-030-15-N	30	1¼"	0.228	330	420	530	670	930	1180	1350	1500	1720			
WFT-030-16-N	30	1½"	0.390	930	1240	1650	2190	3210	4280	5060	5700	6750			
WFT-030-17-N	30	2"	0.500	1420	1910	2570	3460	5120	6890	8190	9260	11020			
WFT-075-13-N	75	3/4"	0.166	175	225	295	385	545	705	825	920	1075	1200	1305	1525
WFT-075-14-N	75	1"	0.166	175	225	295	385	545	705	825	920	1075	1200	1305	1525
WFT-075-15-N	75	1¼"	0.312	640	850	1130	1500	2180	2900	3420	3850	4540	5110	5600	6610
WFT-075-16-N	75	1½"	0.312	640	850	1130	1500	2180	2900	3420	3850	4540	5110	5600	6610
WFT-075-17-N	75	2"	0.422	1020	1340	1760	2310	3330	4380	5140	5760	6770	7590	8290	9730

Up to 15 PSI

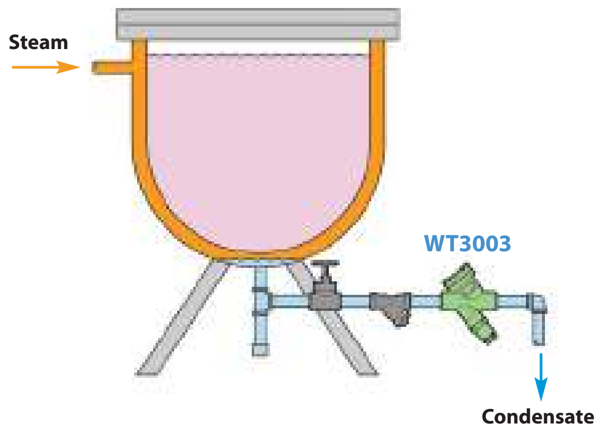
Up to 30 PSI

Up to **75 PSI**

This 3/4" trap can discharge 855 lbs/hr at 20 psi but is drastically undersized at 1/2 psi

1¼" trap is able to handle the condensate load of 614 lbs/hr at 1/2 psi. (see Load Chart to left)

The actual load is only 855 lbs/hr. However, with 2.5X SLFs applied, this larger trap was selected since it has adequate capacity at lower pressures.

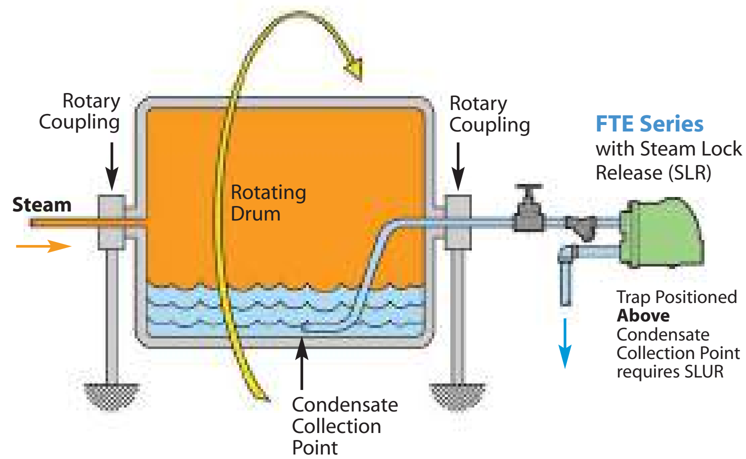


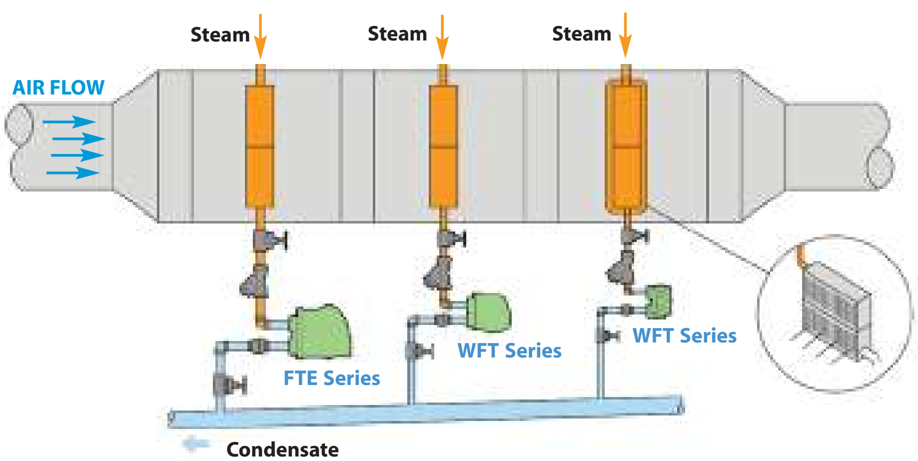
Jacketed Kettle

As the name implies, Jacketed Kettles have a Jacket of Steam surrounding the outside of a Kettle. They are commonly used in the food and beverage industry for indirect heating of the contents in the kettle. This application demonstrates the use of the WT3003 Thermostatic Steam trap. Along with high condensate capacity handling and superior air handling capability, this trap can also operate at higher pressures. An advantage they have over F&T traps is that a single trap model operates over the entire pressure range making them easier to apply and maintain. It is typically recommended to install a thermostatic trap approximately 2 feet from process outlet piping to accommodate some back-up of condensate due to sub-cooling.

Rotating Steam Dryer

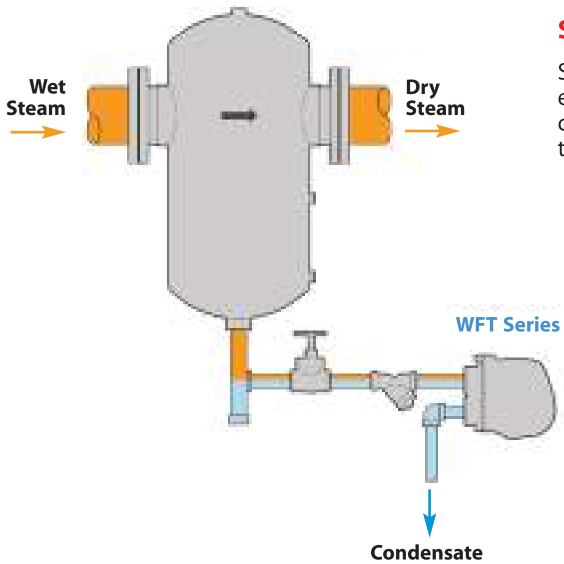
Commonly found in the Paper Making industry, a rotating piece of equipment offers a unique challenge of removing the condensate. Steam inside a rotating drum cylinder is used to heat product such as sheets of paper over the outside surface of the drum. Since the drum is rotating, the trap must be positioned ***above*** the condensate collection point. The steam pressure inside the drum pushes the condensate up through the pipe to the steam trap. If steam enters the tubing, it will "Steam Lock" the trap by causing it to close which in turn causes the condensate to build up inside the rotating drum. Since the pipe line is surrounded by steam, it may take an extended length of time for the steam in the pipe to dissipate. By using the Steam Lock Release feature, a small amount of steam is continually discharged thru the seat, allowing the condensate to continually reach the steam trap. This steam lock release feature is available on ALL F&T and Thermostatic traps and should be considered on this type of application.





Multi-Bank Air Heating Coils / Air Handling Unit (AHU)

For certain Industrial Heating and Drying applications, several Air Heating coils of various sizes may be set up in series to accommodate the process. The heat load of each coil should be taken into account when sizing the steam traps. It's preferable to have a separate steam trap on each individual coil.

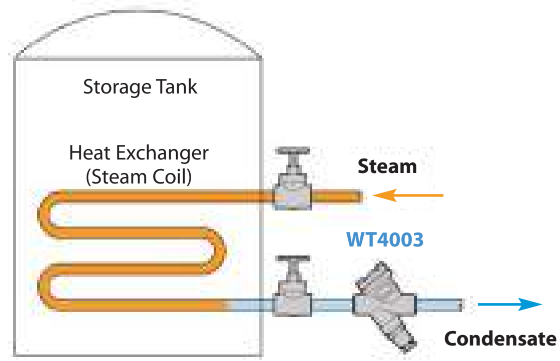


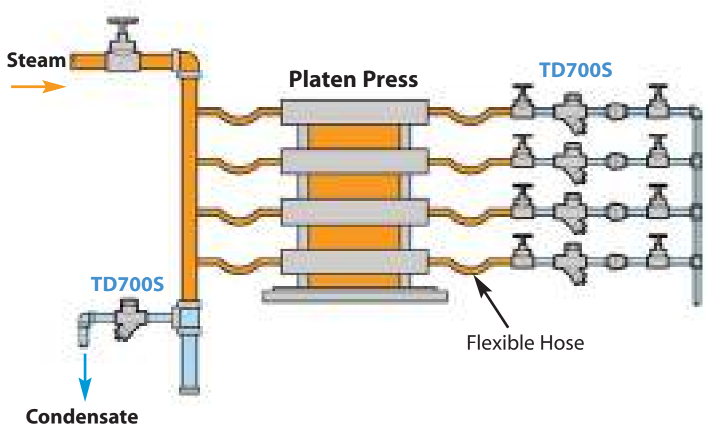
Steam Separator

Separators are used on steam mains and steam supply lines to remove entrained water in the steam. Steam flows through the Separator and the condensate falls by gravity to the bottom where it needs to be discharged through a steam trap. F&T traps are recommended for this application.

Storage Tank Coil

When heating Storage tanks, the heat exchanger may be placed inside the tank. This may be simpler and less expensive than using a pump to circulate the product thru an external heat exchanger. Shown is a WT4000 Series thermostatic process trap removing the condensate. If a small amount of sub-cooled condensate is backed up, it will not adversely affect the process.



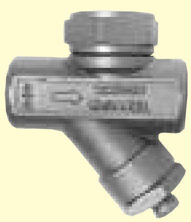
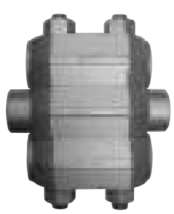


Platens

Platens are extensively used in the molding industry when steam is required to heat the mold, allowing plastics and rubber to be formed into different shapes and sizes. On this particular Process application, a TD700S thermodynamic trap is being used to remove the condensate. Since Air is generally only present during system start-up, and this type of process may run non-stop for extended periods of time, a thermodynamic trap is a potential choice for this application.

Thermodynamic

Model	Body Material	PMO (PSIG)	Sizes	Connections	Page No.
TD600	Stainless Steel	**600**	3/8" – 1"	NPT	**38**
TD600S	Stainless Steel	**600**	1/2", 3/4", 1"	NPT	**40**
TD700S	Alloy Steel	**600**	1/2", 3/4", 1"	NPT, SW, FLG	**42**
TD900S	Alloy Steel	**900**	1/2", 3/4", 1"	NPT, SW, FLG	**44**
TD3600	Alloy Steel	**3600**	1/2", 3/4", 1"	SW, BW, FLG	**46**

		Characteristics	Material	Application
TD600	 No Strainer	The one piece body-seat design is extremely simple, rugged and economical, however, they are not fully in-line repairable. Trap body cannot be welded in-line.	420 Stainless Steel	Most widely used and economical thermodynamic trap for Drip & Tracing Applications **30** to **600 psig**
TD600S	 **Strainer**			
TD700S	 Replacement Capsule Feature	**In-line Repairable** Seat & body are non-integral. Replacement capsule allows for complete repair without removing trap body from piping system. Can be welded in-line.	Alloy Steel	Drip & Tracing Applications **30** to **600 psig**
TD900S		**In-line Repairable** Seat & body are non-integral; allows for complete repair without removing trap body from piping system. Can be welded in-line.	Alloy Steel	Drip Application High-Pressure to **900 psig**
TD3600		**Ultra High-Pressure** 3600 PSIG **In-line Repairable** Can be welded in-line.	Alloy Steel	Drip Application Ultra High-Pressure to **3600 psig**

Introduction

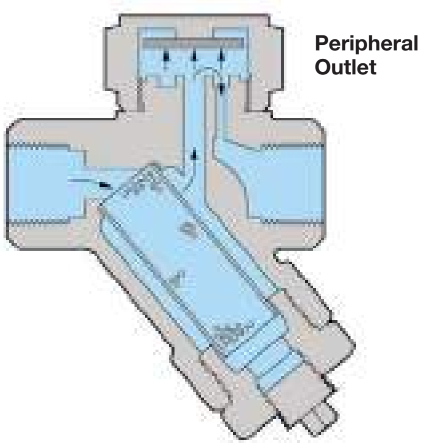
THERMODYNAMIC TRAPS

Thermodynamic traps use only one moving part, the valve disc, which allows condensate to be discharged when present and closes tightly upon the arrival of steam. These traps have an inherently rugged design and are commonly used as drip traps on steam mains and supply lines. Their solid construction and single moving part make them resistant to waterhammer and are freeze-proof when installed vertically. Thermodynamic traps will only discharge small amounts of air and therefore are typically not used in process applications. Since Thermodynamic traps rely on steam velocity to operate, they are not intended for low pressure service (below 30 PSI).

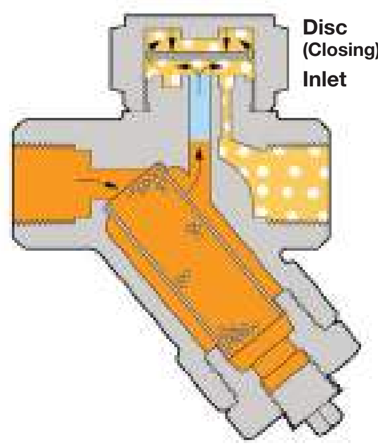
Operation:

The inlet pressure to the trap pushes the disc off the seat and allows unwanted condensate to be discharged through the peripheral outlet surrounding the inlet (**Figure A**). As hot condensate reaches the disc chamber, flash steam is created that travels at high velocity from the inlet to the outlet creating a low pressure area under the disc and higher pressure above the disc (**Figure B**). This differential pressure causes the disc to close against the seat and trap the steam in the system (**Figure C**). The steam pressure above the disc creates a force holding the disc closed. Heat transfer takes place through the cap and the steam pressure above the disc begins to reduce. When the downward force created by the steam pressure above the disc falls below the force created by the incoming condensate, the disc is pushed off its seat and the process repeats itself (**Figure A**). Cycle time is dependent on steam temperature, and more importantly, ambient temperature outside the trap. Since the amount of time the valve remains closed is primarily dependent on the heat transfer from the steam above the disc to the ambient environment, frequent cycling of the valve can occur in cold or wet environments. Applying an insulating cap over the cover of the trap will reduce the cycle rate.

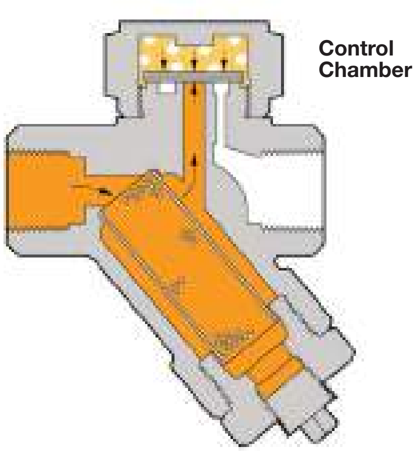
A) Valve Disc (Open)



B) Valve Disc (Starting to Close)



C) Valve Disc (Closed)



Flash Steam

Condensate

Steam

A) When condensate is present, trap remains in the open position allowing condensate to discharge.

B) When steam enters the trap, it creates an internal pressure above the disc that instantly forces the disc and seat to close tightly, preventing steam from escaping.

C) Trap will remain closed, trapping steam in the system until the steam above the disc condenses, due to heat loss through the cap.

Thermodynamic Steam Trap

TD600
Thermodynamic

Model	**TD600, TD600L**
Sizes	**3/8", 1/2", 3/4", 1"**
Connections	**NPT**
Body Material	**Stainless Steel 420F**
Options	**Insulation Cap**
PMO Max. Operating Pressure	**600 PSIG**
TMO Max. Operating Temperature	**800°F**
PMA Max. Allowable Pressure	**600 PSIG up to 800°F**
TMA Max. Allowable Temperature	**800°F @ 600 PSIG**

Typical Applications

DRIP, TRACING: TD600 model steam traps are most commonly used in drip applications, such as draining condensate from steam mains and steam supply lines. They can also be used for steam tracing applications. These traps are suitable for outdoor applications that are subject to freezing as well as superheated steam conditions. They are compact and rugged with only a single moving part. If a trap with an integral strainer is desired, the TD600S is recommended. If a fully in-line repairable design is required, the TD700S or the UTD450 with Universal Quick-Change connector is recommended.

How It Works

The disc is the only moving part inside a thermodynamic trap. When steam enters the trap, it creates an internal pressure above the disc that instantly forces the disc to close tightly on the seat, preventing the steam from escaping. The internal steam pressure (holding the disc and seat shut) eventually drops, and the trap re-opens. When condensate enters the trap, it pushes the disc upwards, allowing the condensate to freely discharge. If steam is present, the trap instantly shuts.

Features

- High pressure applications up to 600 PSIG
- Hardened stainless steel seat and disc for extended service life even at high pressure
- Single trap will operate over the entire pressure range of 3.5-600 PSIG (recommended above 30 PSIG)
- Suitable for superheated steam
- Freeze-proof when trap is piped in a vertical orientation for complete drainage of condensate
- Three-hole balanced discharge extends life of the seat area
- Trap will function in any orientation (horizontal preferred)

Sample Specification

The steam trap shall be a thermodynamic disc type with all stainless steel construction. Integral seat design and disc to be hardened for long service life. Unit shall be capable of installation in any orientation and self-draining when mounted vertically.

Installation and Maintenance

The TD600 can be installed in any orientation; however, horizontal with cap facing upward is preferred for longest service life. The one piece body-seat design is extremely simple and economical; however, this configuration is generally considered not fully repairable since the seat cannot be repaired if damaged or worn. Welding of trap body directly into pipeline is not recommended since excessive heat may cause distortion of the seat area. The TD600 does not contain an integral strainer and separate strainer should therefore be installed to protect from dirt and pipe scale. If a fully in-line repairable design or a trap that can be welded into pipeline is desired, the TD700S, TD900S or the UTD450 with Universal Quick-Change connector is recommended.

Helpful Selection Information

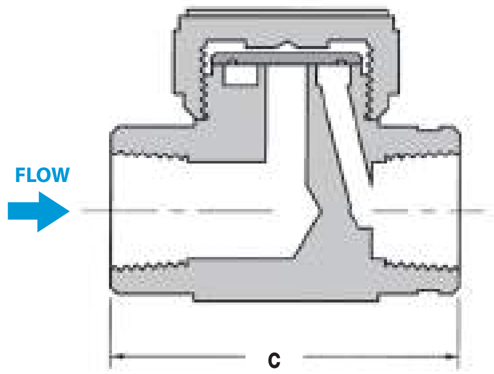
The TD600L has reduced size discharge orifice holes which are preferable in terms of performance, longevity, and efficiency; particularly on pressures over 150 psi. For most drip applications the 1/2" TD600L should have sufficient capacity. For higher load drip applications or if a 3/4" pipe connection is required, use 3/4" TD600L for best results. Choosing a model with a condensate handling capacity in the range of the specific application will prolong trap life.

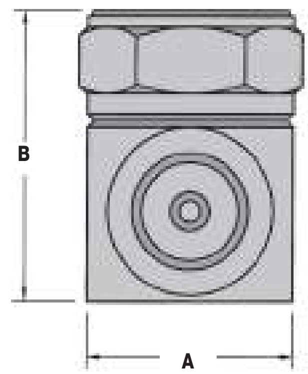
L = Reduced Size Discharge Orifice holes which are preferable in terms of performance, longevity, and efficiency; particularly on pressures over 150 psi.

Options

An insulation cap is available to reduce cycle rates and steam loss in rain, snow, or cold environments.

TD600
Thermodynamic





DIMENSIONS & WEIGHTS – *inches*

Size	Model Code	Connection	A	B	C	Weight (lbs)
3/8"	TD600-11-N	NPT	1.37	1.69	2.00	0.75
1/2"	TD600-12-N	NPT	1.50	2.00	2.69	1.25
3/4"	TD600-13-N	NPT	1.75	2.38	2.81	2.00
1"	TD600-14-N	NPT	2.12	2.81	3.81	3.00
1/2"	TD600L-12-N	NPT	1.50	1.81	2.71	1.00
3/4"	TD600L-13-N	NPT	1.50	2.25	2.75	1.75

How to Size / Order

Select working pressure; follow column down to correct capacity (lbs/hr) block. Example:

Application: 500 lbs/hr at 100 PSIG working inlet pressure
Size/Model: 3/4" **TD600L-13-N**

MATERIALS

Body	Stainless Steel, AISI 420F
Disc	Stainless Steel, AISI 420
Cover	Stainless Steel, AISI 416
Insulation Cap	Stainless Steel, AISI 304

CAPACITIES – *Condensate (lbs/hr)*

Size	Model Code	Steam Inlet Pressure (PSIG)																				
		3.5	5	10	15	20	25	30	40	50	75	100	150	200	250	300	350	400	450	500	550	600
1/2"	TD600L-12-N	180	185	190	195	200	215	220	230	250	310	375	500	620	710	800	825	900	1070	1120	1185	1290
3/4"	TD600L-13-N	300	315	350	380	415	440	470	515	580	710	825	1020	1165	1300	1440	1565	1670	1775	1880	1960	2060
3/8"	TD600-11-N	180	185	190	195	200	215	220	230	250	310	375	500	620	710	800	825	900	1070	1120	1185	1290
1/2"	TD600-12-N	300	315	350	380	415	440	470	515	580	710	825	1020	1165	1300	1440	1565	1670	1775	1880	1960	2060
3/4"	TD600-13-N	415	430	475	520	565	610	650	720	825	1020	1185	1480	1710	1950	2110	2265	2490	2625	2780	2985	3140
1"	TD600-14-N	650	680	740	815	885	940	1000	1080	1225	1500	1800	2215	2625	2935	3300	3600	3875	4120	4350	4560	4840

Notes: *1) Maximum back pressure not to exceed 80% of inlet pressure (measured in absolute pressure) or trap may not close.*
2) For optimum performance, recommended for operating pressure above 30 PSIG.

Thermodynamic Steam Trap

TD600S
Thermodynamic

Model	**TD600S, TD600LS**
Sizes	**1/2", 3/4", 1"**
Connections	**NPT**
Body Material	**Stainless Steel 420F**
Options	**Blowdown Valve, Insulation Cap**
PMO Max. Operating Pressure	**600 PSIG**
TMO Max. Operating Temperature	**750ºF**
PMA Max. Allowable Pressure	**915 PSIG up to 250ºF**
TMA Max. Allowable Temperature	**610ºF @ 750 PSIG**

TD600S
Strainer

TD600SB
Strainer &
Blowdown Valve

Typical Applications

DRIP, TRACING: TD600S model steam traps with integral strainer are most commonly used in drip applications, such as draining condensate from steam mains and steam supply lines. They can also be used for steam tracing applications. These traps are suitable for outdoor applications that are subject to freezing as well as superheated steam conditions. They are compact and rugged with only a single moving part. Integral strainer protects against dirt and scale. If a fully in-line repairable design is required, the TD700S or the UTD450 with Universal Quick-Change Connector is recommended.

How It Works

The disc is the only moving part inside a thermodynamic trap. When steam enters the trap, it creates an internal pressure above the disc that instantly forces the disc to close tightly on the seat, preventing the steam from escaping. The internal steam pressure (holding the disc and seat shut) eventually drops, and the trap re-opens. When condensate enters the trap, it pushes the disc upwards, allowing the condensate to freely discharge. If steam is present, the trap instantly shuts.

Features

- Integral strainer with optional blowdown valve to protect trap from contamination
- High pressure applications up to 600 PSIG
- Hardened stainless steel seat and disc for extended service life even at high pressure
- Single trap will operate over the entire pressure range of 3.5-600 PSIG (recommended above 30 PSIG)
- Suitable for superheated steam
- Freeze-proof when trap is piped in a vertical orientation for complete drainage of condensate
- Three-hole balanced discharge extends life of the seat area
- Trap will function in any orientation (horizontal preferred)

Sample Specification

The steam trap shall be all stainless steel thermodynamic type with hardened integral seat and disc with integral strainer and blowdown valve.

Installation and Maintenance

The TD600S can be installed in any orientation; however, horizontal with cap facing upward is preferred for longest service life. The one piece body-seat design is extremely simple and economical; however, this configuration is generally considered not fully repairable since the seat cannot be replaced if damaged or worn. Welding of trap body directly into pipeline is not recommended since excessive heat can cause distortion of the seat area. All models of the TD600S contain an integral strainer for protection against dirt and scale. If a fully in-line repairable design or a trap that can be welded into pipeline is desired, the TD700S, TD900S or the UTD450 with Universal Quick-Change connectors is recommended.

Helpful Selection Information

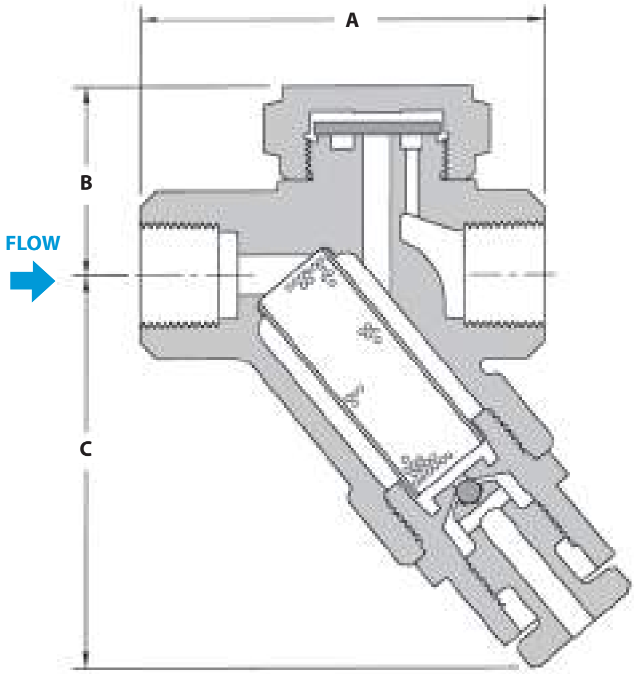
The TD600LS has reduced size discharge orifice holes which are preferable in terms of performance, longevity, and efficiency; particularly on pressures over 150 psi. For most drip applications the 1/2" TD600LS should have sufficient capacity. For higher load drip applications or if a 3/4" pipe connection is required, use 3/4" TD600LS for best results. Choosing a model with a condensate handling capacity in the range of the specific application will prolong trap life.

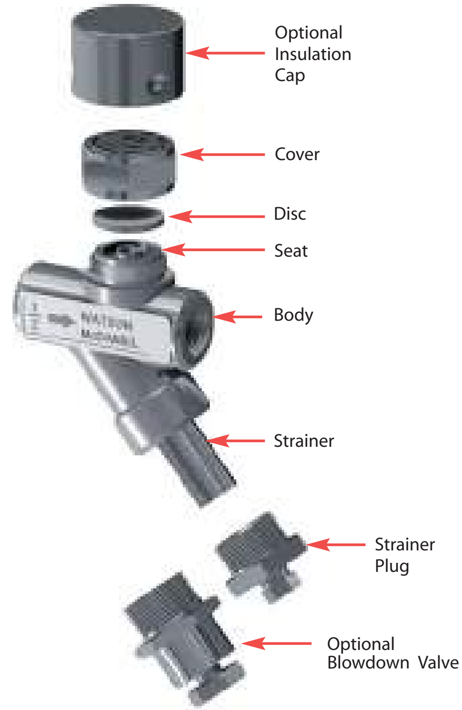
L = Reduced Size Discharge Orifice holes which are preferable in terms of performance, longevity, and efficiency; particularly on pressures over 150 psi.

Options

An insulation cap is available to reduce cycle rates and steam loss in rain, snow, or cold environments. Blowdown valve, used for flushing dirt and scale from strainer.

TD600S
Thermodynamic





DIMENSIONS & WEIGHTS – *inches*

Size	Model	Conn.	A	B	C	Weight (lbs)
Series TD600S (Strainer)						
1/2"	TD600S-12-N	NPT	3.16	1.50	2.53	2
1/2"	TD600LS-12-N	NPT	3.16	1.44	2.53	1.5
3/4"	TD600S-13-N	NPT	3.56	1.62	2.53	2.5
3/4"	TD600LS-13-N	NPT	3.56	1.56	2.53	2.4
1"	TD600LS-13-N	NPT	3.75	1.44	2.53	2.5
Series TD600SB (Strainer & Blowdown Valve)						
1/2"	TD600SB-12-N	NPT	3.16	1.50	3.5	2.3
1/2"	TD600LSB-12-N	NPT	3.16	1.44	3.5	2.0
3/4"	TD600SB-13-N	NPT	3.56	1.62	3.5	2.8
3/4"	TD600LSB-13-N	NPT	3.56	1.56	3.5	2.7
1"	TD600LSB-14-N	NPT	3.72	1.44	3.5	2.7

MATERIALS

Body	Stainless Steel, AISI 420F
Disc	Stainless Steel, AISI 420
Cover	Stainless Steel, AISI 416
Insulation Cap	Stainless Steel, AISI 304
Strainer Screen	Stainless Steel, AISI 304
Blowdown Valve	Stainless Steel, AISI 303

How to Size / Order

Select working pressure; follow column down to correct capacity (lbs/hr) block. Example:

Application: 500 lbs/hr at 100 PSIG working inlet pressure
Size/Model: 3/4″ **TD600LS-13-N**

CAPACITIES – *Condensate (lbs/hr)*

Size	Model	Steam Inlet Pressure (PSIG) 3.5	5	10	15	20	25	30	40	50	75	100	150	200	250	300	400	450	500	550	600
1/2″ 1″	TD600LS-12-N TD600LS-14-N	180	185	190	195	200	215	220	230	250	310	375	500	620	710	800	900	1070	1120	1185	1290
3/4″	TD600LS-13-N	300	315	350	380	415	440	470	515	580	710	825	1020	1165	1300	1440	1670	1775	1880	1960	2060
1/2″	TD600S-12-N	300	315	350	380	415	440	470	515	580	710	825	1020	1165	1300	1440	1670	1775	1880	1960	2060
3/4″	TD600S-13-N	415	430	475	520	565	610	650	720	825	1020	1185	1480	1710	1950	2110	2265	2625	2780	2985	3140

Note: *Maximum back pressure not to exceed 80% of inlet pressure (measured in absolute pressure) or trap may not close.*
Note: *For optimum performance, recommended for operating pressure above 30 PSIG.*

Thermodynamic Steam Trap (Repairable)

TD700S
Thermodynamic

Model	**TD700S, TD700HS**
Sizes	**1/2", 3/4", 1"**
Connections	**NPT, SW, FLG**
Body Material	**Chrome-Moly Alloy Steel**
Options	**Blowdown Valve, Insulation Cap**
PMO Max. Operating Pressure	**600 PSIG**
TMO Max. Operating Temperature	**800°F**
PMA Max. Allowable Pressure	**600 PSIG up to 800°F**
TMA Max. Allowable Temperature	**800°F @ 600 PSIG**

TD700S is a Direct Replacement for Yarway Model 721

TD700S
Strainer

TD700SB
Strainer &
Blowdown Valve

Typical Applications

DRIP, TRACING: TD700S model steam traps are fully in-line repairable and most commonly used in drip applications, such as draining condensate from steam mains and steam supply lines. They can also be used for steam tracing applications. These traps are suitable for outdoor applications that are subject to freezing as well as superheated steam conditions. They feature a "Quick-Replace" capsule that contains the trap's complete internal working mechanism, which is easily replaced while the trap body remains in-line. All models contain an integral strainer for protection against dirt and scale.

How It Works

The disc is the only moving part inside a thermodynamic trap. When steam enters the trap, it creates an internal pressure above the disc that instantly forces the disc to close tightly on the seat, preventing the steam from escaping. The internal steam pressure (holding the disc and seat shut) eventually drops, and the trap re-opens. When condensate enters the trap, it pushes the disc upwards, allowing the condensate to freely discharge. If steam is present, the trap instantly shuts.

Features

- "Quick-Replace" capsule design for easy in-line repair
- Integral strainer with optional blowdown valve to protect trap from contamination
- High pressure applications up to 600 PSIG
- Hardened stainless steel seat and disc for extended service life even at high pressure
- Single trap will operate over the entire pressure range 4-600 PSIG (recommended above 30 PSI)
- Suitable for superheated steam
- Freeze-proof when trap is piped in a vertical orientation for complete drainage of condensate
- Non-integral seat and chrome-moly body allow for trap to be welded in-line
- Trap will function in any orientation (horizontal preferred)

Sample Specification

The steam trap shall be a thermodynamic style in a chrome-moly alloy steel body with an integral strainer and optional blowdown valve. Unit shall have an all stainless steel in-line removable seat and disc capsule assembly. Trap shall be capable of installation in any orientation and self-draining when mounted vertically.

Installation and Maintenance

The TD700S can be installed in any orientation; however, horizontal with cap facing upward is preferred for longest service life. For maintenance, ALL internal components are easily removed and completely changed using a replacement kit. All models of the TD700S contain an integral strainer for protection against dirt and scale. Available in NPT, Socket-Weld and Flange connections.

Helpful Selection Information

The TD700HS is a high pressure version of the standard TD700S model. While both the TD700S and TD700HS will operate with pressures up to 600 PSIG, the TD700HS has a slightly smaller discharge orifice and is recommended for system pressures over 300 PSIG because of increased efficiency and performance. The TD700S is available in NPT, socket weld, and flange connections from 1/2" through 1". Replacement capsules are available, see Parts & Kits Section.

Options

Blowdown valve, used for flushing dirt and scale from strainer.

Customized Flanged Connections:

TD700HS

The **TD700HS** is the high pressure version of the TD700S.

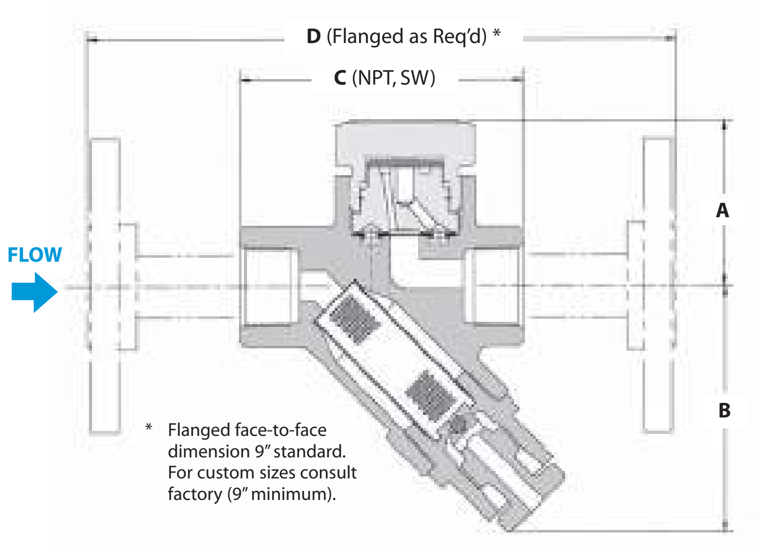
The standard model **TD700S** will operate over the entire pressure range, however, the **TD700HS** will operate more efficiently and have a longer service life for pressures over 300 PSIG.

TD700S	Standard pressure capsule	4-300 PSIG
TD700HS	High pressure capsule	150-600 PSIG

Option: **TD700SB** = Blowdown Valve

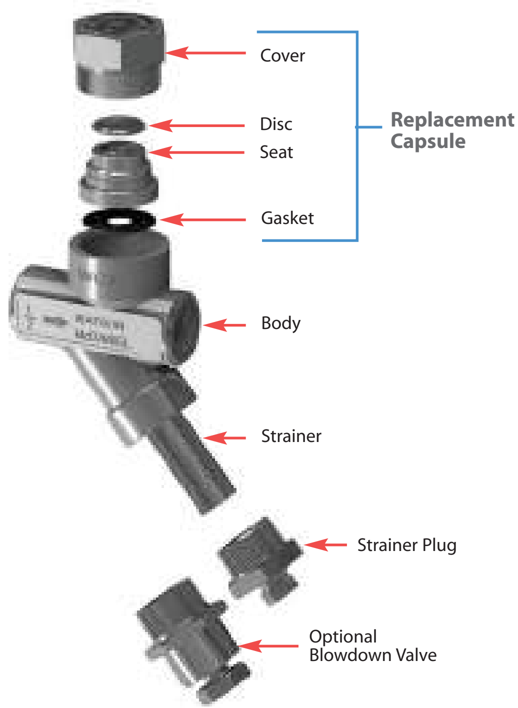
Thermodynamic Steam Trap (Repairable)

TD700S
Thermodynamic



DIMENSIONS & WEIGHTS – *inches*

Size/Model	Connection	A	B	C	Weight (lbs)
Series TD700S & TD700HS (Strainer)					
1/2"	NPT, SW	2.04	2.50	3.16	2.0
3/4"	NPT, SW	2.04	2.50	3.55	2.0
1"	NPT, SW	2.04	2.50	6.31	2.0
Series TD700SB & TD700HSB (Strainer & Blowdown Valve)					
1/2"	NPT, SW	2.04	3.06	3.16	2.25
3/4"	NPT, SW	2.04	3.06	3.55	2.25
1"	NPT, SW	2.04	3.06	6.31	2.25



MATERIALS

Body	Chrome Moly ASTM A-217, GR WC9
Seat	Stainless Steel, 420F
Seat Gasket	316SS/Grafoil
Cover	Stainless Steel, 416
Disc	Stainless Steel, 420
Retaining Ring	Stainless Steel Spring Wire
Screen	Stainless Steel, 304
Strainer Plug, Pipe Plug	Stainless Steel, 303
Blowdown Valve	Stainless Steel
Flanges	Carbon Steel

How to Size / Order

Select working pressure; follow column down to correct capacity (lbs/hr) block. Example:

Application: 275 lbs/hr at 100 PSIG working inlet pressure

Size/Model: **TD700S**, specify pipe size and connections (NPT, SW, FLG)

CAPACITIES – *Condensate (lbs/hr)*

Size	Conn.	Model Code	Steam Inlet Pressure (PSIG) 4	5	6	7	8	9	10	20	30	40	50	60	80	100	150	300	400	500	600
1/2"	NPT	TD700S-12-N	95	105	115	120	125	130	140	180	220	250	265	280	320	350	405	550	600	650	700
	SW	TD700S-12-SW																			
3/4"	NPT	TD700S-13-N	95	105	115	120	125	130	140	180	220	250	265	280	320	350	405	550	600	650	700
	SW	TD700S-13-SW																			
1"	NPT	TD700S-14-N	95	105	115	120	125	130	140	180	220	250	265	280	320	350	405	550	600	650	700
	SW	TD700S-14-SW																			
1/2"	NPT	TD700HS-12-N															250	330	380	410	450
	SW	TD700HS-12-SW																			
3/4"	NPT	TD700HS-13-N															250	330	380	410	450
	SW	TD700HS-13-SW																			
1"	NPT	TD700HS-14-N															250	330	380	410	450
	SW	TD700HS-14-SW																			

Notes: 1) *Maximum back pressure not to exceed 80% of inlet pressure (measured in absolute pressure) or trap may not close.*
2) *For optimum performance, recommended for operating pressure above 30 PSIG.*

Thermodynamic Steam Trap (Repairable)

TD900S
Thermodynamic

Model	**TD900S, TD900LS**
Sizes	1/2", 3/4", 1"
Connections	NPT, SW, 600# FLG
Body Material	Low Carbon Chrome-Moly
Options	Insulation Cap
PMO Max. Operating Pressure	**900 PSIG**
TMO Max. Operating Temperature	842ºF
PMA Max. Allowable Pressure	1500 PSIG @ 100ºF
TMA Max. Allowable Temperature	842ºF @ 981 PSIG

Typical Applications

DRIP: TD900S model steam traps, capable of handling pressures up to 900 PSIG, are used in drip applications such as draining condensate from steam mains and steam supply lines. The complete internal working mechanism can be replaced while the trap body remains connected in-line. All models contain an integral strainer for protection against dirt and scale. These traps are suitable for outdoor applications that are subject to freezing as well as superheated steam conditions.

How It Works

The disc is the only moving part inside a thermodynamic trap. When steam enters the trap, it creates an internal pressure above the disc that instantly forces the disc to close tightly on the seat, preventing the steam from escaping. The internal steam pressure (holding the disc and seat shut) eventually drops, and the trap re-opens. When condensate enters the trap, it pushes the disc upwards, allowing the condensate to freely discharge. If steam is present, the trap instantly shuts.

Features

- "Quick-Change" seat and disc for easy in-line repair
- High pressure applications up to 900 PSIG
- Integral strainer to protect trap from contamination
- Hardened stainless steel seat and disc for extended service life even at extremely high pressures
- Single trap model will operate over the entire pressure range (20-900 PSIG)
- Suitable for superheated steam
- Freeze-proof when trap is piped in a vertical orientation for complete drainage of condensate
- Trap will function in any orientation (horizontal preferred)

Sample Specification

The steam trap shall be a thermodynamic style with body material in chrome-moly alloy steel. Available in size 1/2", 3/4" and 1" Class 600 socket weld ends or flanges. Unit shall have hardened stainless steel seat and disc with a removable stainless steel strainer.

Installation and Maintenance

The TD900S can be installed in any orientation; however, horizontal with cap facing upward is preferred for longest service life. For maintenance, ALL internal components are easily removed and completely changed using a replacement kit. All models contain an integral strainer for protection against dirt and scale. Available in NPT, Socket-Weld and Flange connections.

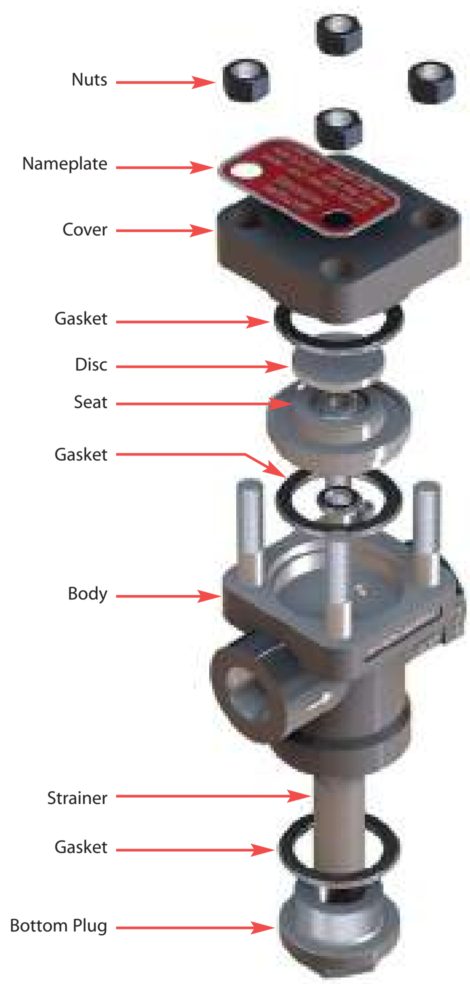
Helpful Selection Information

The TD900LS is a reduced capacity version of the standard TD900S model. The TD900S is available in NPT, Socket Weld,and Flange connections from 1/2" thru 1".

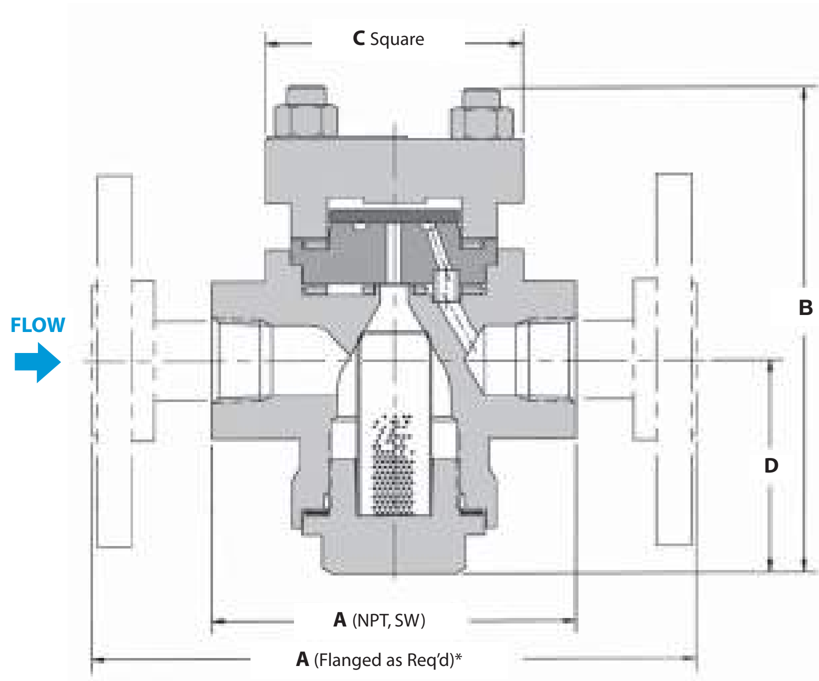
Options

Customized Flanged Connections: Specify size and face-to-face dimensions.

Thermodynamic Steam Trap (Repairable)



Complete internal working mechanism can be replaced while trap body remains connected in-line



* Flanged face-to-face dimension 9″ standard.
For custom sizes consult factory (9″ minimum).

DIMENSIONS & WEIGHTS – *inches*

Size	Model	Connection	A	B	C	D	Weight (lbs)
1/2"	TD900S/TD900LS	NPT, SW	3.6	4.8	2.6	2.1	4.5
		*600# FLG	9.0	4.8	2.6	2.1	9.0
3/4"	TD900S/TD900LS	NPT, SW	3.6	4.8	2.6	2.1	4.5
		*600# FLG	9.0	4.8	2.6	2.1	11.0
1"	TD900S/TD900LS	NPT, SW	6.5	4.8	2.6	2.1	4.5
		*600# FLG	9.0	4.8	2.6	2.1	11.0

MATERIALS

Body	Alloy Steel, GR WC9
Seat	Stainless Steel, AISI 420
Cover	Alloy Steel, GR WC9
Strainer Cap	Alloy Steel, GR WC9
Strainer	Stainless Steel, AISI 300
Disc	Stainless Steel, AISI 420
Gasket	Stainless Steel, AISI 304
Studs	SA-193, GR B7
Nuts	SA-194, GR 2H

CAPACITIES – *Condensate (lbs/hr)*

Size	Model Code (NPT)	Model Code (SW)	Steam Inlet Pressure (PSIG)											
			20	50	100	150	200	300	400	500	600	700	800	900
1/2″	TD900S-12-N	TD900S-12-SW												
3/4″	TD900S-13-N	TD900S-13-SW	243	411	555	641	700	781	835	874	905	930	951	968
1″	TD900S-14-N	TD900S-14-SW												
1/2″	TD900LS-12-N	TD900LS-12-SW												
3/4″	TD900LS-13-N	TD900LS-13-SW				181	210	253	290	325	360	381	405	429
1″	TD900LS-14-N	TD900LS-14-SW												

Notes: WD900S: *1) Minimum recommended working pressure: 20 PSIG.*
2) Maximum back pressure not to exceed 80% of inlet pressure (measured in absolute pressure) or trap may not close.
WD900LS: *1) Minimum recommended working pressure: 150 PSIG.*
2) Maximum back pressure not to exceed 50% of inlet pressure (measured in absolute pressure) or trap may not close.

Steam Traps
High-Pressure Thermodynamic Steam Trap

TD3600
Thermodynamic

Model	**TD3600**
Sizes	1/2”, 3/4”, 1”
Connections	BW, SW, 600# FLG, 1500# FLG
Body Material	Forged Alloy Steel
PMO Max. Operating Pressure	**3600 PSIG**
TMO Max. Operating Temperature	975 °F @ 3600 psi 1025 °F @ 2220 psi
PMA Max. Allowable Pressure	2220 PSIG @ 1025 °F 3600 PSIG @ 975 °F
TMA Max. Allowable Temperature	1025 °F @ 2220 PSIG

Note: Connections may limit Pressure & Temperature ratings.

Typical Applications

DRIP: TD3600 model steam traps are designed to handle the drainage of condensate from extremely high pressure systems, and are commonly used as drip traps on high-pressure steam mains and steam supply lines. These traps are suitable for outdoor applications that are subject to freezing as well as superheated steam conditions. The complete internal working mechanism can be completely replaced while the trap body remains in line.

How it Works

The disc is the only moving part inside a thermodynamic trap. When steam enters the trap, it creates an internal pressure above the disc that instantly forces the disc to close tightly on the seat, preventing the steam from escaping. The internal steam pressure (holding the disc and seat shut) eventually drops, and the trap re-opens. When condensate enters the trap, it pushes the disc upwards, allowing the condensate to freely discharge. If steam is present, the trap instantly shuts.

Features

- “Quick-Change” seat and disc for easy in-line repair
- High pressure applications up to 3600 PSIG
- Integral strainer to protect trap from contamination
- Hardened stainless steel seat and disc for extended service life even at extremely high pressures
- Steam trap model will operate over the entire pressure range (100-3600 PSIG)
- Suitable for superheated steam
- Freeze-proof when trap is piped in a vertical orientation for complete drainage of condensate
- Trap will function in any orientation (horizontal preferred)

Sample Specification

The steam trap shall be a thermodynamic style with body material in forged alloy steel. Available in size 1/2″, 3/4″ and 1″ Socket Weld, Butt Weld ends or ANSI 600# &1500# RF flanged connections. Unit shall have hardened repairable stainless steel seat and disc with a removable stainless steel sintered strainer.

Installation and Maintenance

The TD3600 can be installed in any orientation; however, with cap facing upward is preferred for longest service life. For maintenance, ALL internal components are easily removed and completely changed using a replacement kit. The TD3600 contains an integral high pressure sintered strainer for protection against dirt and scale.

Helpful Selection Information

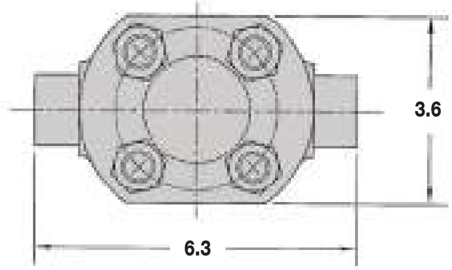
This trap was designed for handling the drainage of condensate from EXTREMELY HIGH PRESSURE systems, with a maximum operating pressure of 3600 PSIG. The TD3600 is available in Socket Weld, Butt Weld and Flange connections from 1/2″ through 1″.

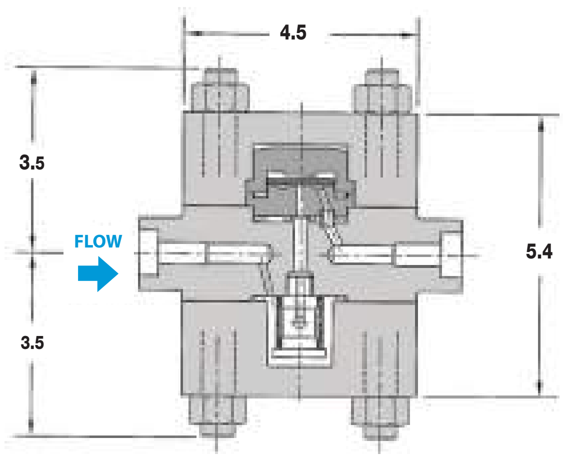
Options

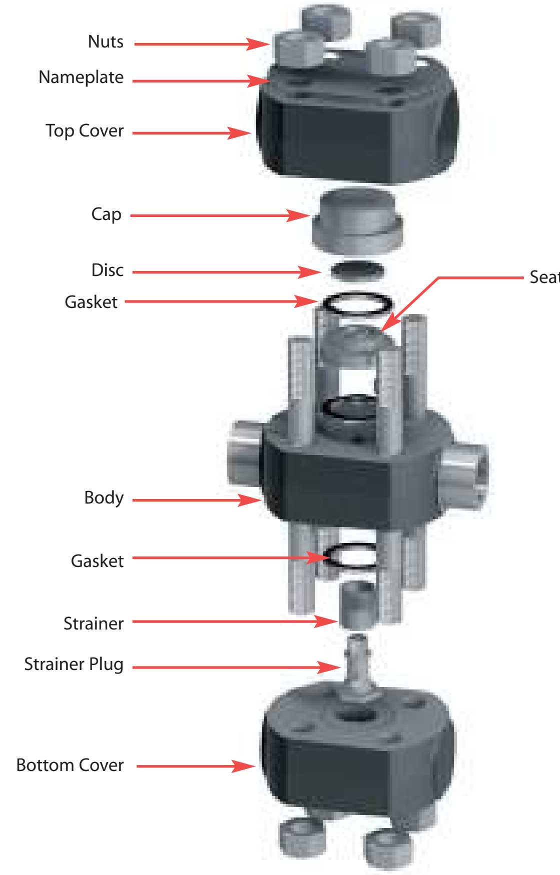
Customized Flanged Connections:
Specify size and face-to-face dimensions.

DIMENSIONS – *inches*

Weight: 25 lbs.







MATERIALS

Body	Forged Alloy Steel, ASTM 182 F22
Seat	Stainless Steel, AISI 420
Cover, top & bottom	Forged Alloy Steel, ASTM 182 F22
Strainer	Sintered Stainless Steel, AISI 300
Disc	Stainless Steel, AISI 420
Gasket	Stainless Steel, AISI 304
Studs	SA-193, GR B16
Nuts	SA-194, GR 4

How to Size / Order

Select working pressure; follow column down to correct capacity (lbs/hr) block. Example:

Application: 380 lbs/hr at 1000 PSIG working inlet pressure

Size/Model: **TD3600**, Specify pipe size and connections (BW, SW, 600# FLG, 1500# FLG)

CAPACITIES – *Condensate (lbs/hr)*

Size	Conn.	Model Code	Steam Inlet Pressure (PSIG)												
			100	500	1000	1250	1750	2000	2250	2500	2750	3000	3250	3500	3600
1/2"	SW	TD3600-12-SW	165	290	380	400	435	470	500	525	550	575	595	610	625
3/4"	SW	TD3600-13-SW													
1"	SW	TD3600-14-SW													

Note: *Maximum back pressure not to exceed 50% of inlet pressure (measured in absolute pressure) or trap may not close. Add note about other connections.*

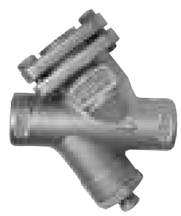
Thermostatic Traps Steam Traps

Industrial type Thermostatic traps are used on drip, process and tracing applications, and use an extremely rugged welded stainless steel bellows. They have excellent air venting capability with a capacity and pressure range for a wide variety of applications. Physical size of a thermostatic trap is considerably smaller than F&T or IB style traps of similar capacity making installation and repair considerably easier. For Example: A Thermostatic trap weighing only 4 pounds is able to replace an F&T trap or an IB trap weighing over 40 pounds. In contrast to an F&T or an IB trap, a single model of a thermostatic trap works over the entire pressure range (from 0-650 PSIG) simplifying model selection. In addition, Thermostatic traps are self-draining eliminating issues with freezing in cold climates. With several repairable and non-repairable models available, thermostatic traps offer many advantages and should be considered.

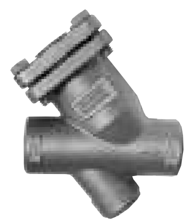
WT1000

WT2000

WT2500

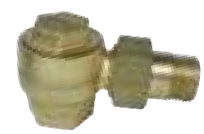


WT3000



WT4000

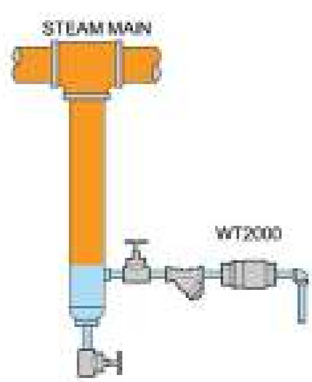
WT5000



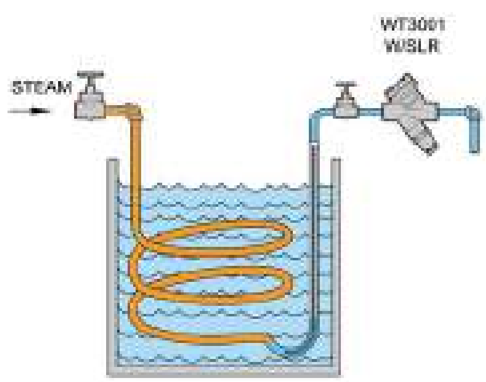
TA/TS

Thermostatic					
Model	Body Material	PMO (PSIG)	Sizes	Connections	Page No.
WT1000	Stainless Steel	**300**	1/2", 3/4"	NPT	**52**
WT2000	Stainless Steel	**650**	1/2", 3/4"	NPT	**52**
WT3000	Stainless Steel	**650**	1/2", 3/4"	NPT, SW, FLG	**54**
WT4000	Stainless Steel	**300**	3/4", 1"	NPT, SW, FLG	**56**
WT5000	Stainless Steel	**650**	3/8" – 1"	NPT, SW	**58**
TA/TS	Brass	**25/125**	1/2", 3/4"	NPT	**60**
WT2500	Cast Iron	**250**	1/2", 3/4"	NPT	**62**

Typical Applications for Thermostatic Steam Traps

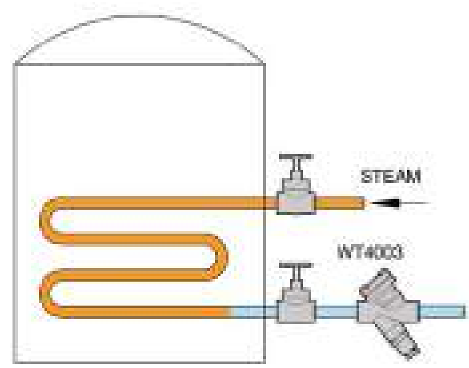


Steam Main Drip



Plating Tank (Batch Process)

With steam trap positioned above condensate collection point using the Steam Lock Release option (SLR)



Outdoor Storage Tank (Batch Process)

THERMOSTATIC STEAM TRAPS

Operation:

The bellows type thermostatic trap contains a fluid-filled thermal element (bellows). The operation of this thermal element is governed by the volumetric thermal expansion of the fluid inside the bellows as it changes states. There is no adjustment required for this trap as the fluid inside the bellows is chosen for its quick response to the change in temperature between steam and condensate at various pressures. The operation of the bellows follows the steam saturation curve, always discharging condensate a few degrees cooler than the steam temperature.

During start-up, when the system is cold, the bellows is retracted and the valve plug is lifted off the seat allowing air and condensate to be discharged from the system. As hot steam approaches the thermal element in the trap, the fluid inside the bellows vaporizes and expands, closing the valve tightly. As long as steam is present, the valve will remain closed. Only when subcooled condensate or air is present will the valve open.

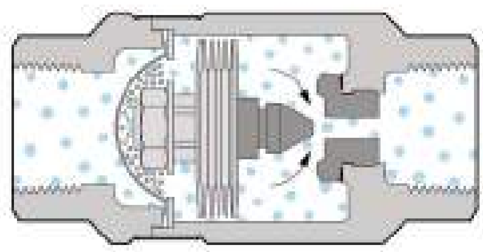
Watson McDaniel thermal element traps offer wide operating pressure ranges, rugged welded stainless steel bellows, and various orifice sizes, making them a great choice for a majority of applications.

Sub-cool:

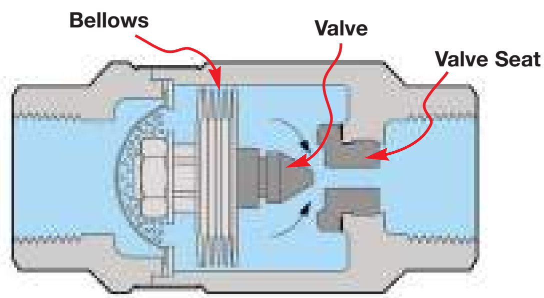
The sub-cooling of condensate prior to discharge can have certain beneficial effects. In the majority of tracing applications, the sub-cooling of condensate is highly desirable because of the additional energy that is extracted from the Hot condensate. If the trap did not sub-cool condensate, this energy would be wasted.

In Batch style process applications such as jacketed kettles, plating tanks and heating of outdoor storage tanks, the sub-cooling of condensate is generally not a factor to consider since the amount of condensate back-up requires less than 1% of the heat transfer surface area and is therefore considered negligible. So a heat exchanger with 50 square feet of surface area requires only ½ a square foot of surface area to sub-cool the condensate. In a Continuous process application that exhibit rapid changes in steam pressures, steam traps requiring sub-cool could lead to additional condensate back up. This scenario is typical in instantaneous hot water heaters using a shell & tube heat exchanger with temperature control valves. The steam pressure in the heat exchanger can drop extremely fast when the water demand changes. In this case, additional sub-cooling of the condensate is required before it will discharge. In some cases, this may be acceptable, but in general, only F&T traps are recommended for process with rapid changes in steam pressures since they always discharge condensate immediately as it is formed. In addition, traps that sub-cool condensate have a softer discharge since less flash steam is generated in the return line.

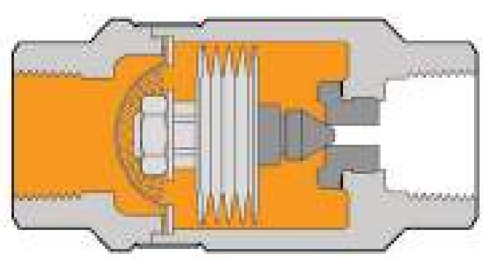
A) AIR When air, which is cooler than steam, is present, the bellows is retracted and the seat is open, allowing large quantities of air to be discharged.

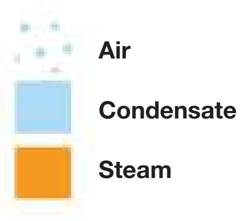


B) CONDENSATE When condensate, which is cooler than steam, is present, the bellows retracts and the seat opens, allowing condensate to be discharged.



C) STEAM When steam reaches the trap, the bellows expands, closing off the seat and preventing the steam from escaping.





Non-Repairable (Seal-welded Stainless Steel Body)

The **WT1000** & **WT2000** Thermostatic Steam Traps have Stainless Steel, seal-welded bodies and are Non-repairable.

The **WT1000** is specifically intended for Drip and Tracing Applications.

The **WT2000** is substantially larger in capacity than the WT1000. It can be used for Batch Type Process Applications as well as for Drip and Tracing. Also used as an Air Vent; Model AV2000.

WT1000
Stainless Steel

Seal-welded

WT2000
Stainless Steel

Repairable (4-Bolt Cover)

The **WT3000** & **WT4000** Thermostatic Steam Traps have cast Stainless Steel bodies and are fully-repairable.

The **WT3000** has an identical capacity to the WT2000; commonly used for Process Applications but can also be used for drip and tracing if a repairable design is desired.

The **WT4000** has substantially higher capacity than the WT3000; used for larger Process Applications.

WT3000
Stainless Steel

WT4000
Stainless Steel

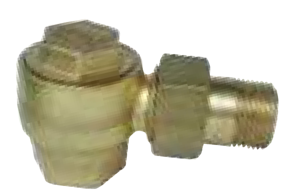
4-Bolt Cover

The **WT2500**, with a cast iron body, is an economical alternative to the WT3000 and is identical in capacity; however, its limited to 250 PSIG. It is likewise fully-repairable and can be used where cast iron is acceptable.

The **TA/TS Series** are referred to as Thermostatic Radiator Traps. They have brass bodies and are fully-repairable; predominantly used in the HVAC industry for steam traps and air vents.

WT2500
Cast-Iron

TA & TS
Brass



Temperature Adjustable Bi-Metal

The **WT5000** Bi-Metal Steam Trap has a Stainless Steel body, is fully-repairable and intended for Steam Tracing Applications.

Its unique feature is a temperature-adjustable Bi-Metal element which allows for precise control of condensate discharge temperature (temperature adjustment can be made in the field). This is a desirable feature for tracing, so that condensate discharge temperature can be controlled to suit a particular application.

WT5000
Bi-Metal

Thermostatic Steam Trap (Non-Repairable)

Model	**WT1000 (Non-Repairable)**
Sizes	**1/2", 3/4"**
Connections	**NPT**
Body Material	**Stainless Steel**
PMO Max. Operating Pressure	**300 PSIG**
TMO Max. Operating Temperature	**Saturated Steam Temperature**
PMA Max. Allowable Pressure	**1032 PSIG @ 100°F**
TMA Max. Allowable Temperature	**750°F @ 800 PSIG**

Typical Applications

DRIP, TRACING: The **WT1000** is a low capacity thermostatic trap ideally sized for steam tracing. Thermostatic traps are small, light weight and have excellent air discharging capabilities. Discharging air at start-up allows steam to quickly enter the system. Trap body is permanently seal welded together and therefore non-repairable. Contains an extremely strong and rugged precision welded Stainless Steel thermal element. Its small discharge orifice, which makes it an optimal size trap for both drip and tracing applications, is susceptible to clogging depending on system conditions, therefore, a separate strainer should be installed.

How It Works

This thermostatic trap contains a welded stainless steel thermal element that expands when heated and contracts when cooled to 5°F below saturated steam temperature. When air or sub-cooled condensate are present, the trap is in the open discharge position. When steam reaches the trap, the element expands and closes off tightly.

Features

- Excellent at discharging air which allows steam to enter system quickly; extremely important during start-up
- Welded stainless steel thermal element resists shock from water hammer
- Freeze-proof when trap is installed in a vertical orientation allowing for complete condensate drainage
- Stainless steel Barstock body
- In the unlikely event of bellows failure; trap discharge remains open

Installation & Maintenance

Trap can be installed in any orientation. The WT1000 steam trap body is seal-welded and therefore non-repairable. If a new trap is required, remove from line and replace. This product cannot be welded in-line or failure of the thermal element due to excess heat may occur. Available in NPT threaded connections only.

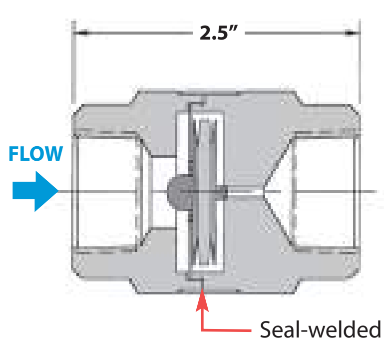
Sample Specification

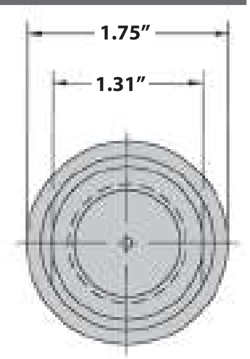
The steam trap shall be of thermostatic type with stainless steel body and stainless steel thermal element.

MATERIALS

Trap Housing	Stainless Steel, AISI 304L
Thermal Element	Stainless Steel, 300 Series
Valve	Stainless Steel, AISI 440C

DIMENSIONS – *inches*





Weight: 1.25 lbs.

CAPACITIES – *Condensate (lbs/hr)*

Size	Model Code	Steam Inlet Pressure (PSIG) 5	10	20	50	100	125	150	200	250	300
1/2"	WT1000-12-N	95	140	195	305	435	485	530	610	685	750
3/4"	WT1000-13-N										

Steam Traps

Thermostatic Steam Trap (Non-Repairable)

WT2000
Thermostatic

Model	**WT2000 (Non-Repairable)**
Sizes	**1/2", 3/4"**
Connections	**NPT**
Body Material	**Stainless Steel**
PMO Max. Operating Pressure	**650 PSIG**
TMO Max. Operating Temperature	**Saturated Steam Temp.**
PMA Max. Allowable Pressure	**1032 PSIG @ 100ºF**
TMA Max. Allowable Temperature	**750ºF @ 800 PSIG**

Typical Applications

DRIP, TRACING, PROCESS: The **WT2000** is a general purpose medium-capacity thermostatic trap that can be used for steam tracing, as a drip trap on steam mains and steam supply lines, as well as for process applications. They are also commonly used as an Air Vent on heat exchangers or at the ends of steam mains. Thermostatic traps are small, light weight, operate over a wide pressure range, and have excellent air handling capabilities. Discharging air at start-up allows steam to quickly enter the system. All stainless steel construction and integral strainer, make the WT2000 an excellent choice for a variety of applications. Trap body is permanently seal welded together and therefore non-repairable. Contains an extremely strong and rugged precision welded Stainless Steel thermal element which is highly resistant to waterhammer.

How It Works

This thermostatic trap contains a welded stainless steel thermal element that expands when heated and contracts when cooled to 5˚F below saturated steam temperature. When air or sub-cooled condensate are present, the trap is in the open discharge position. When steam reaches the trap, the element expands and closes off tightly.

Features

- Thermostatic traps are excellent at discharging air, which allows steam to enter quickly; extremely important during start-up
- Integral strainer to protect trap from contamination
- Welded stainless steel thermal element resists shock from waterhammer
- Freeze-proof when trap is installed in a vertical orientation allowing for complete condensate drainage
- Body is produced from stainless steel investment casting
- Hardened stainless steel seat for extended service life
- Will operate at steam pressures up to 650 PSIG

Sample Specification

Steam trap shall be of thermostatic type with stainless steel body, thermal element, internal screen, and hardened valve and seat.

Installation and Maintenance

Trap can be installed in any position. The WT2000 steam trap body is seal-welded and therefore non-repairable. If a new trap is required, remove from line and replace. Cannot be welded in-line or failure of the thermal element may occur. Available in NPT threaded connections only.

Helpful Selection Information

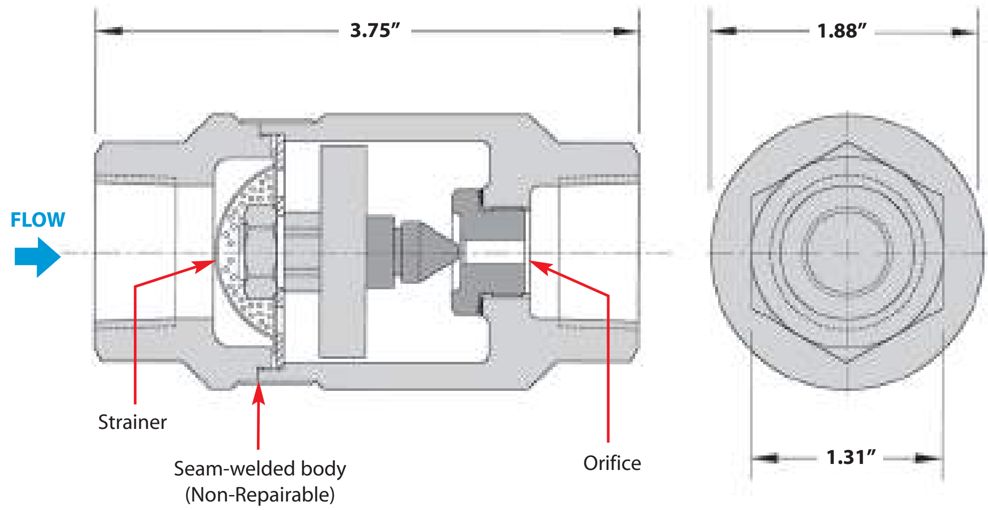
Two orifice sizes are available: The 3/16″ orifice should be used on all drip and tracing applications as well as small process applications with lower condensate loads. The 5/16″ orifice is available to be used on process applications if additional capacity is required.

Options

- Special Bellows Option; available upon request:
  - Fail-closed Bellows (standard bellows fails in open position)
  - 43˚F Sub-cool Bellows (Note: Standard bellows are designed for approximately 5˚F sub-cool temperature)
- **SLR** = Steam lock release
- Standard models contain a non-cleanable strainer screen. Also available without screen where it is desireable to flush dirt and scale thru the trap. Recommend WT2003 with larger orifice if used without strainer.

Thermostatic Steam Trap (Non-Repairable)

WT2000
Thermostatic



Weight: 1.5 lbs.

MATERIALS

Trap Housing	Stainless Steel, ASTM A351-CF3
Thermal Element	Stainless Steel
Valve & Seat	Stainless Steel, AISI 416
Strainer Screen	Stainless Steel

How to Size / Order

Select working pressure; follow column down to correct capacity (lbs/hr) block. Example:

Application: 1827 lbs/hr at 100 PSIG working inlet pressure
Size/Model: **WT2001-12-N**, 1/2″ NPT, 3/16″ orifice

CAPACITIES – *Condensate (lbs/hr)*

Size	Model Code	Orifice Size	Steam Inlet Pressure (PSIG) 5	10	20	50	100	125	150	200	250	300	350	400	500	600	650
1/2″	WT2001-12-N	3/16″	441	625	882	1391	1827	1969	2095	2305	2483	2636	2777	2903	3129	3323	3413
3/4″	WT2001-13-N																
1/2″	WT2003-12-N	5/16″	903	1271	1811	2861	3754	4043	4300	4730	5093	5413	5702	5959	6421	6820	7004
3/4″	WT2003-13-N																

Note: 3/16″ orifice should be used on all drip and tracing applications.

Back Pressure as Percentage of Inlet Pressure	10	20	25	30	40	50	60	70	80	90
Percentage Decrease in Trap Capacity	0	0	0	2	5	12	20	30	40	55

Steam Traps

Thermostatic Steam Trap (Repairable)

WT3000
Thermostatic

Model	WT3000 (Repairable)
Sizes	1/2", 3/4"
Connections	NPT, SW, FLG
Body Material	Stainless Steel
Options	Strainer, Blowdown Valve
PMO Max. Operating Pressure	650 PSIG
TMO Max. Operating Temperature	Saturated Steam Temp.
PMA Max. Allowable Pressure	906 PSIG @ 100°F
TMA Max. Allowable Temperature	750°F @ 725 PSIG

Typical Applications

DRIP, TRACING, PROCESS: The **WT3000** is a general purpose medium capacity thermostatic trap that can be used for steam tracing; as a drip trap on steam mains and steam supply lines; as well as for process applications. All internal working components can be replaced while the trap body remains in-line. Thermostatic traps are small, light weight, operate over a wide pressure range, and have excellent air handling capabilities. Discharging air at start-up allows steam to quickly enter the system. All stainless steel construction and integral strainer option make the WT3000 an excellent choice for a variety of applications. Contains an extremely strong and rugged precision welded Stainless Steel thermal element which is highly resistant to waterhammer.

How It Works

This thermostatic trap contains a welded stainless steel thermal element that expands when heated and contracts when cooled to 5˚F below saturated steam temperature. When air or sub-cooled condensate are present, the trap is in the open discharge position. When steam reaches the trap, the element expands and closes off tightly.

Features

- The thermal element and seat can be easily removed and replaced in minutes with the trap body still in-line
- Operates at steam pressures up to 650 PSIG
- Thermostatic traps are excellent at discharging air, which allows steam to enter quickly; extremely important during start-up
- Welded stainless steel thermal element resists shock from waterhammer
- Freeze-proof when trap is installed in a vertical orientation allowing for complete condensate drainage
- Body is produced from stainless steel investment casting
- Hardened stainless steel seat for extended service life
- Available with integral strainer and blowdown valve

Sample Specification

The steam trap shall be of a thermostatic type with stainless steel body, thermal element and internal strainer. Trap must be in-line repairable with a bolt-on type cover that is sealed with a spiral wound Stainless Steel AISI 316 gasket. Seat and valve to be hardened stainless steel.

Installation and Maintenance

Trap can be installed in any orientation. All internal working components are extremely easy to replace and can be performed while the trap body remains connected in-line. Repair kit includes ALL parts to fully rebuild the steam trap including thermal element, seat and gasket. The WT3000S model comes with an optional strainer. WT3000SB comes with optional blowdown valve for flushing dirt and scale from strainer.

Helpful Selection Information

Two orifice sizes are available: The 3/16″ orifice should be used on all drip and tracing applications as well as small process applications with lower condensate loads. The 5/16″ orifice is available to be used on process applications if additional capacity is required.

Options

Strainer, blowdown valve, steam lock release and special bellows available.

S = Strainer (**WT3001S**)

SB = Strainer and blowdown valve (**WT3001SB**)

SLR = Steam lock release

Special Bellows Option; available upon request:

- Fail-closed Bellows (standard bellows fails in open position)
- 43˚F Sub-cool Bellows (Note: Standard bellows are designed for approximately 5˚F sub-cool temperature)

How to Size / Order

Refer to the Capacity Chart to determine which model, the WT3001 or WT3003 is required to satisfy the condensate load based on steam inlet pressure.

Example:

Application: 3754 lbs/hr at 100 PSIG steam inlet pressure
Size/Model: **WT3003S**, 5/16″ orifice with strainer,
Specify size & connections (NPT, SW, FLG)

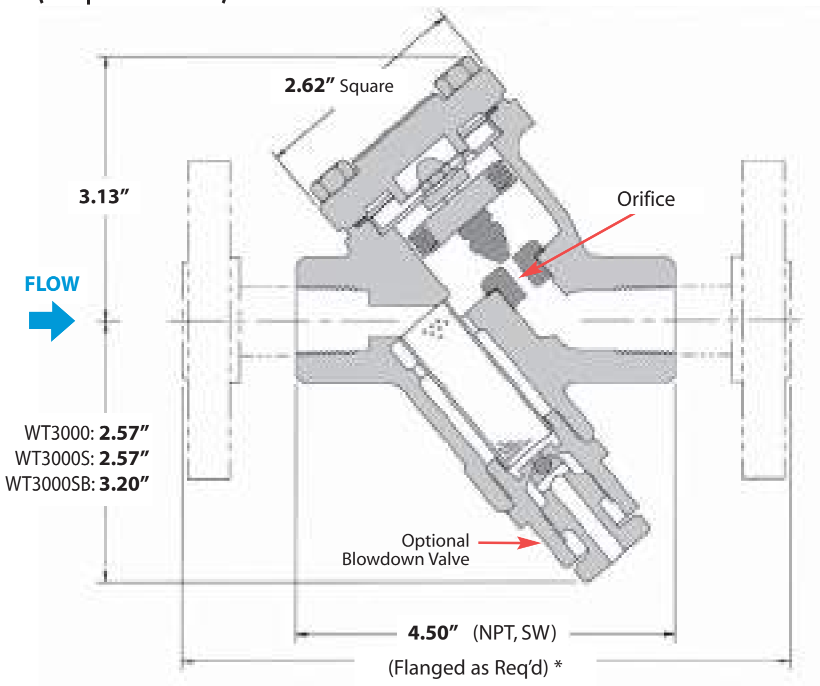
Example Model Codes:

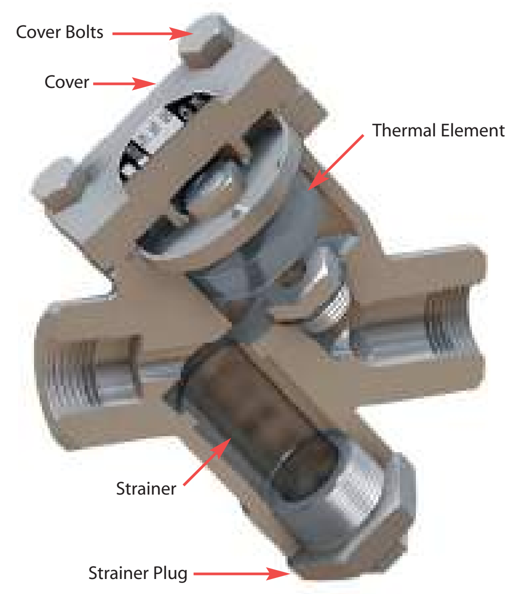
WT3003S-13-N 3/4″ NPT with strainer, and 5/16″ orifice.

WT3001SB-12-N 1/2″ NPT with strainer and blowdown valve, 3/16″ orifice

Thermostatic Steam Trap

(Repairable)





Weight: 4.5 lbs.

* Flanged face-to-face dimension 9" standard. For custom sizes consult factory (9" minimum).

Size/Connection*	Model Code	Orifice Size	Description
1/2" NPT	**WT3001-12-N**	3/16"	No Strainer
3/4" NPT	**WT3001-13-N**	3/16"	No Strainer
1/2" NPT	**WT3001S-12-N**	3/16"	Strainer
3/4" NPT	**WT3001S-13-N**	3/16"	Strainer
1/2" NPT	**WT3001SB-12-N**	3/16"	Strainer & Blowdown
3/4" NPT	**WT3001SB-13-N**	3/16"	Strainer & Blowdown
1/2" NPT	**WT3003-12-N**	5/16"	No Strainer
3/4" NPT	**WT3003-13-N**	5/16"	No Strainer
1/2" NPT	**WT3003S-12-N**	5/16"	Strainer
3/4" NPT	**WT3003S-13-N**	5/16"	Strainer
1/2" NPT	**WT3003SB-12-N**	5/16"	Strainer & Blowdown
3/4" NPT	**WT3003SB-13-N**	5/16"	Strainer & Blowdown

** For Socket Weld Connection change **N** to **SW***

MATERIALS

Cover & Body	Stainless Steel, AISI 316L
Thermal Element	Stainless Steel, AISI 300
Valve & Seat	Stainless Steel, AISI 416
Cover Gasket	Stainless Steel, AISI 316
Seat Gasket	Stainless Steel, AISI 316
Cover Bolts	Steel, ASTM A193 GR B7 Nickel Plated
Strainer*	0.046 Perforated Stainless Steel AISI 304
Blowdown Valve*	Stainless Steel AISI 303

** Strainer and blowdown valve are optional*

CAPACITIES – *Condensate (lbs/hr)*

Model	Orifice Size	Steam Inlet Pressure (PSIG)														
		5	10	20	50	100	125	150	200	250	300	350	400	500	600	650
WT3001	**3/16"**	441	625	882	1391	1827	1969	2095	2305	2483	2636	2777	2903	3129	3323	3413
WT3003	**5/16"**	903	1271	1811	2861	3754	4043	4300	4730	5093	5413	5702	5959	6421	6820	7004

Back Pressure as Percentage of Inlet Pressure	10	20	25	30	40	50	60	70	80	90
Percentage Decrease in Trap Capacity	0	0	0	2	5	12	20	30	40	55

Steam Traps
Thermostatic Steam Trap (Repairable)

Model	**WT4000 (Repairable)**
Sizes	**3/4", 1"**
Connections	**NPT, SW, FLG**
Body Material	**Stainless Steel**
Options	**Strainer, Blowdown Valve**
PMO Max. Operating Pressure	**300 PSIG**
TMO Max. Operating Temperature	**Saturated Steam Temperature**
PMA Max. Allowable Pressure	**906 PSIG @ 100°F**
TMA Max. Allowable Temperature	**750°F @ 725 PSIG**

Typical Applications

PROCESS: The **WT4000** is a high capacity version of the WT3000, for removing condensate and air from larger process applications. This steam trap is fully repairable while the body remains in-line. Like all thermostatic traps, they are small, light weight, operate over a wide pressure range, and have excellent air handling capabilities. Discharging air at start-up allows steam to quickly enter the system. All stainless steel construction and integral strainer option make the WT4000 an excellent choice for most process applications. Contains an extremely strong and rugged precision welded Stainless Steel thermal element which is highly resistant to waterhammer.

How It Works

This thermostatic trap contains a welded stainless steel thermal element that expands when heated and contracts when cooled to 5°F below saturated steam temperature. When air or sub-cooled condensate are present, the trap is in the open discharge position. When steam reaches the trap, the element expands and closes off tightly.

Features

- The thermal element and seat can be easily removed and replaced in minutes with the trap body still in-line
- Operates at steam pressures up to 300 PSIG
- Thermostatic traps are excellent at discharging air, which allows steam to enter quickly; extremely important during start-up
- Welded stainless steel thermal element resists shock from waterhammer
- Freeze-proof when the trap is installed in a vertical orientation allowing for complete condensate drainage
- Body is produced from stainless steel investment casting
- Hardened stainless steel seat for extended service life
- Available with integral strainer and blowdown valve

Sample Specification

The steam trap shall be of thermostatic type with stainless steel body, thermal element, and internal strainer. Trap must be in-line repairable with a bolt-on type cover that is sealed with a spiral wound Stainless Steel AISI 316 gasket. Seat and valve to be hardened stainless steel.

Installation and Maintenance

Trap can be installed in any orientation. All internal working components are extremely easy to replace and can be performed while the trap body remains connected in-line. Repair kit includes ALL parts to fully rebuild the steam trap including thermal element, seat and gasket. The WT4000 does not contain a strainer. The WT4000S contains a strainer. WT4000SB contains a blowdown valve for flushing dirt and scale from strainer.

Helpful Selection Information

Two orifice sizes are available: 7/16″ standard capacity and 5/16″ reduced capacity. Select these models for steam systems with maximum working pressure of 300 PSIG.

Options

Strainer, blowdown valve, and steam lock release.

S = Strainer (**WT4001S**)

SB = Strainer and blowdown valve (**WT4001SB**)

SLR = Steam lock release

Customized flanged connections: Specify size, face-to-face dimensions.

How to Size / Order

Refer to the Capacity Chart to determine which model, the WT4001 or WT4003 is required to satisfy the condensate load based on steam inlet pressure.

Example:

Application: 5610 lbs/hr at 100 PSIG steam inlet pressure

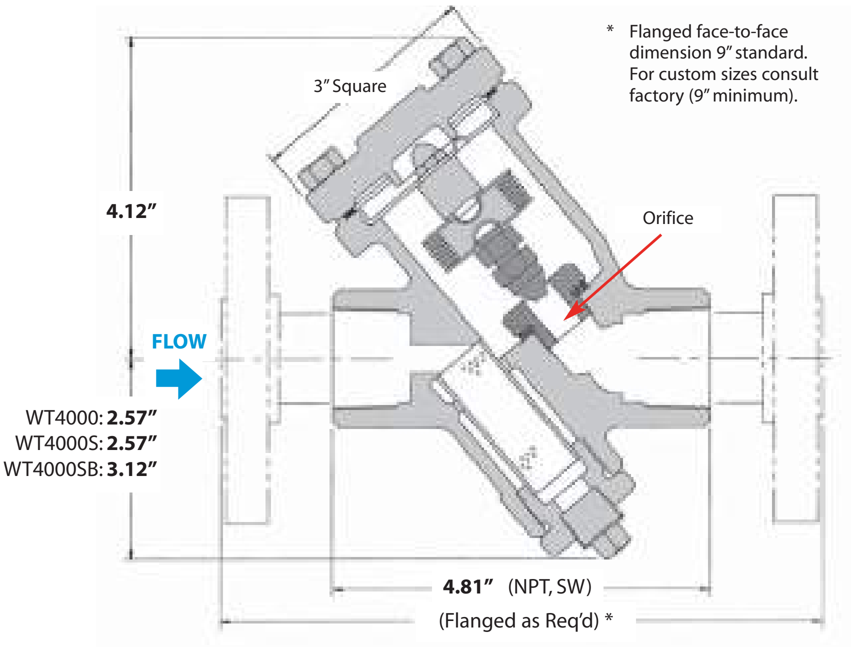
Size/Model: **WT4001S**, 5/16″ orifice, and strainer
Specify size & connections (NPT, SW, FLG)

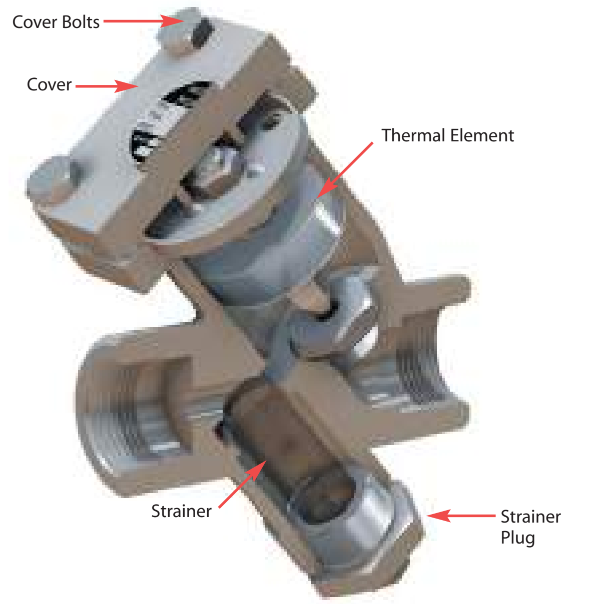
Example Model Codes:

WT4001S-13-N 3/4″ NPT with strainer, and 5/16″ orifice

WT4003SB-14-N 1″ NPT with strainer and blowdown valve, 7/16″ orifice

Thermostatic Steam Trap (Repairable)





Weight: 4.5 lbs.

Size/Connection*		Model Code	Orifice Size	Description
3/4"	NPT	**WT4001-13-N**	5/16"	No Strainer
1"	NPT	**WT4001-14-N**	5/16"	No Strainer
3/4"	NPT	**WT4001S-13-N**	5/16"	Strainer
1"	NPT	**WT4001S-14-N**	5/16"	Strainer
3/4"	NPT	**WT4001SB-13-N**	5/16"	Strainer & Blowdown
1"	NPT	**WT4001SB-14-N**	5/16"	Strainer & Blowdown
3/4"	NPT	**WT4003-13-N**	7/16"	No Strainer
1"	NPT	**WT4003-14-N**	7/16"	No Strainer
3/4"	NPT	**WT4003S-13-N**	7/16"	Strainer
1"	NPT	**WT4003S-14-N**	7/16"	Strainer
3/4"	NPT	**WT4003SB-13-N**	7/16"	Strainer & Blowdown
1"	NPT	**WT4003SB-14-N**	7/16"	Strainer & Blowdown

** For Socket Weld Connection change **N** to **SW***

MATERIALS

Body	Stainless Steel, AISI 316L
Cover	Stainless Steel, AISI 316L
Cover Gasket	Spiral Wound Stainless Steel, AISI 316
Cover Bolts	Steel, ASTM A193 GR B7 Nickel Plated
Thermal Element	Stainless Steel, AISI 302
Valve & Seat	Hardened Stainless Steel, AISI 416
Seat Gasket	Stainless Steel, AISI 316
Strainer*	0.046 Perforated Stainless Steel AISI 304
Blowdown Valve*	Stainless Steel AISI 300

** Strainer and blowdown valve are optional*

CAPACITIES – *Condensate (lbs/hr)*

Model	Orifice Size	Steam Inlet Pressure (PSIG) 1	2	5	10	20	50	100	125	150	200	250	300
WT4001	**5/16"**	605	855	1350	1910	2705	4275	5610	6045	6425	7070	7615	8095
WT4003	**7/16"**	940	1325	2095	2960	4190	6620	8695	9365	9950	10955	11800	12540

Back Pressure as Percentage of Inlet Pressure	10	20	25	30	40	50	60	70	80	90
Percentage Decrease in Trap Capacity	0	0	0	2	5	12	20	30	40	55

Steam Traps
Bi-Metal Adjustable Discharge Temperature
(Repairable)

WT5000
Bi-Metal

Model	**WT5000 (Bi-Metal)**
Sizes	3/8", 1/2", 3/4, 1"
Connections	NPT, SW
Body Material	Stainless Steel
PMO Max. Operating Pressure	**650 PSIG**
TMO Max. Operating Temperature	662°F
PMA Max. Allowable Pressure	900 PSIG
TMA Max. Allowable Temperature	800°F

Typical Applications

TRACING: The **WT5000** is specifically designed for steam tracing applications where accurate and adjustable control of condensate discharge temperature is desired. Can be used where a temperature sensitive medium is being transferred in piping system or held in a storage vessel and standard steam tracing methods may not be adequate to maintain specific product temperatures. Having the ability to adjust the condensate discharge temperature would allow for accurate temperature control of the product being traced. The significant feature of the WT5000 is that the condensate discharge temperature is easily field-adjustable.

How It Works

Bi-metallic plates of dissimilar metals which are connected to the valve seat assembly respond to temperature variations. At relatively cool conditions, the trap is open for the discharge of condensate. When the temperature of the condensate is equal to or higher than the set temperature, the metals react and expand, closing the trap. External field-adjustability of the bi-metal element allows control of the condensate discharge temperature.

The condensate temperature can be field adjusted as follows:

To **INCREASE** the temperature, turn the adjuster screw:
→ **COUNTERCLOCKWISE**

To **DECREASE** the temperature, turn the adjuster screw:
→ **CLOCKWISE**

Note: The lower the set temperature, the more condensate will back-up in front of the trap inlet connection. Therefore, consideration should be given to providing adequate piping to accommodate any such back-up.

Features

- Excellent for various steam tracing and small process applications using the additional energy (sensible heat) of the hot condensate
- Field-adjustable bi-metal element allows control of condensate discharge temperature
- Internal screen and seat/plug design help prevent pipe scale and debris from accumulating on seating surfaces to provide trouble-free operation
- In-line repairable

Sample Specification

The steam trap shall be a bi-metal type with stainless steel body, seat, valve plug and bimetallic element. Bi-metal element shall be externally adjustable for control of condensate discharge temperature. Trap must be in-line repairable with a replaceable bi-metal element, valve plug and seat.

Installation and Maintenance

Trap can be installed in any orientation. The body is made from stainless steel and is fully repairable while the steam trap remains in-line. If the trap fails, remove the cover and replace the internal working components. Repair kit includes bimetallic element (including valve stem and plug), seat and gasket.

Helpful Selection Information

Available in 3/8" through 1" NPT and socket weld connections. Select this model for steam systems with maximum working pressure of 650 PSIG.

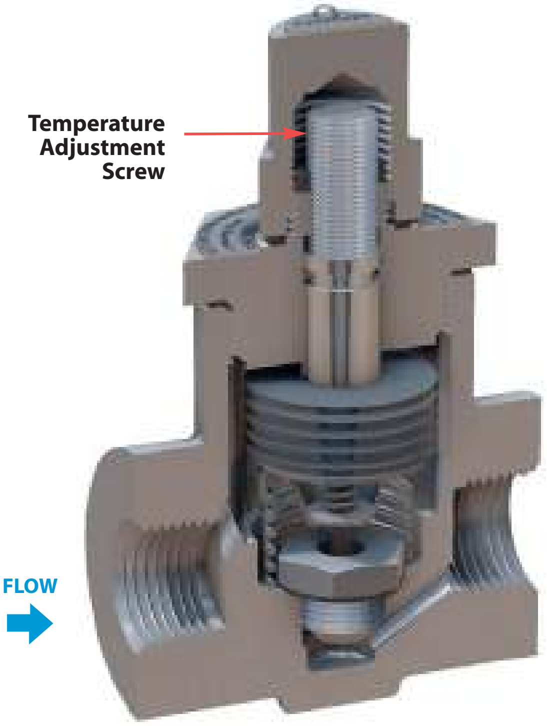
Size/Connection		Model Code	Weight lbs	Cross Reference TLV
3/8"	NPT	**WT5000-11-N**	3.0	LEX3N-TZ
1/2"	NPT	**WT5000-12-N**		
3/4"	NPT	**WT5000-13-N**		
1"	NPT	**WT5000-14-N**		
3/8"	SW	**WT5000-11-SW**	3.0	LEX3N-TZ
1/2"	SW	**WT5000-12-SW**		
3/4"	SW	**WT5000-13-SW**		
1"	SW	**WT5000-14-SW**		

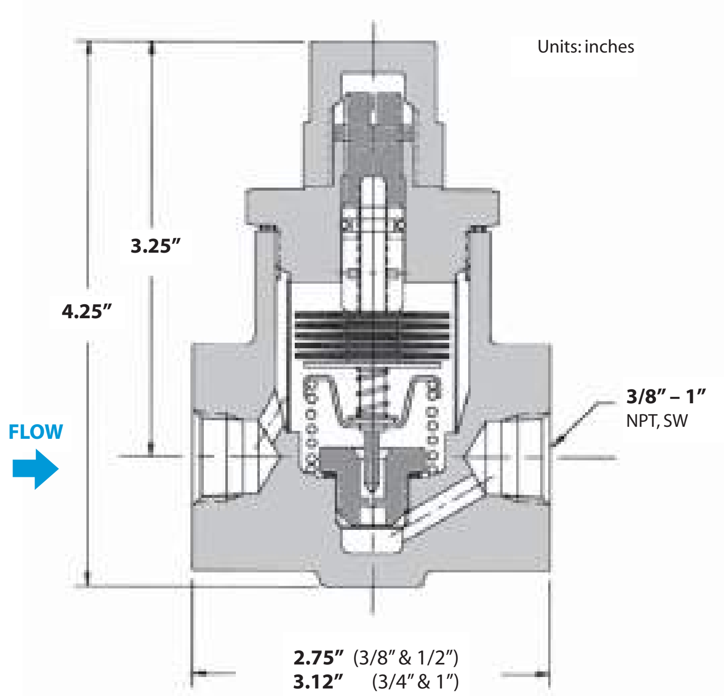
MATERIALS	
Body and Cover	304 Stainless Steel
Bimetal Element	GB14
Valve Seat	420 Stainless Steel
Valve Stem	420 Stainless Steel

Bi-Metal Adjustable Discharge Temperature

WT5000
Bi-Metal

(Repairable)

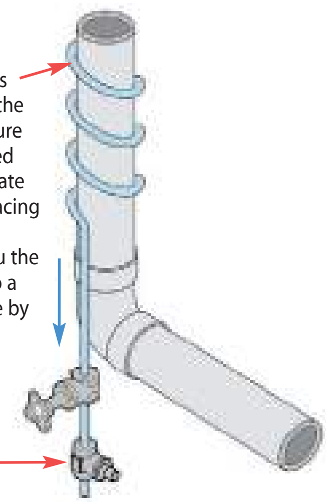




Notes:

1) Capacities in chart are based on discharging condensate to atmospheric pressure (0 PSIG).
2) **Initial Opening Temperature = T** is the temperature at which the trap just begins to open. A negligable amount of condensate flow takes place at this temperature. It is adjustable between 120˚F and 390˚F.
3) **Initial Opening Temperature** must be at least 27 degrees below the saturated steam temperature to prevent possible steam loss.
4) When the condensate cools below the initial opening temperature, the Bi-metal mechanism opens further, increasing trap capacity. Trap capacity can be adjusted up to the max value given in the chart.
5) For instructions on setting the trap discharge temperature and capacity, refer to the Watson McDaniel Installation and Maintenance Guide.
6) *Example:* A WT5000 trap with 125 PSIG Steam Inlet Pressure can be set to an Initial Opening Temperature between 120˚F and 326˚F. It can pass up to 413 lbs/hr when the temperature of the condensate is 80˚F below the initial opening temperature (T–80˚F).

Demonstrated in this tracing application, the discharge temperature of the trap is adjusted so that hot condensate backs up into the tracing line. This allows the product flowing thru the pipe to be heated to a specific temperature by the condensate.



T = Initial Opening Temperature of the Trap can be set from 120˚F to 390˚F

Trap Capacities at Various Inlet Pressures – *Lbs/hr @ T, T-20˚F, T-40˚F, T-60˚F, T-80˚F*

T can range from 120˚F to 390˚F.	**Saturated Steam Temperature (˚F)** (based on given steam inlet pressure)														
	250	**274**	**298**	**338**	**353**	**366**	**388**	**406**	**422**	**436**	**448**	**460**	**470**	**489**	**497**
T range for Steam Inlet Pressure of 15 PSIG is 120 to 223˚F	**Maximum Initial Opening Temperature** must be at least 27 degrees below saturated steam temperature. (390˚F max)														
	223	247	271	311	326	339	361	379	390	→	→	→	→	→	390
Condensate Discharge Temperature	**Steam Inlet Pressure (PSIG)**														
	15	**30**	**50**	**100**	**125**	**150**	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**600**	**650**
T = Initial Opening Temp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T–20˚F 20˚below Initial Opening Temperature	56	70	102	144	161	177	204	228	250	270	289	306	323	354	368
T–40˚F 40˚below Initial Opening Temperature	116	164	212	300	336	368	425	475	520	562	600	637	671	735	756
T–60˚F 60˚below Initial Opening Temperature	134	190	245	346	387	424	490	548	600	648	693	735	775	849	883
T–80˚F 80˚below Initial Opening Temperature	143	202	261	370	413	453	523	584	640	691	739	784	826	905	942

Steam Traps

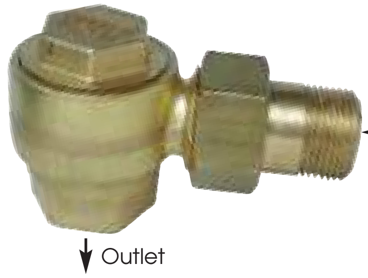
Thermostatic Steam Trap

(Repairable)

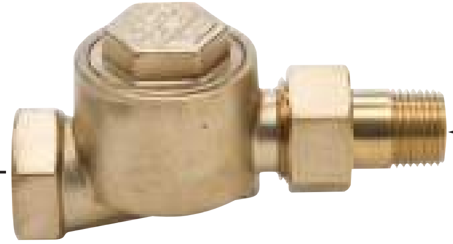
TA25B, TA125
TS25B, TS125

Model	**TA25B, TA125, TS25B, TS125**
Sizes	**1/2", 3/4"**
Connections	**NPT**
Body Material	**Brass**
PMO Max. Operating Pressure	**TA25B, TS25B 25 PSIG** **TA125, TS125 125 PSIG**
TMO Max. Operating Temperature	**Saturated Steam Temperature**
PMA Max. Allowable Pressure	**125 PSIG up to 450°F**
TMA Max. Allowable Temperature	**450°F @125 PSIG**

TA Type • Right-Angle Connection



TS Type • Straight-thru Connection



Typical Applications

TA & TS type steam traps are predominantly used in the HVAC industry. They are referred to as radiator traps because the quick-disconnect right angle connection of the TA Type is found on most steam radiator installations. The TS Type offers a straight-through connection alternative. TA and TS Series radiator traps were designed specifically for removing condensate and air from 2-pipe steam heating systems. Their excellent air-handling capabilities, compact size, and economical cost make them a great choice for air vents on heat exchangers or for steam trap applications on OEM equipment. Contains an extremely strong and rugged precision-welded Stainless Steel thermal element which is highly resistant to waterhammer.

How It Works

This thermostatic trap contains a welded stainless steel thermal element that expands when heated and contracts when cooled. When air and condensate are present the trap is in the open discharge position. When steam reaches the trap the element expands and closes off tightly.

Features

- Excellent air handling capability
- In-line repairable
- Welded stainless steel thermal element
- Stainless seat on TA125 & TS125
- High thermal efficiency

Sample Specification

The steam trap shall be of thermostatic type with brass or bronze body and stainless steel thermal element. Trap must be in-line repairable.

Installation and Maintenance

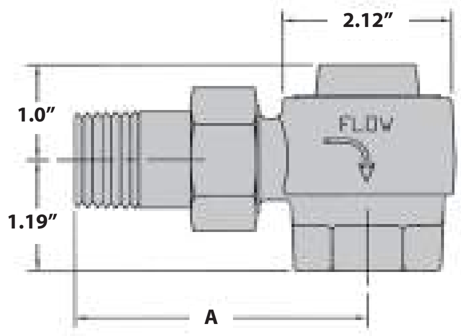
Trap can be installed in any orientation. The bodies are made from a high-quality brass forging and are easily repairable while the steam trap remains in-line by removing the cap and replacing the seat and thermal element. Repair kit includes thermal element, seat and gasket.

Thermostatic Steam Trap

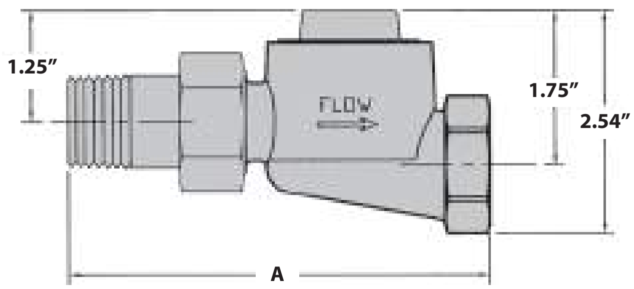
(Repairable)

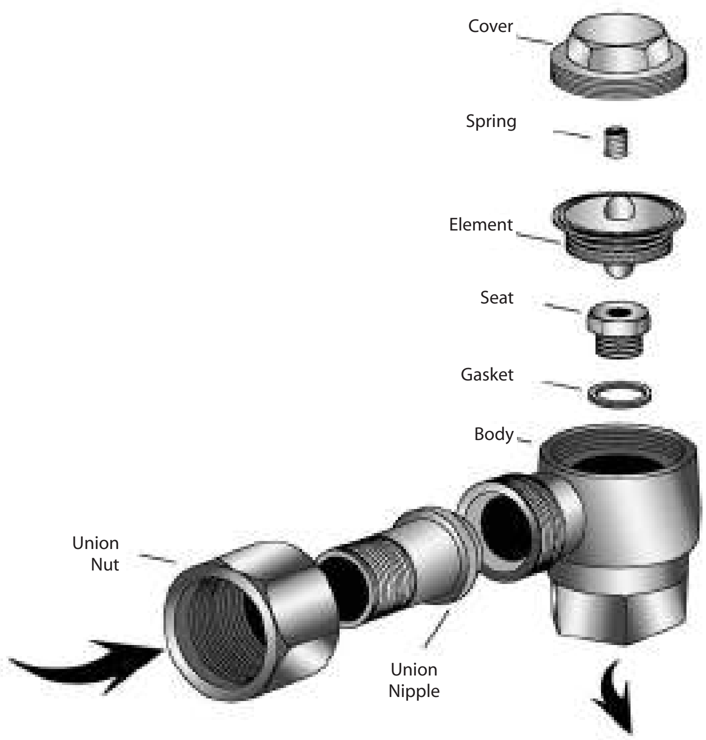
TA25B, TA125
TS25B, TS125

TA Type • Right-Angle Connection



TS Type • Straight-thru Connection





DIMENSIONS & WEIGHTS – *inches*

Model	Pipe Size	A	Weight (lbs)
TA25B, TA125	1/2"	2.1875	1.5
TA25B, TA125	3/4"	3.062	1.5
TS25B, TS125	1/2"	4.500	1.5
TS25B, TS125	3/4"	4.625	1.5

Note: *Other Union Connections and Lengths are available; consult factory.*

How to Size / Order

Select differential pressure; follow column down to correct capacity (lbs/hr) block. Example:

Application: 2100 lbs/hr at 40 PSI differential pressure

Size/Model: 3/4" **TA125**

CAPACITIES – *Condensate (lbs/hr)*

Size	Model Code	PMO (PSIG)	Steam Inlet Pressure (PSIG) 15	25	40	65	125
1/2"	TA25B-12-N TS25B-12-N	25	825	1070			
	TA125-12-N TS125-12-N	125	825	1070	1323	1610	1950
3/4"	TA25B-13-N TS25B-13-N	25	1290	1700			
	TA125-13-N TS125-13-N	125	1290	1700	2100	2575	3300

MATERIALS

Body	Forged Brass, CA 377
Element	Welded Stainless Steel, AISI 302
Cover	Forged Brass, CA 377
Spring	Stainless Steel, AISI 304
Seat	TA25B/TS25B: Brass ASTM B-21 TA125/TS125: Stainless Steel, AISI 303
Gasket	Brass, ASTM B-21
Union Nipple	Brass, ASTM B-16
Union Nut	Brass, ASTM B-16

Thermostatic Steam Trap (Repairable)

Model	**WT2500 (Repairable)**
Sizes	1/2", 3/4"
Connections	NPT
Body Material	Cast Iron
PMO Max. Operating Pressure	**250 PSIG**
TMO Max. Operating Temperature	406°F
PMA Max. Allowable Pressure	250 PSIG up to 450°F
TMA Max. Allowable Temperature	450°F @ 250 PSIG

Typical Applications

DRIP, TRACING, PROCESS: The **WT2500** is a general purpose medium capacity thermostatic trap that can be used for steam tracing; as a drip trap on steam mains and steam supply lines; as well as for process applications. All internal working components can be replaced while the trap body remains in-line. Like all thermostatic traps, they are small, light weight, operate over a wide pressure range, and have excellent air handling capabilities. Discharging air at start-up allows steam to quickly enter the system. The WT2500 is an excellent choice for a variety of applications. Contains an extremely strong and rugged precision welded Stainless Steel thermal element which is highly resistant to waterhammer.

How It Works

The thermostatic trap contains a welded stainless steel thermal element that expands when heated and contracts when cooled. When air and condensate are present, the trap is in the open discharge position. When steam reaches the trap, the element expands and closes off tightly.

Features

- The thermal element and seat can be easily removed and replaced in minutes with the trap body still in-line
- Operates at steam pressures up to 250 PSIG
- Thermostatic traps have excellent air handling capability
- Welded stainless steel thermal element resists shock from water hammer
- Freeze-proof when trap is installed in a vertical orientation allowing for complete condensate drainage
- Hardened stainless steel seat for extended service life

Sample Specification

The steam trap shall be of a thermostatic type with cast iron body and stainless steel thermal element. Trap must be in-line repairable with a bolt-on type cover that is sealed with a spiral wound Stainless Steel AISI 316 gasket. Valve and seat to be hardened stainless steel.

Installation and Maintenance

Trap can be installed in any orientation. All internal working components are extremely easy to replace and can be performed while the trap body remains in line by removing the four-bolt cover. Repair kit includes ALL parts to fully rebuild the steam trap including thermal element, seat and gasket.

Helpful Selection Information

Two orifice sizes are available: The 3/16″ orifice should be used on all drip and tracing applications as well as small process applications with lower condensate loads. The 5/16″ orifice is available to be used on process applications if additional capacity is required.

Options

SLR = Steam lock release

How to Size / Order

Select working pressure; follow column down to correct capacity (lbs/hr). Example:

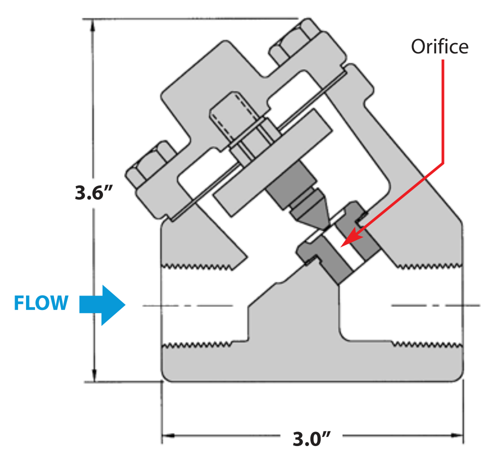
Application: 1827 lbs/hr at 100 PSIG working inlet pressure
Size/Model: **WT2501-12-N**, 1/2″ NPT, 3/16″ orifice.

MATERIALS

Cover & Body	Cast Iron ASTM A-126 Class B
Thermal Element	Stainless Steel, AISI 302
Valve & Seat	Stainless Steel, AISI 416
Cover Gasket	Garlock

CAPACITIES – *condensate (lbs/hr)*

Size	Model Code	Orifice Size	Steam Inlet Pressure (PSIG) 5	10	20	50	100	125	150	200	250
1/2″	WT2501-12-N	3/16″	441	625	882	1391	1827	1969	2095	2305	2483
3/4″	WT2501-13-N										
1/2″	WT2503-12-N	5/16″	903	1271	1811	2861	3754	4043	4300	4730	5093
3/4″	WT2503-13-N										

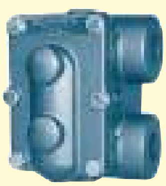
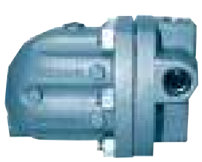



POINT
DOWN


WATSON
McDANIEL
01944

Float & Thermostatic					64-83
Model	Body Material	PMO (PSIG)	Sizes	Connections	Page No.
WFT	Cast Iron	**250**	3/4" – 2"	NPT	**66**
FTT	Ductile Iron	**300**	1/2" – 2"	NPT	**70**
FTE/FTES	Ductile Iron/Cast Steel	**200/300**	1 1/2", 2", 2 1/2"	NPT, SW, FLG	**74**
FT600/FT601	Carbon Steel/Stainless Steel	**450**	3/4" – 4"	NPT, SW, FLG	**76**
FT	Cast Iron	**75**	3/4" – 2"	NPT	**82**

PMO = Maximum Operating Pressure

	Characteristics	Material	Application
WFT 	Parallel Pipe Connection	Cast Iron	Primary Selection for Low to Medium Capacity General Purpose Process Applications Smaller sizes can also be used for Drip Applications
FTT 	In-Line Pipe Connection	Ductile Iron	
FTE & **FTES** 	Extremely High-Capacity	**FTE**: Ductile Iron **FTES**: Cast Steel	High Capacity Process Applications
FT600 & **FT601** 	Cast Steel Body	**FT600**: Carbon Steel **FT601**: Stainless Steel	Where Carbon Steel or Stainless Steel bodies are required
FT 	Parallel Pipe Connection (H-pattern)	Cast Iron	General Purpose, Low to Medium Capacity Process Applications up to 75 psig Smaller sizes can also be used for Drip Applications

Introduction

FLOAT & THERMOSTATIC TRAPS

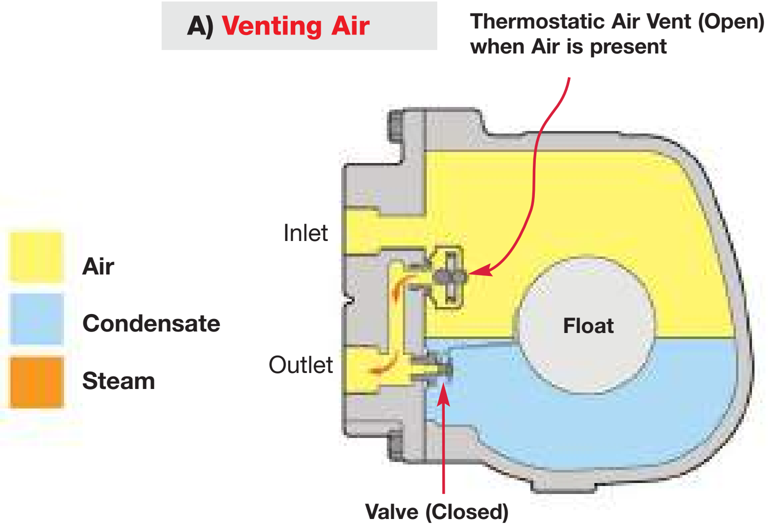
F&T steam traps are the most common trap type used for process applications. They use a float-operated valve mechanism to discharge condensate as it is formed, and an air vent for discharging air at start-up; both very important requirements for process applications. The WFT and FTT-Series with Iron bodies, are suitable for most general purpose process applications up to 250 PSIG. The 3/4″ WFT and FTT are often used for drip applications. The FTE-Series has extremely high capacity. The FT600 Series available with Cast Steel or Stainless Steel bodies; often required in Chemical and Petrochemical refineries and other industries.

F&T Traps are classified as mechanical style traps and require the buoyancy of the float, and a lever mechanism to lift the valve disc off the seat orifice. Larger seat orifices and higher steam pressures require additional buoyancy and mechanical force for the trap to open. Select a trap model with an equal or higher PMO rating than the steam pressure, or the trap will not open. F&T traps are not self-draining and are therefore subject to freezing in cold climates. Freeze protection valves are available to fully drain most model F&T traps during shut down periods.

Operation:

At start-up, air and condensate enter the steam trap. The air will be discharged through the open thermostatic air vent (**Figure A**). As the condensate level in the trap rises, it lifts the float which opens the valve to allow the discharge of condensate. When steam enters the trap, the thermostatic element expands and closes the air vent, preventing the steam from escaping (**Figure B**). As the condensate discharges through the seat orifice, the float lowers, and shuts the valve (**Figure C**). The float closes the valve with a level of condensate above the seating orifice to prevent loss of any steam. The float level rises and falls to modulate the seat opening in order to maintain a constant equilibrium between the incoming and discharging condensate. Due to the balance of forces required between the incoming pressure and internal trap components, several orifice sizes are offered to accommodate various differential pressure ranges. These traps can be fitted with a steam lock release (SLR) to be used when the steam trap is physically positioned above the condensate collection point. For superheated steam applications, the thermostatic air vent is replaced with a live orifice air vent.

A) Venting Air

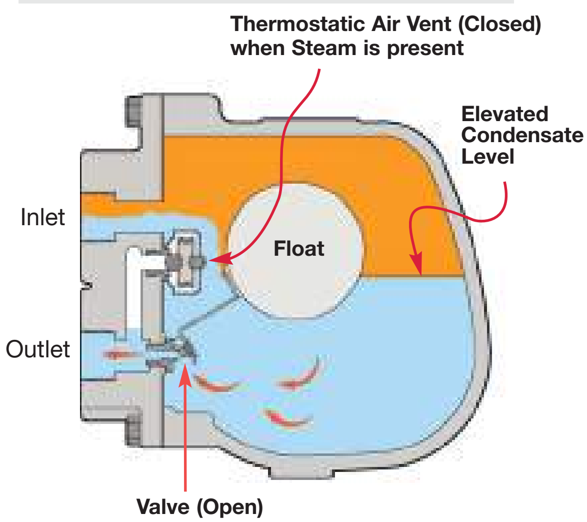


A) When cold air enters the trap during start-up, the thermostatic air vent is open, allowing the discharge of large quantities of air from the system.

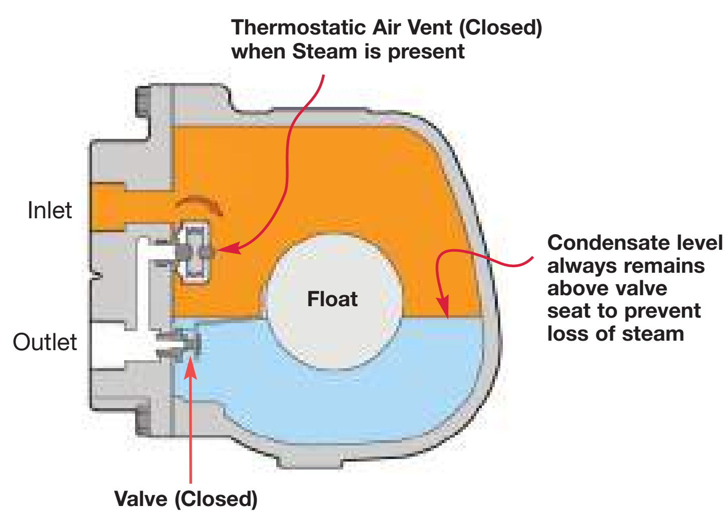
B) When condensate enters the trap, the float lifts which opens the valve, allowing condensate to discharge.

C) When steam is present, and no condensate is entering the trap, the valve and thermostatic air vent remain closed, trapping steam in the system.

B) Discharging Condensate



C) Closed (Trapping Steam)



Steam Traps

Float & Thermostatic Steam Trap

WFT Series

Float & Thermostatic

Model	**WFT**
Sizes	**3/4", 1", 1 1/4", 1 1/2", 2"**
Connections	**NPT**
Body Material	**Cast Iron**
PMO Max. Operating Pressure	**250 PSIG**
TMO Max. Operating Temperature	**Saturated Steam Temperature**
PMA Max. Allowable Pressure	**250 PSIG up to 450°F**
TMA Max. Allowable Temperature	**450°F @ 250 PSIG**

Typical Applications

PROCESS, DRIP: **WFT Series** with parallel port connections were specifically designed for removing condensate and air from HVAC and industrial process applications such as unit heaters, pressing machines, heat exchangers and coils. They contain a high-quality welded stainless steel thermostatic air vent and stainless steel mechanism. The WFT Series are fully repairable while the trap remains in-line and are available in 3/4" thru 2" NPT connections. For drip applications, such as draining steam mains and steam supply lines, use model 3/4" WFT-125 (WFT-125-13-N).

How It Works

Float and thermostatic traps contain a float-operated valve and seat mechanism with a separate thermostatic element which work together to remove both condensate and air from the steam system. The float, which is attached to a valve, rises and opens the valve when condensate enters the trap, allowing the condensate to discharge. Air is discharged through the thermostatic air vent to the outlet side of the trap. Steam entering the trap causes the thermostatic element to expand, closing the air vent and trapping the steam.

Features

- All stainless steel internals with hardened seat and wear parts
- In-line repairability is simplified by having all internals attached to the cover
- Welded stainless steel thermostatic air vent resists shock from waterhammer. Live orifice air vent is available for superheated applications
- Excellent air handling capability allows air to be discharged rapidly so steam can enter the system quickly during start-up
- F&T traps discharge condensate immediately as it is formed (no condensate will back up into the system)

Sample Specification

The trap shall be of float and thermostatic design with cast iron body and parallel piping configuration. Thermostatic air vent to be welded stainless steel. All internals must be stainless steel with hardened seat area. Trap must be in-line repairable.

Installation and Maintenance

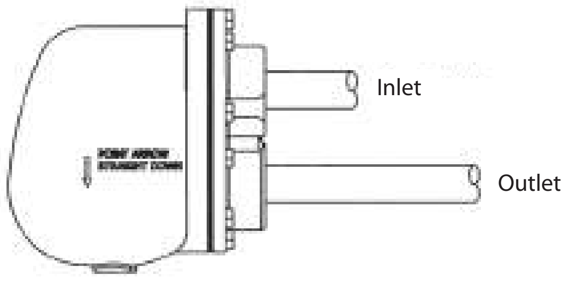
The trap must be installed upright and level for the float mechanism to operate properly. All internal components can be replaced with the trap connected in-line. Repair kits include thermostatic air vent, float, valve seat and disc, and gaskets. The standard thermostatic air vent can be damaged by superheat; therefore, in applications with superheated steam, the thermostatic air vent should be replaced with a special "live orifice" air vent.

Options

- Live orifice air vent for superheated steam applications.
- NPT Connection for freeze protection

MATERIALS	
Body & Cover	Cast Iron
Gasket	Grafoil
Cover Screws	Steel, GR5
Float	Stainless Steel, AISI 304
Internals	Stainless Steel, 300 Series
Thermostat	Stainless Steel
Valve Seat	Stainless Steel, 17-4 PH
Valve Disc	Stainless Steel, AISI 420F

Demonstration of Parallel piping connections:



How to Size / Order

The PMO (maximum operating pressure) rating of model selected must meet or exceed the maximum steam pressure or the trap may not open. For example; the WFT-125 has a PMO of 125 psi. Condensate capacity (lbs/hr) of the trap is based on the differential pressure across the trap. For drip applications, a 3/4" WFT size is generally sufficient to exceed warm-up loads with a 2X safety factor. The condensate loads (lbs/hr) for process applications are normally calculated at the maximum steam pressure; then an appropriate safety margin is applied in order to select a trap with sufficient capacity when operating at lower steam pressures. Reference full explanation of Safety Load Factors in Steam Trap Introduction section.

When a temperature control valve regulates the flow of steam to the process equipment (Heat Exchanger) being drained of condensate, it is recommended to select a trap with a PMO that exceeds the inlet steam pressure to the temperature control valve. This assures that under all operating conditions, the steam pressure will not exceed the PMO of the trap.

For Example: Process application has a maximum steam inlet pressure of 100 psi, a maximum condensate load of 2,500 lbs/hr and is discharging to a condensate return line with a possible back pressure of 25 PSIG. **ΔP** = 100-25 = 75 PSI

To select trap: If the Safety Load Factor is chosen to be 2X max capacity at max differential pressure, then Trap should be selected based on 5,000 lbs/hr (2,500 x 2 = 5,000) at 75 PSI differential pressure with a PMO in excess of 100 PSIG

Selection: **WFT-125-17-N**, PMO=125 PSIG, 2″ NPT with a condensate capacity of 7,460 lbs/hr at 75 PSI differential pressure.

CAPACITIES – *Condensate (lbs/hr)*

Model Code	PMO (PSIG)	Pipe Size	Orifice Size	ΔP = Differential Pressure (PSI) 1/4	1/2	1	2	5	10	15	20	30	40	50	75	100	125	150	175	200	225	250
WFT-015-13-N	15	3/4″	0.250	390	490	620	780	1050	1320	1500												
WFT-015-14-N	15	1″	0.250	390	490	620	780	1050	1320	1500												
WFT-015-15-N	15	1 1/4″	0.312	610	770	960	1210	1630	2040	2330												
WFT-015-16-N	15	1 1/2″	0.500	1420	1910	2570	3460	5120	6890	8190												
WFT-015-17-N	15	2″	0.625	2260	2950	3860	5040	7170	9360	10930												
WFT-030-13-N	30	3/4″	0.228	330	420	530	670	930	1180	1350	1500	1720										
WFT-030-14-N	30	1″	0.228	330	420	530	670	930	1180	1350	1500	1720										
WFT-030-15-N	30	1 1/4″	0.228	330	420	530	670	930	1180	1350	1500	1720										
WFT-030-16-N	30	1 1/2″	0.390	930	1240	1650	2190	3210	4280	5060	5700	6750										
WFT-030-17-N	30	2″	0.500	1420	1910	2570	3460	5120	6890	8190	9260	11020										
WFT-075-13-N	75	3/4″	0.166	175	225	295	385	545	705	825	920	1075	1200	1305	1525							
WFT-075-14-N	75	1″	0.166	175	225	295	385	545	705	825	920	1075	1200	1305	1525							
WFT-075-15-N	75	1 1/4″	0.312	640	850	1130	1500	2180	2900	3420	3850	4540	5110	5600	6610							
WFT-075-16-N	75	1 1/2″	0.312	640	850	1130	1500	2180	2900	3420	3850	4540	5110	5600	6610							
WFT-075-17-N	75	2″	0.422	1020	1340	1760	2310	3330	4380	5140	5760	6770	7590	8290	9730							
WFT-125-13-N	125	3/4″	0.128	105	135	180	235	340	445	525	585	690	770	845	990	1110	1210					
WFT-125-14-N	125	1″	0.128	105	135	180	235	340	445	525	585	690	770	845	990	1110	1210					
WFT-125-15-N	125	1 1/4″	0.250	410	540	710	930	1340	1770	2070	2320	2730	3050	3340	3920	4390	4790					
WFT-125-16-N	125	1 1/2″	0.250	410	540	710	930	1340	1770	2070	2320	2730	3050	3340	3920	4390	4790					
WFT-125-17-N	125	2″	0.332	720	960	1270	1690	2460	3270	3860	4340	5130	5770	6320	7460	8390	9190					
WFT-175-13-N	175	3/4″	0.166	190	250	320	420	590	770	900	1010	1180	1310	1430	1670	1870	2030	2180	2310			
WFT-175-14-N	175	1″	0.166	190	250	320	420	590	770	900	1010	1180	1310	1430	1670	1870	2030	2180	2310			
WFT-175-15-N	175	1 1/4″	0.250	410	540	710	930	1340	1770	2070	2320	2730	3050	3340	3920	4390	4790	5150	5470			
WFT-175-16-N	175	1 1/2″	0.250	410	540	710	930	1340	1770	2070	2320	2730	3050	3340	3920	4390	4790	5150	5470			
WFT-175-17-N	175	2″	0.281	520	680	900	1180	1700	2230	2620	2930	3440	3860	4210	4950	5540	6050	6510	6920			
WFT-250-13-N	250	3/4″	0.128	115	145	190	245	345	450	520	580	675	755	820	955	1060	1155	1235	1310	1375	1440	1495
WFT-250-14-N	250	1″	0.128	115	145	190	245	345	450	520	580	675	755	820	955	1060	1155	1235	1310	1375	1440	1495
WFT-250-15-N	250	1 1/4″	0.203	270	350	450	590	820	1070	1240	1380	1600	1780	1940	2250	2500	2720	2910	3080	3240	3380	3520
WFT-250-16-N	250	1 1/2″	0.203	270	350	450	590	820	1070	1240	1380	1600	1780	1940	2250	2500	2720	2910	3080	3240	3380	3520
WFT-250-17-N	250	2″	0.250	410	540	710	930	1340	1760	2060	2310	2710	3040	3320	3890	4360	4760	5110	5430	5730	6000	6250

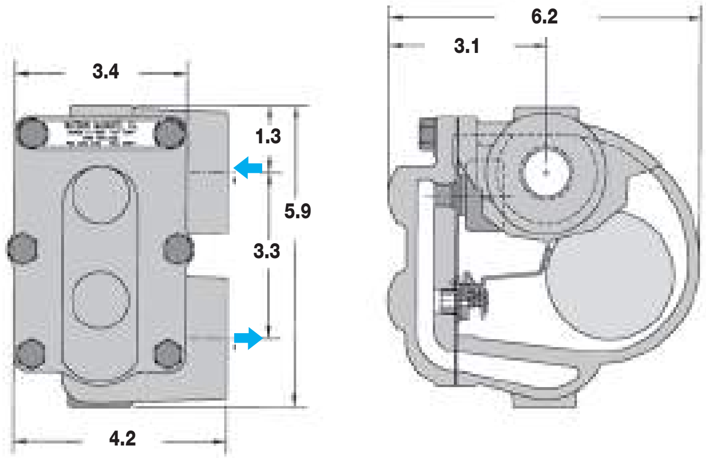
Float & Thermostatic Steam Trap

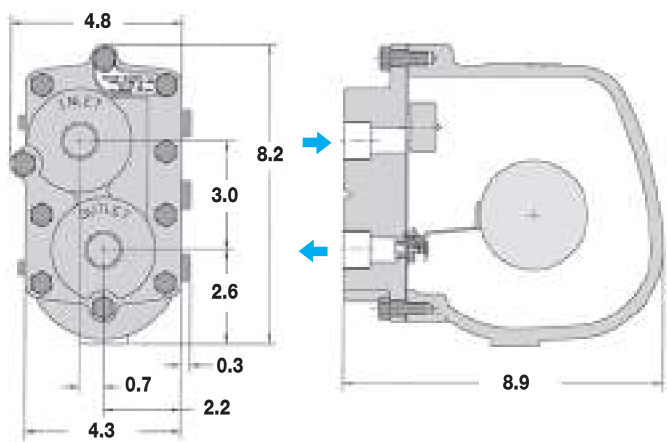
WFT Series
Float & Thermostatic

Dimensions: inches

WFT
3/4" • 1" • 1 1/4"

WFT
3/4" & 1"



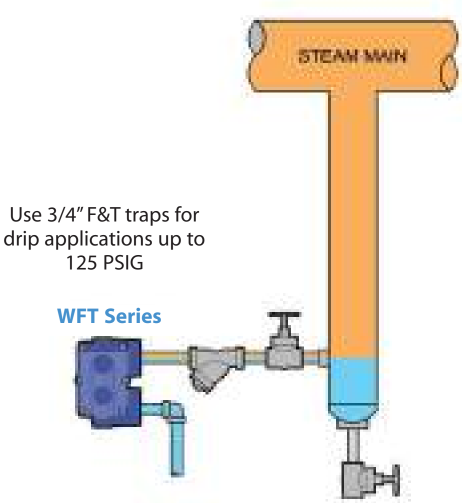


SPECIFICATIONS

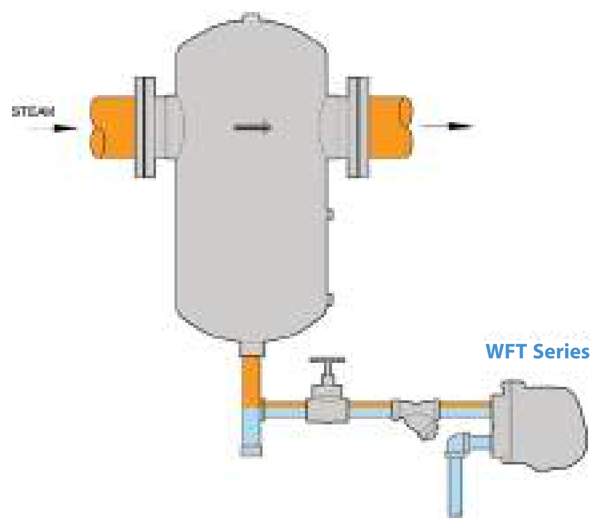
Model	Sizes	Connection	PMO (PSIG)	PMA (PSIG)	Weight (lbs)
WFT-15	3/4", 1", 1 1/4"	NPT	15	125	9
WFT-30	3/4", 1", 1 1/4"	NPT	30	125	9
WFT-75	3/4", 1"	NPT	75	125	9
WFT-125	3/4", 1"	NPT	125	125	9

SPECIFICATIONS

Model	Sizes	Connection	PMO (PSIG)	PMA (PSIG)	Weight (lbs)
WFT-175	3/4", 1"	NPT	175	250	20
WFT-250	3/4", 1"	NPT	250	250	20



Steam Main Drip Application

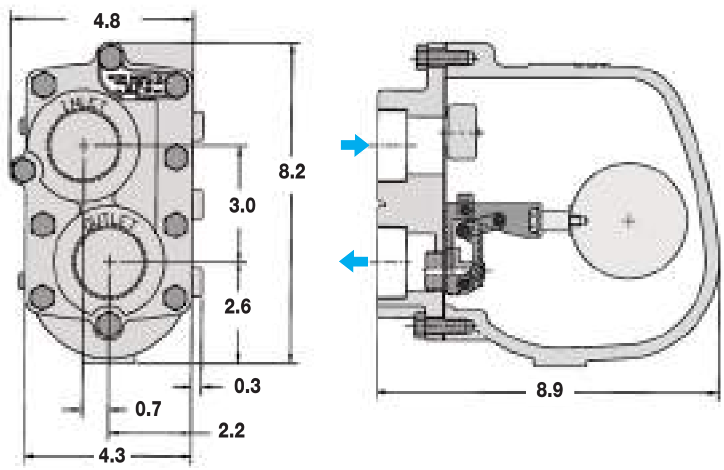


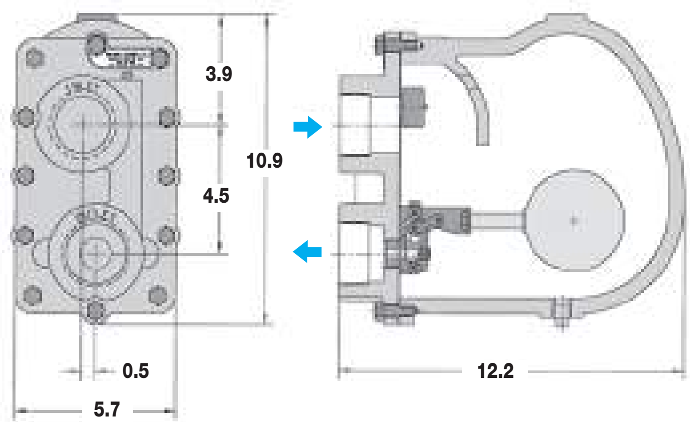
Separator Application

Dimensions: inches

WFT
1 1/4″ & 1 1/2″

WFT
2″





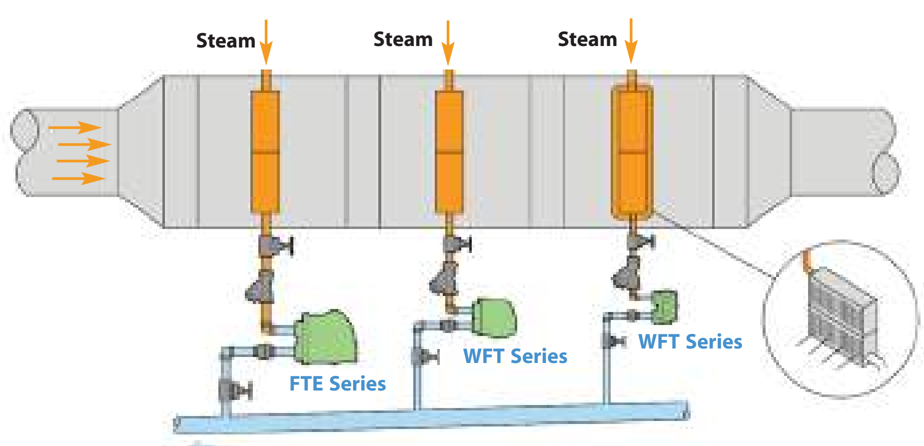
SPECIFICATIONS

Model	Sizes	Connection	PMO (PSIG)	PMA (PSIG)	Weight (lbs)
WFT-15	1 1/2″	NPT	15	250	21
WFT-30	1 1/2″	NPT	30	250	21
WFT-75	1 1/4″, 1 1/2″	NPT	75	250	21
WFT-125	1 1/4″, 1 1/2″	NPT	125	250	21
WFT-175	1 1/4″, 1 1/2″	NPT	175	250	21
WFT-250	1 1/4″, 1 1/2″	NPT	250	250	21

SPECIFICATIONS

Model	Sizes	Connection	PMO (PSIG)	PMA (PSIG)	Weight (lbs)
WFT-15	2″	NPT	15	250	53
WFT-30	2″	NPT	30	250	53
WFT-75	2″	NPT	75	250	53
WFT-125	2″	NPT	125	250	53
WFT-175	2″	NPT	175	250	53
WFT-250	2″	NPT	250	250	53

Multi-bank Air Heating Coils / Air Handler Unit



Float & Thermostatic Steam Trap

FTT Series

Float & Thermostatic

Model	FTT
Sizes	1/2", 3/4", 1", 1 1/2", 2"
Connections	NPT, 150# FLG (1" - 2")
Body Material	Ductile Iron
PMO Max. Operating Pressure	300 PSIG
TMO Max. Operating Temperature	Saturated Steam Temperature
PMA Max. Allowable Pressure	300 PSIG up to 450°F
TMA Max. Allowable Temperature	450°F @ 300 PSIG

1/2" & 3/4" available in NPT only.

Typical Applications

DRIP, PROCESS: **FTT Series** steam traps with in-line pipe connections are used for the removal of condensate and air in HVAC and industrial process applications such as unit heaters, water heaters, pressing machines, heat exchangers and coils. They contain a high-quality welded stainless steel thermostatic air vent and stainless seat and mechanism. F&T traps have excellent air handling capability, making them a better choice than Inverted Bucket traps for most process applications. For drip applications, such as draining steam mains and steam supply lines, use 1/2" or 3/4" sizes.

How It Works

Float and thermostatic traps contain a float and seat mechanism with a separate thermostatic element which work together to remove both condensate and air from the steam system. The float, which is attached to a valve, rises and opens the valve when condensate enters the trap. This allows the condensate to discharge. Air is discharged through the thermostatic air vent to the outlet side of the trap. Steam entering the trap causes the thermostatic element to expand, closing the air vent and trapping the steam.

Sample Specification

The trap shall be of float and thermostatic design with ductile iron body and in-line piping configuration. Thermostatic air vent to be welded stainless steel. All internals must be stainless steel with hardened seat area. Trap must be in-line repairable.

Options

- Live orifice air vent for superheated steam applications.
- NPT Connection for freeze protection

Installation and Maintenance

The trap must be installed upright and level for the float mechanism to operate properly. All internal components can be replaced with the trap body remaining in-line. Repair kits include thermostatic air vent, float, valve seat and disc, and gaskets. The standard thermostatic air vent can be damaged by superheat; therefore, in applications with superheated steam, the thermostatic air vent should be replaced with a special "live orifice" air vent.

Features

- Ductile Iron has a higher pressure and temperature rating and is more resistant to shock loads than cast Iron
- All stainless steel internals with hardened seat and wear parts
- In-line repairability is simplified by having all internals attached to the cover
- Welded stainless steel thermostatic air vent resists shock from waterhammer. Live orifice air vent is available for superheated applications
- Excellent air handling capability allows air to be discharged rapidly so steam can enter the system quickly during start-up
- F&T traps discharge condensate immediately as it is formed (no condensate will back up into the system)

How to Size / Order

The PMO (maximum operating pressure) rating of model selected must meet or exceed the maximum steam pressure or the trap may not open. For example; the FTT-145 has a PMO of 145 psi. Condensate capacity (lbs/hr) of the trap is based on the differential pressure across the trap. For drip applications, a 1/2" FTT size is generally sufficient to exceed warm-up loads with a 2X safety factor. The condensate loads (lbs/hr) for process applications are normally calculated at the maximum steam pressure; then an appropriate safety margin is applied in order to select the trap with sufficient capacity when operating at lower steam pressures. Reference full explanation of Safety Load Factors in Steam Traps Introduction section.

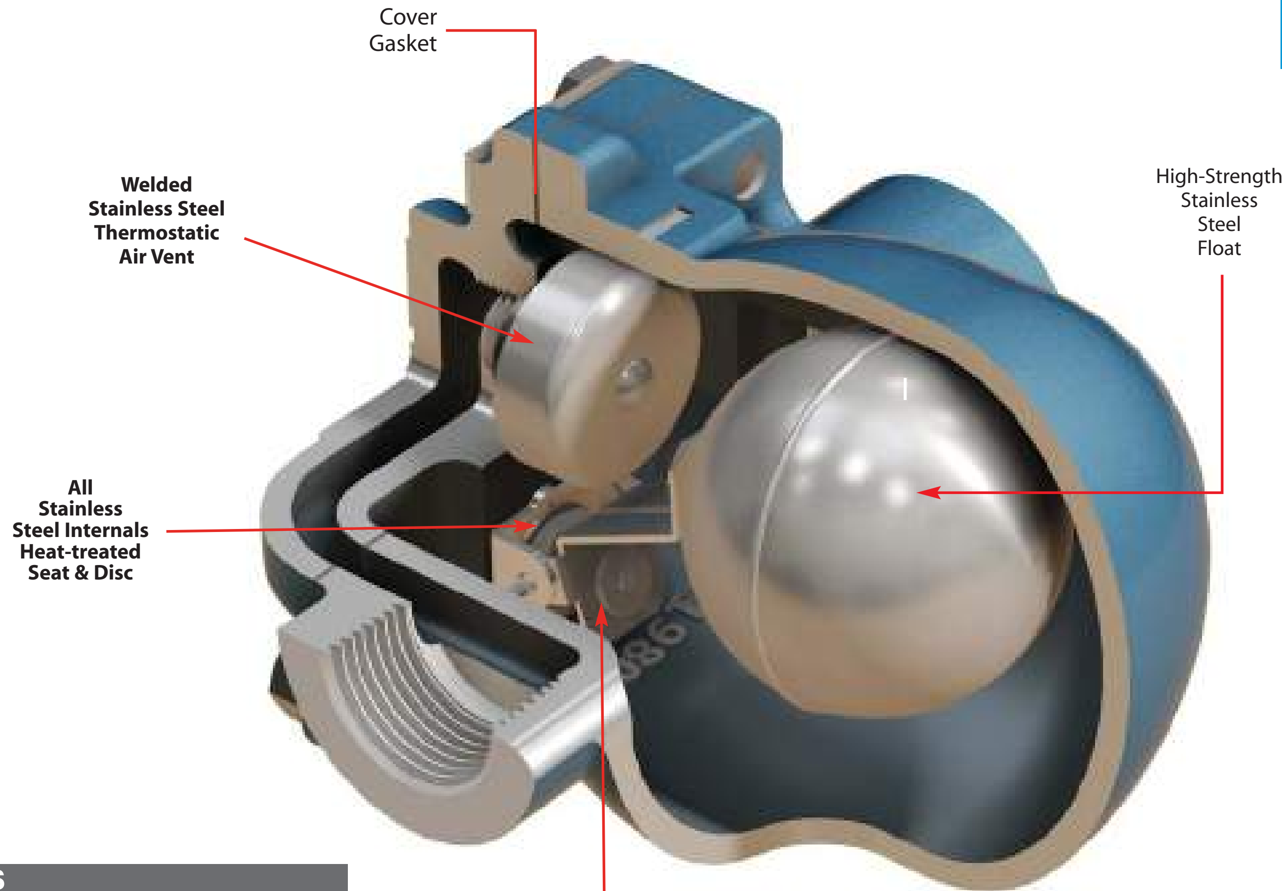
When a temperature control valve is regulating flow to the process equipment, it is recommended to select a trap with a PMO that will exceed the inlet steam pressure to the control valve.

For Example: Process application has a maximum steam inlet pressure of 100 psi, a maximum condensate load of 2,500 lbs/hr and is discharging to a condensate return line with a possible back pressure of 25 psig. **ΔP** = 100-25 = 75 PSI

To select trap: If the Safety Load Factor is chosen to be 2X max capacity at max differential pressure, then Trap should be selected based on 5,000 lbs/hr (2,500 x 2 = 5,000) at 75 PSI differential pressure with a PMO in excess of 100 PSIG

Selection: **FTT-145-16-N**, PMO=145 PSIG, 1 1/2" NPT with a condensate capacity of 9,600 lbs/hr at 75 PSI differential pressure.

FTT Series
Float & Thermostatic



MATERIALS	
Body & Cover	Ductile Iron
Gasket	Grafoil
Cover Screws	Steel, GR5
Float	Stainless Steel, AISI 304
Internals	Stainless Steel
Thermostat	Stainless Steel
Valve Seat	Stainless Steel, 17-4 PH
Valve Disc	Stainless Steel, AISI 420F

Connection Code: **N**=NPT **F150** = 150# FLG
1/2″ & 3/4″ available in NPT only.
PMO = Max Operating Pressure

CAPACITIES – *Condensate (lbs/hr)*

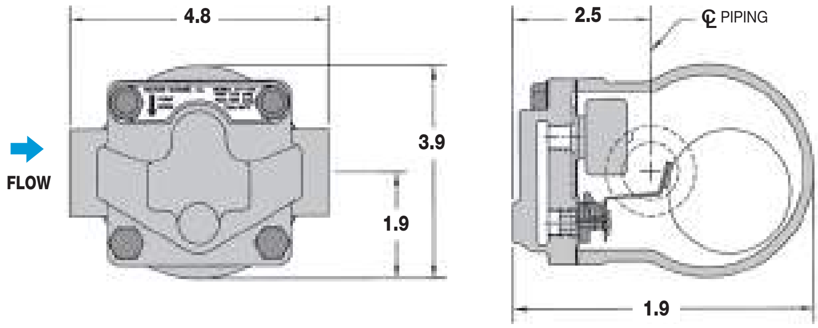
Model Code	PMO (PSIG)	Pipe Size	ΔP = Differential Pressure (PSI) 1/4	1/2	1	2	5	10	15	20	30	40	50	65	75	100	125	145	200	225	250	300
FTT-065-12-N	65	1/2″	115	155	205	270	390	520	610	685	810	910	995	1110								
FTT-065-13-N	65	3/4″	115	155	205	270	390	520	610	685	810	910	995	1110								
FTT-065-14-N	65	1″	340	500	775	1100	1700	2400	2800	3250	3925	4200	5000	5825								
FTT-065-16-N	65	$1^{1}/_{2}$″	1150	1650	2500	3450	5300	7500	8180	10600	13100	15000	16800	18900								
FTT-065-17-N	65	2″	3470	4820	8500	11950	18700	25200	26900	36000	43000	49600	55500	61300								
FTT-145-12-N	145	1/2″	55	75	100	135	200	270	320	365	435	490	540	600	640	725	795	850				
FTT-145-13-N	145	3/4″	55	75	100	135	200	270	320	365	435	490	540	600	640	725	795	850				
FTT-145-14-N	145	1″	190	275	405	550	840	1200	1380	1600	1850	2200	2450	2750	2920	3400	3700	3900				
FTT-145-16-N	145	$1^{1}/_{2}$″	685	970	1275	1750	2740	3750	4490	5100	6250	7200	8000	8900	9600	11250	12000	13300				
FTT-145-17-N	145	2″	1860	2680	3125	4400	6900	9250	13790	14600	16900	19400	21900	25000	26800	31000	34000	37000				
FTT-225-12-N	225	1/2″	40	50	70	95	135	185	220	245	290	330	360	405	430	485	530	565	645	680		
FTT-225-13-N	225	3/4″	40	50	70	95	135	185	220	245	290	330	360	405	430	485	530	565	645	680		
FTT-225-14-N	225	1″	150	200	300	405	600	820	975	1130	1375	1510	1620	1875	2000	2350	2600	2750	3100	3250		
FTT-250-16-N	250	$1^{1}/_{2}$″	530	710	825	1130	1760	2500	2950	3375	4125	4740	5250	6000	6400	7300	8000	8650	10200	10800	11300	
FTT-250-17-N	250	2″	695	985	1560	2185	3490	4800	5800	6750	8250	9500	10650	12400	13300	15000	16600	18120	21200	22300	23200	
FTT-300-14-N	300	1″	100	155	220	300	460	630	750	860	1060	1240	1360	1450	1600	1820	2000	2130	2500	2650	2800	3000

Float & Thermostatic Steam Trap

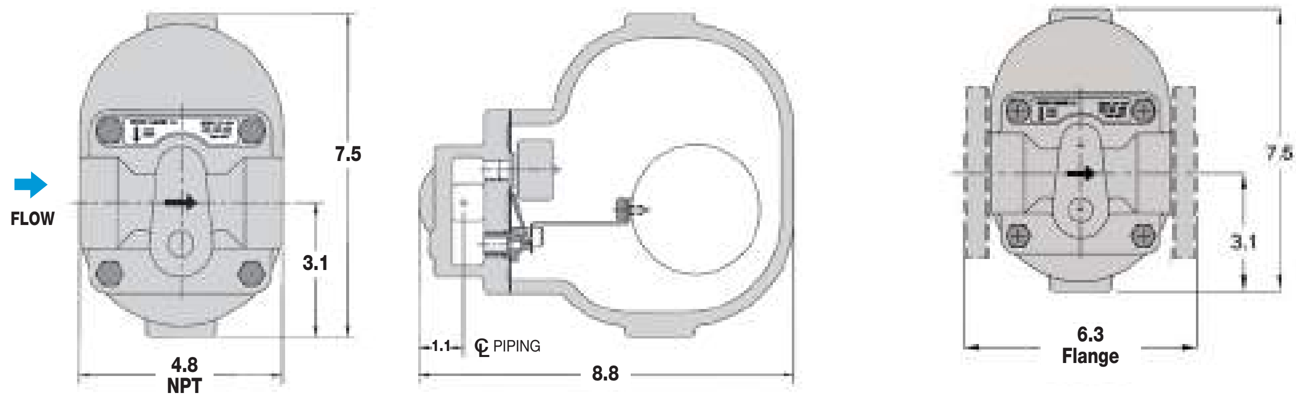
FTT Series
Float & Thermostatic

Dimensions: inches

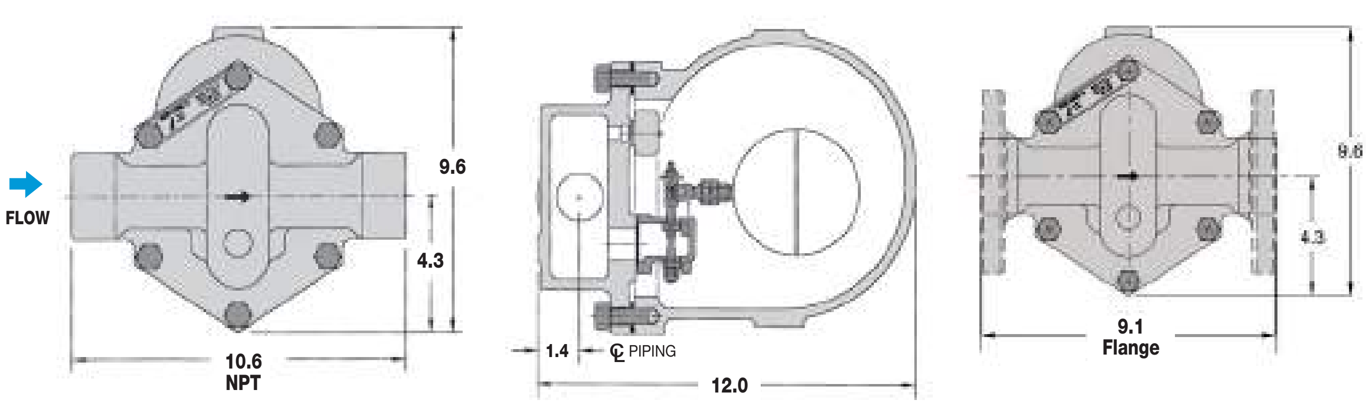
FTT • 1/2" & 3/4"
Weight: **6 lbs.**



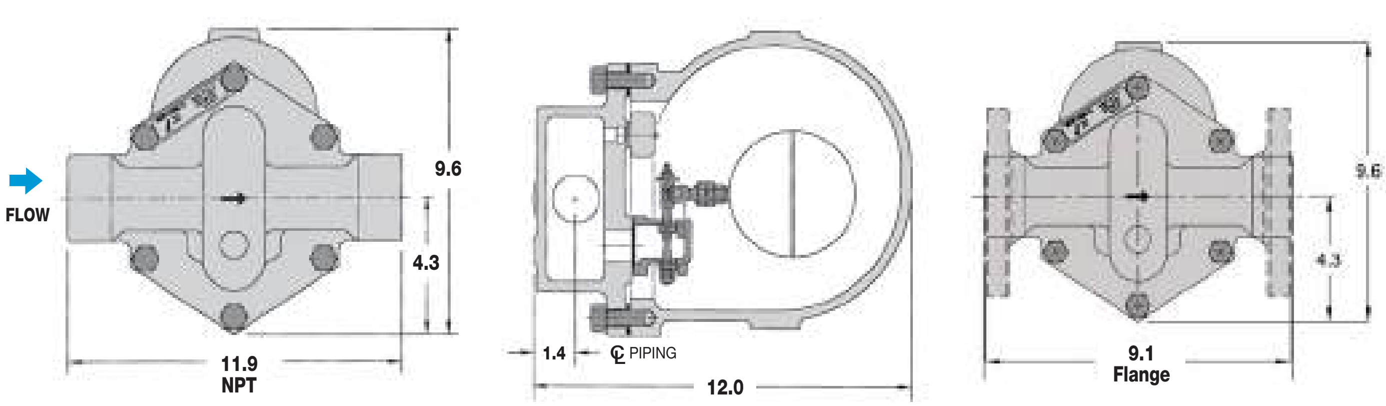
FTT 1"
Weight threaded NPT: **16 lbs.**



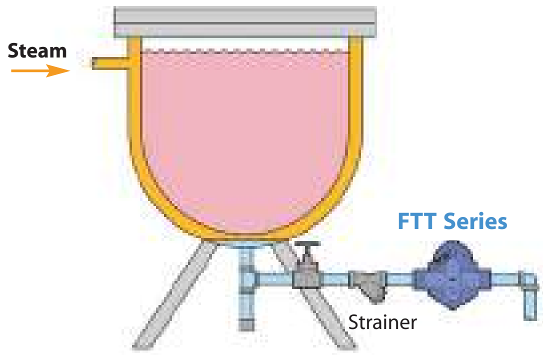
FTT • 1½" • Weight threaded NPT **38 lbs.**



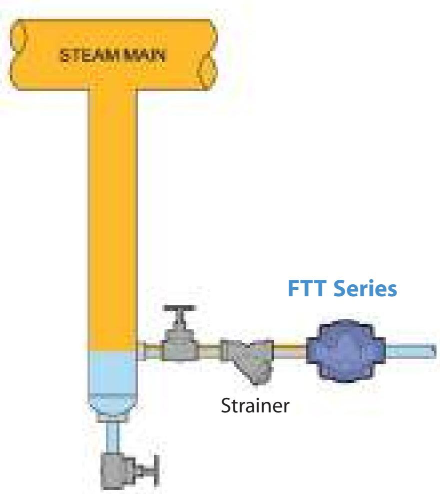
FTT • 2" • Weight threaded NPT **42 lbs.**



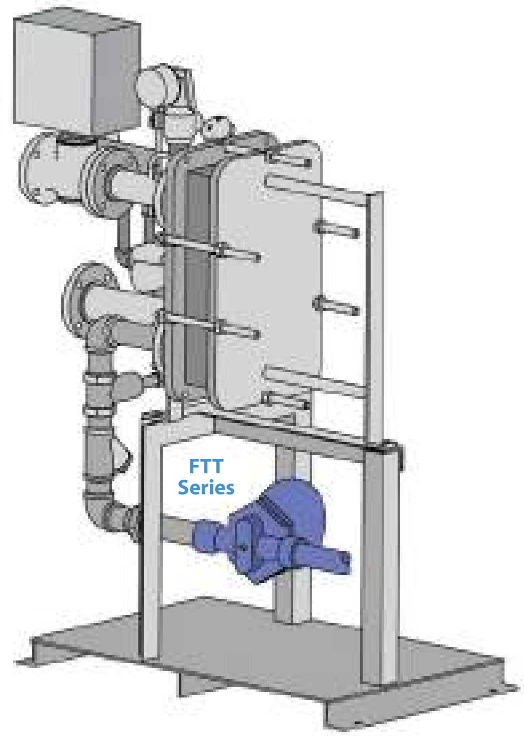
Typical Applications for Float & Thermostatic Steam Traps



Jacketed Kettle Application



Steam Main Drip Application



Instantaneous Steam to Hot Water Heater (Heat Miser)

Float & Thermostatic Steam Trap

FTE & FTES
Float & Thermostatic

Model	FTE	FTES
Sizes	1½", 2", 2½"	2½"
Connections	NPT	NPT, SW, FLG
Body Material	Ductile Iron	Cast Steel
PMO Max. Operating Pressure	200 PSIG	300 PSIG
TMO Max. Operating Temperature	450°F	450°F
PMA Max. Allowable Pressure	300 PSIG up to 450°F	300 PSIG up to 750°F
TMA Max. Allowable Temperature	450°F @ 300 PSIG	750°F @ 300 PSIG

The FTE & FTES are used for extremely high capacity condensate drainage applications.

Typical Applications

PROCESS: FTE & FTES Series are high capacity steam traps specifically designed to remove condensate and air from HVAC and industrial process applications with extremely high condensate load requirements. Examples include reboilers, absorption chillers, large air-handling coils, large heat exchangers and other large process equipment. They are available with a ductile iron (FTE) or steel body (FTES) and contain a high quality welded stainless steel thermostatic air vent and stainless mechanism. F&T traps have excellent air-handling capability, making them a better choice than Inverted Bucket traps for most process applications.

Features

- Ductile Iron has a higher pressure and temperature rating and is more resistant to shock loads than Cast Iron
- Cast Steel Body will allow operating pressures and temperatures up to 300 PSIG and 450˚F
- High capacity steam trap for draining large process equipment (over 100,000 lbs/hr)
- All stainless steel internals with hardened seat and wear parts
- In-line repairability is simplified by having all internals attached to the cover
- Welded stainless steel thermostatic air vent resists shock from waterhammer. Live orifice air vent is available for superheated applications
- Excellent air handling capability allows air to be discharged rapidly so steam can enter the system quickly during start-up
- F&T traps discharge condensate immediately as it is formed (no condensate will back up into the system)

How It Works

Float and thermostatic traps contain a float and seat mechanism with a separate thermostatic element which work together to remove both condensate and air from the steam system. The float, which is attached to a valve, rises and opens the valve when condensate enters the trap. This allows the condensate to discharge. Air is discharged through the thermostatic air vent to the outlet side of the trap. Steam entering the trap causes the thermostatic element to expand, closing the air vent and trapping the steam.

Sample Specification

The trap shall be of float and thermostatic design with ductile iron or cast steel body. The trap must incorporate all stainless steel internals with hardened seat and welded stainless steel thermostatic air vent. Trap must be in-line repairable.

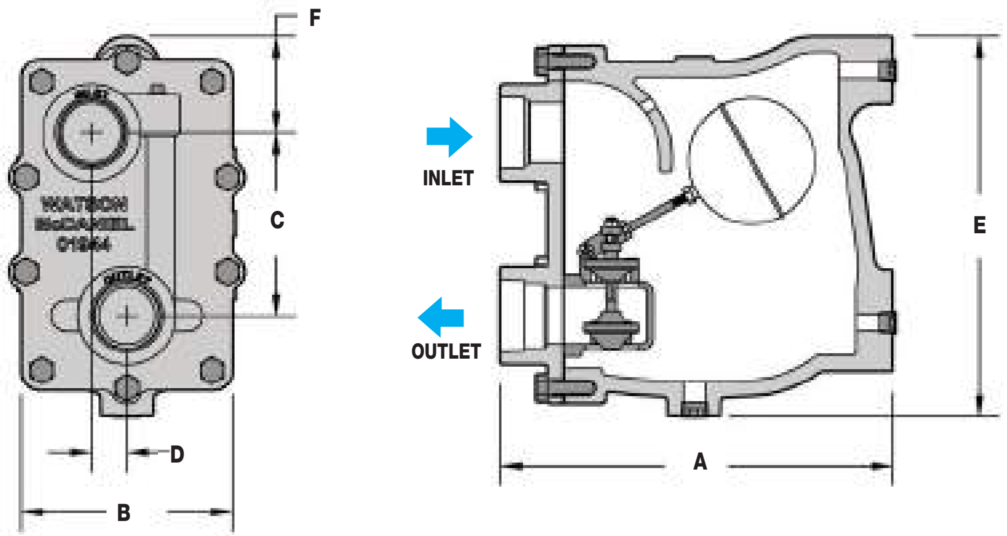
Installation and Maintenance

The trap must be installed upright and level for the float mechanism to operate properly. All internal components can be replaced with the trap body remaining in-line. Repair kits include thermostatic air vent, float, valve seat and disc, and gaskets. The **FTES** Series have cast steel bodies and are available in 2½" NPT, socket weld and flange connections. The standard thermostatic air vent can be damaged by superheat; therefore, in applications with superheated steam, the thermostatic air vent should be replaced with a special "live orifice" air vent.

Options

Live orifice air vent for superheated steam applications.

Parallel-pipe inlet/outlet connections are standard as shown. An optional In-line inlet/outlet connection is available; contact factory.



DIMENSIONS & WEIGHTS – *inches*							
Size/Model	A	B	C	D	E	F	Weight
2″ FTE-20	12.6	5.7	4.5	0.5	11.1	3.9	54
2″ FTE-50	16.0	8.4	7.3	1.4	15.6	3.6	150
2½″ FTE-50	15.5	8.4	7.3	1.4	15.6	3.6	150
2½″ FTE-125	15.5	8.4	7.3	1.4	15.6	3.6	150
1½″ FTE-200	9.6	4.3	3.0	0.7	8.8	2.6	35
2″ FTE-200	12.6	5.7	4.5	0.5	11.1	3.9	65
2½″ FTE-200	15.5	8.4	7.3	1.4	15.6	3.6	150
2½″ FTES-300	15.5	8.4	7.3	1.4	15.6	3.6	150

Note: 2½″ **FTES-50**, **125** & **300** have same dimensions and weights.

MATERIALS	
Body & Cover (FTE)	Ductile Iron
Body & Cover (FTES)	Cast Steel, ASTM A-216
Cover Screw	Grade 5 Carbon Steel
Cover Gasket	Grafoil
Valve Discs	Stainless Steel, AISI 17-4PH
Main Valve Assembly Housing	Stainless Steel, AISI 17-4PH
Valve Assembly Gasket	Garlock
Ball Float	Stainless Steel, AISI 304
Thermostatic Vent	Stainless Steel, AISI 300 Optional: Live orifice air vent

How to Size / Order

The PMO (maximum operating pressure) rating of model selected must meet or exceed the maximum steam pressure or the trap may not open. For example; the FTE-125 has a PMO of 125 psi. Condensate capacity (lbs/hr) of the trap is based on the differential pressure across the trap. The condensate loads (lbs/hr) for process applications are normally calculated at the maximum steam pressure; then an appropriate safety margin is applied in order to select a trap with sufficient capacity when operating at lower steam pressures. Reference full explanation of Safety Load Factors in Steam Traps Introduction section.

When a temperature control valve is regulating flow to the process equipment, it is recommended to select a trap with a PMO that will exceed the inlet steam pressure to the control valve.

For Example: Process application has a maximum steam inlet pressure of 100 psi, a maximum condensate load of 10,000 lbs/hr and is discharging to a condensate return line with a possible back pressure of 25 psig. **ΔP** = 100-25 = 75 PSI

To select trap: If the Safety Load Factor is chosen to be 2X max capacity at max differential pressure, then Trap should be selected based on 20,000 lbs/hr (10,000 x 2 = 20,000) at 75 PSI differential pressure with a PMO in excess of 100 PSIG

Selection: **FTE-200-17-N**, PMO=200 PSIG, 2″ NPT with a condensate capacity of 21,500 lbs/hr at 75 PSI differential pressure.

CAPACITIES – *Condensate (lbs/hr)*

Model Code	PMO (PSIG)	Pipe Size	Orifice Size	ΔP = Differential Pressure (PSI) 1/4	1/2	1	2	5	10	15	20	30	50	75	100	125	200	250	300
FTE-20-17-N*	20	2″	.937″	6100	7800	9300	11800	15900	19500	22500	26000								
FTE-50-17-N	50	2″	2.125″	12800	16900	20100	25300	33000	40200	43500	46000	47800	52500						
FTE-50-18-N	50	2½″	2.125″	20400	25700	31000	37000	46300	55100	60300	65100	72000	82100						
FTE-125-18-N	125	2½″	2.125″	20400	25700	31000	37000	46300	55100	60300	65100	72000	82100	90400	97700	105000			
FTE-200-16-N	200	1½″	.375″	950	1350	1900	2200	2700	3300	3900	4400	5300	6400	7600	8500	9400	11900		
FTE-200-17-N	200	2″	.75″	2700	4100	5700	7400	9900	11800	13400	14400	16400	19000	21500	23000	24500	29200		
FTE-200-18-N	200	2½″	1.5″	7200	12300	17400	21500	27600	32600	36000	39300	43100	49200	54700	58800	61900	74000		
FTES-50-18-N	50	2½″	2.125″	20400	25700	31000	37000	46300	55100	60300	65100	72000	82100						
FTES-125-18-N	125	2½″	2.125″	20400	25700	31000	37000	46300	55100	60300	65100	72000	82100	90400	97700	105000			
FTES-300-18-N	300	2½″	1.5″	7200	12300	17400	21500	27600	32600	36000	39300	43100	49200	54700	58800	61900	74000	86000	100550

** Single seat orifice. All others are double seated.*

Float & Thermostatic Steam Trap

FT600 & FT601
Float & Thermostatic

Model	**FT600 & FT601***
Sizes	**3/4", 1", 1 1/2", 2", 3", 4"**
Connections	**NPT, SW, FLG**
Body Material	**Carbon Steel or 316SS**
Options	**Live Orifice Air Vent**
PMO Max. Operating Pressure	**450 PSIG**
TMO Max. Operating Temperature	**750ºF**
PMA Max. Allowable Pressure	**990 PSIG @ 100ºF**
TMA Max. Allowable Temperature	**750ºF @ 670 PSIG**

*** FT601 Body Material is 316 SS**
FT600 Body Material is Carbon Steel

Typical Applications

PROCESS: FT600 Series steam traps with Cast Steel Body were specifically designed for removing condensate and air from higher pressure steam applications or where steel bodies are specified. They are typically used in chemical plants and petrochemical refineries on re-boilers, heat exchangers, and other critical process applications. The excellent air-handling capability of float and thermostatic traps make them a better choice than bucket traps for applications requiring quick system start-up. Maximum steam pressure is 450 PSIG. Note: Model FT601 is identical to FT600 except body material is 316 SS.

How It Works

Float and thermostatic traps contain a float and seat mechanism with a separate thermostatic element which work together to remove both condensate and air from the steam system. The float, which is attached to a valve, rises and opens the valve when condensate enters the trap. This allows the condensate to discharge. Air is discharged through the thermostatic air vent to the outlet side of the trap. Steam entering the trap causes the thermostatic element to expand, closing the air vent and trapping the steam.

Features

- Investment cast steel body and cover with class 400 shell rating (670 PSIG @ 750˚F)
- Hardened stainless steel seat and disc for extended service life even at extreme temperatures and pressures
- Excellent air handling capability allows air to be discharged rapidly so steam can enter the system quickly during start-up
- In-line repairability is simplified by having all internals attached to the cover. Studded cover allows for easier removal of body.
- Welded stainless steel air vent resists shock from waterhammer. Live orifice air vent is available for superheated applications
- F&T traps discharge condensate immediately as it is formed (no condensate will back up into the system)

Options

Live orifice air vent for superheated applications.

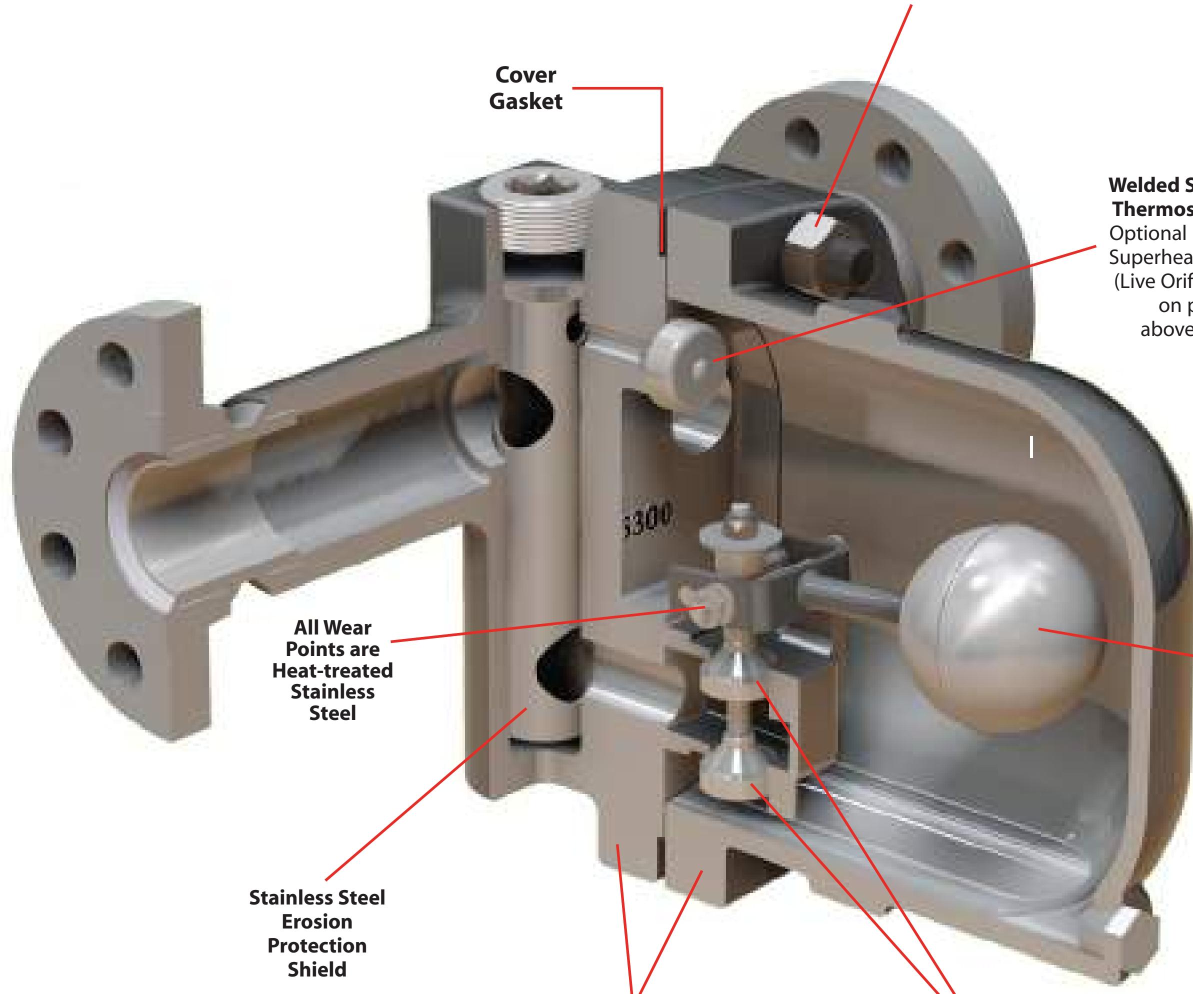
Sample Specification

The steam trap shall be of the mechanical float type having cast steel bodies, horizontal in-line connections in NPT, SW, or flanged, and all stainless steel internals. Incorporated into the trap body shall be an all stainless steel welded thermal element air vent which is water hammer resistant. The air vent is to be located at the high point of trap body to assure proper venting of non-condensables. The trap body will be in-line renewable. All bodies and covers shall be class 400 shell design, suitable for 670 PSIG @ 750ºF.

Installation and Maintenance

The trap must be installed upright and level for the float mechanism to operate properly. All internal components can be replaced while the steam trap remains connected to the piping (in-line repairable). Threaded studs are permanently installed into the cover assembly which greatly simplifies the removal and replacement of the body when servicing. Internal components include a high quality welded stainless steel thermostatic air vent and stainless steel seat and mechanism. The standard thermostatic air vent can be damaged by superheat; therefore, in applications with superheated steam, the thermostatic air vent should be replaced with a special "live orifice" air vent.

FT600 & FT601
Float & Thermostatic



MATERIALS	
FT 600: Body & Cover	Cast Steel, ASTM A-216
FT 601: Body & Cover	316 SS
Cover Studs	Steel, AS 193, GR B7
Cover Nuts	Steel, SA 194, GR 2H
Cover Gasket	Stainless Steel Reinforced Grafoil
Valve Assembly	Stainless Steel, AISI 431
Gasket, Valve Assembly	Stainless Steel Reinforced Grafoil
Pivot Assembly	Stainless Steel, 17-4 PH
Mounting Screws	Stainless Steel Hex Head, 18-8
Float	Stainless Steel, ASTM -240, 304
Air Vent Assembly	Thermostatic element 304 SS Optional: Live orifice

Float & Thermostatic Steam Trap

FT600 & FT601

Float & Thermostatic

How to Size / Order

The maximum operating pressure (PMO) rating of model selected must meet or exceed the maximum steam pressure or the trap may not open. For example; the FT600-145 has a PMO of 145 psi. Condensate capacity (lbs/hr) of the trap is based on the differential pressure across the trap.

For drip applications, a (3/4)" FT600 size is sufficient to exceed warm-up loads with a 2X safety factor. The condensate loads (lbs/hr) for process applications are normally calculated at the maximum steam pressure; then an appropriate safety margin is applied in order to select a trap with sufficient capacity when operating at lower steam pressures. Reference full explanation of Safety Load Factors in Steam Traps Introduction section.

When a temperature control valve regulates the flow of steam to the process equipment (Heat Exchanger) being drained of condensate, it is recommended to select a trap with a PMO that exceeds the inlet steam pressure to the temperature control valve. This assures that under all operating conditions, the steam pressure will not exceed the PMO of the trap.

For Example: Process application has a maximum steam inlet pressure of 100 psi, a maximum condensate load of 2,500 lbs/hr and is discharging to a condensate return line with a possible back pressure of 20 psig. **ΔP** = 100-20 = 80 PSI

To select trap: If the Safety Load Factor is chosen to be 2X max capacity at max differential pressure, then Trap should be selected based on 5,000 lbs/hr (2,500 x 2 = 5,000) at 80 PSI differential pressure with a PMO in excess of 100 PSIG

Selection: **FT600-145-16-N**, PMO=145 PSIG, 1 1/2" NPT with a condensate capacity of 9,900 lbs/hr at 80 PSI differential pressure.

Connection Codes:
(**N**=NPT, **SW**=Socket Weld, **F150**=150# FLG, **F300**=300# FLG, **F600**=600# FLG)

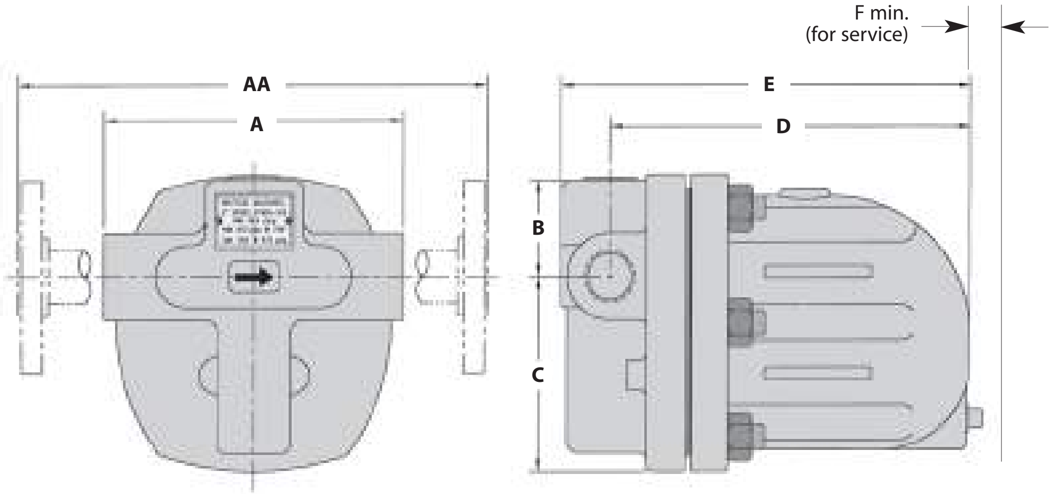
CAPACITIES – *Condensate (lbs/hr)*

Model Code*	PMO (PSIG)	Sizes	ΔP = Differential Pressure (PSI) 1	2	3	4	5	10	20	30	40	50	65	80	100	145	200	300	400	450
FT600-65-13-N	65	3/4"	225	300	363	413	463	635	960	1060	1180	1320	1460							
FT600-65-14-N	65	1"	775	1094	1340	1520	1690	2370	3260	3990	4500	5000	5500							
FT600-65-16-N	65	1 1/2"	2500	3450	4130	4750	5300	7500	10625	13125	15000	16800	18850							
FT600-65-17-N	65	2"	8500	11950	14670	16800	18700	25250	35900	43000	49600	55500	61250							
FT600-145-13-N	145	3/4"	137	180	218	250	275	380	520	625	725	863	895	995	1120	1315				
FT600-145-14-N	145	1"	400	555	660	755	850	1237	1593	1925	2240	2490	2750	3000	3430	3935				
FT600-145-16-N	145	1 1/2"	1275	1750	2125	2430	2740	3750	5100	6250	7200	7995	8875	9900	11250	13300				
FT600-145-17-N	145	2"	3125	4400	5375	6250	6900	9250	14625	16875	19375	21875	25000	27500	31000	37000				
FT600-200-13-N	200	3/4"	93	137	160	187	205	287	400	487	560	610	710	775	875	1060	1250			
FT600-200-14-N	200	1"	300	410	487	560	610	925	1140	1375	1520	1687	1875	2060	2312	2750	3100			
FT600-200-16-N	200	1 1/2"	825	1130	1400	1570	1760	25000	375	4125	4740	5250	6000	6600	7300	8650	10200			
FT600-200-17-N	200	2"	1560	2187	2800	3100	3490	4800	6750	8250	9500	10625	12400	13700	15000	18120	21200			
FT600-300-13-N	300	3/4"	50	68	83	95	106	155	197	240	275	300	340	375	413	490	570	710		
FT600-300-14-N	300	1"	225	300	363	413	463	635	960	1060	1180	1320	1468	1640	1815	2130	2550	3000		
FT600-300-16-N	300	1 1/2"	825	1130	1400	1570	1760	25000	375	4125	4740	5250	6000	6600	7300	8650	10200	12600		
FT600-300-17-N	300	2"	1560	2187	2800	3100	3490	4800	6750	8250	9500	10625	12400	13700	15000	18120	21200	26250		
FT600-450-13-N	450	3/4"	32	42	49	56	62	84	119	145	163	175	192	210	186	275	312	375	425	450
FT600-450-14-N	450	1"	137	180	218	250	275	380	520	625	725	863	895	995	1120	1315	1500	1870	2125	2250
FT600-450-16-N	450	1 1/2"	825	1130	1400	1570	1760	2500	3375	4125	4740	5250	6000	6600	7300	8650	10200	12600	14375	15200
FT600-450-17-N	450	2"	1560	2187	2800	3100	3490	4800	6750	8250	9500	10625	12400	13700	15000	18120	21200	26250	28700	31250

Note: *For 450 Model, the Thermostatic Air Vent is replaced with a live Orifice.*

*** Chart is applicable for both Models FT600 & FT601**

FT600 & FT601:
3/4", 1", 1½", 2"

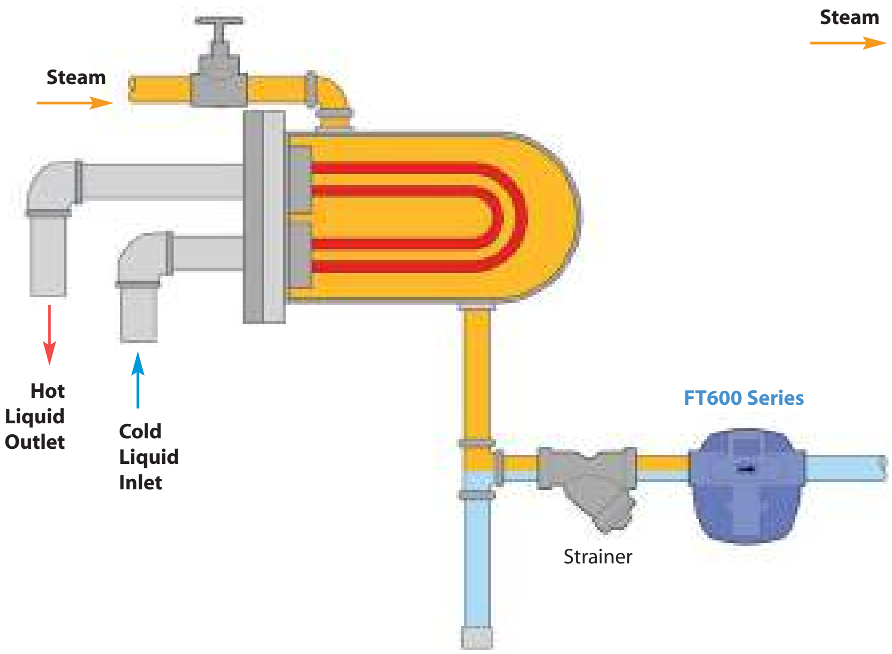


DIMENSIONS & WEIGHTS – *inches*										
									Weight (lbs)	
Model*	Size	A	AA	B	C	D	E	F	NPT/SW	FLG
FT600	3/4"	6.10	10.10	2.07	3.93	7.38	8.41	5.75	25	31
FT600	1"	6.50	10.40	2.50	5.50	8.44	9.50	6.25	31	36
FT600	1½"	9.80	14.00	3.26	6.85	10.40	11.94	7.75	82	91
FT600	2"	11.80	16.00	3.60	7.40	11.59	13.27	8.00	93	107

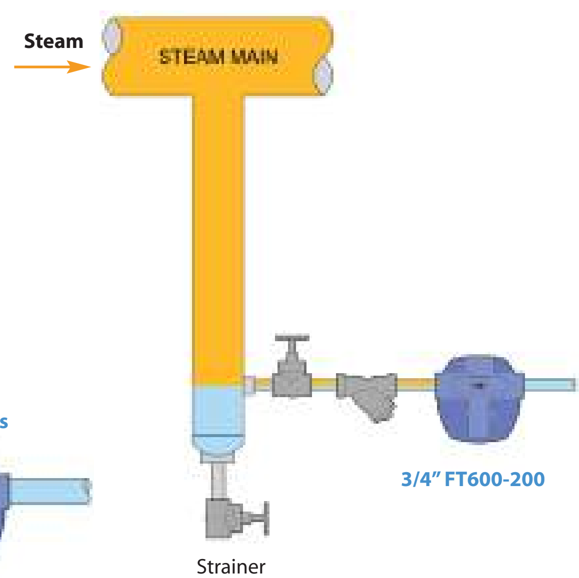
* Chart is applicable for FT600 & FT601

Typical Applications for Float & Thermostatic Steam Traps

Shell & Tube Heat Exchanger Application:



Steam Main Drip Application



Steam Traps

Float & Thermostatic Steam Trap

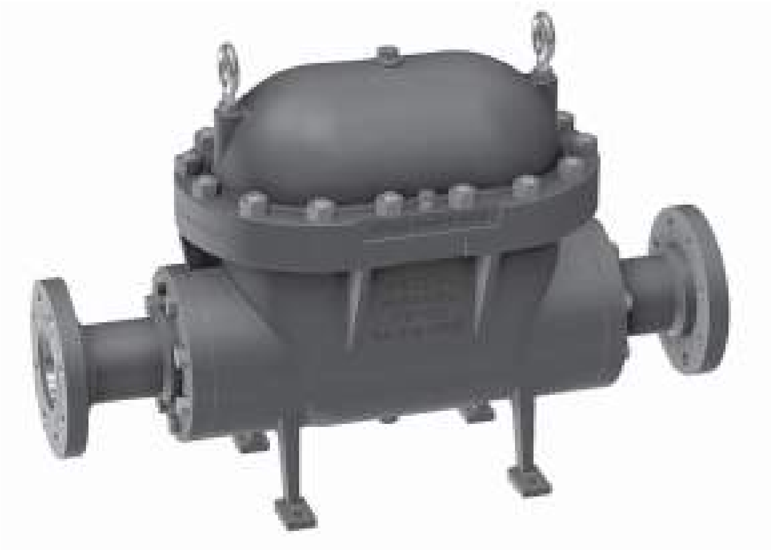
FT600 & FT601

Float & Thermostatic

Model	**FT600 & FT601***
Sizes	**3", 4"**
Connections	**NPT, SW, FLG**
Body Material	**Carbon Steel or 316SS**
PMO Max. Operating Pressure	**450 PSIG**
TMO Max. Operating Temperature	**750°F**
PMA Max. Allowable Pressure	**990 PSIG @ 100°F**
TMA Max. Allowable Temperature	**750°F @ 670 PSIG**

**** FT601 Body Material is 316 SS***
FT600 Body Material is Carbon Steel

3" & 4" FT600 & FT601 contain an open orifice air vent.
If a thermostatic air vent is required, contact factory.



PRESSURE-TEMPERATURE RATING - 3" & 4" Models

PMA 650 PSIG up to 450˚F
TMA 750˚F @ 375 PSIG

Size	Conn	PMO (PSIG)	Model Code
3"	NPT	450	FT600-450-19-N
3"	SW	450	FT600-450-19-SW
3"	150 # Flg	285	FT600-285-19-F150
3"	300 # Flg	450	FT600-450-19-F300
3"	600 # Flg	450	FT600-450-19-F600
4"	150 # Flg	285	FT600-285-20-F150
4"	300 # Flg	450	FT600-450-20-F300
4"	600 # Flg	450	FT600-450-20-F600

CAPACITIES – *Condensate (**1000 lbs/hr**)*

	Differential Pressure (PSI)																				
Temp	1/2	1	2	5	10	15	20	30	40	50	75	100	125	150	175	200	250	300	350	400	450
COLD*	44	59	81	122	170	205	230	280	317	350	425	480	540	580	625	670	740	800	860	910	960
HOT	44	53	64	83	100	112	121	138	149	159	177	190	201	212	222	230	247	260	270	280	290

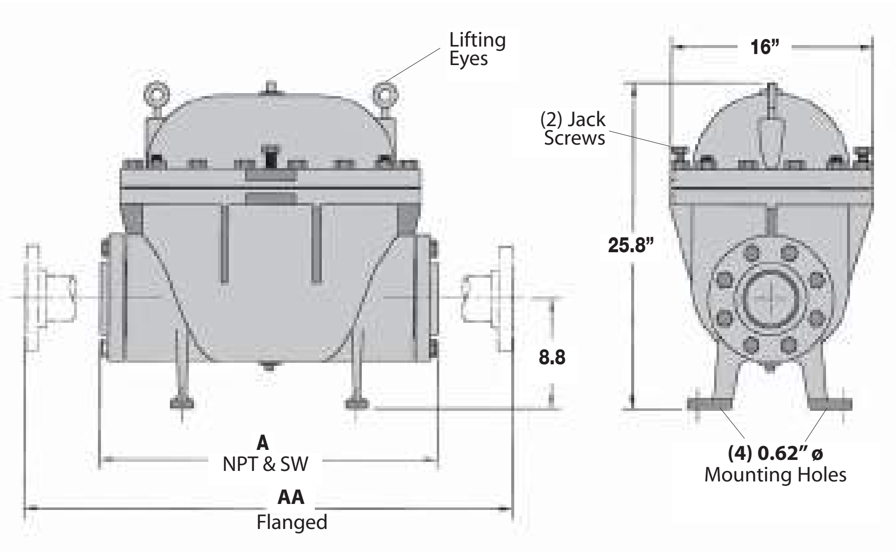
** Cold Water capacities are to be used when the trap is used as a liquid drain trap.*
Note: For liquid drain trap applications, please specify "liquid drain trap" when ordering.

CAPACITY CORRECTION FACTORS

To obtain capacity with a liquid other than water, multiply water capacity by correction factor.

Spec. Gravity	1	.98	.96	.94	.92	.90	.88	.86	.84	.82	.80	.75	.70	.65	.60	.55	.50
Corr. Factor	1	.990	.980	.970	.959	.949	.938	.927	.917	.906	.894	.866	.837	.806	.775	.742	707

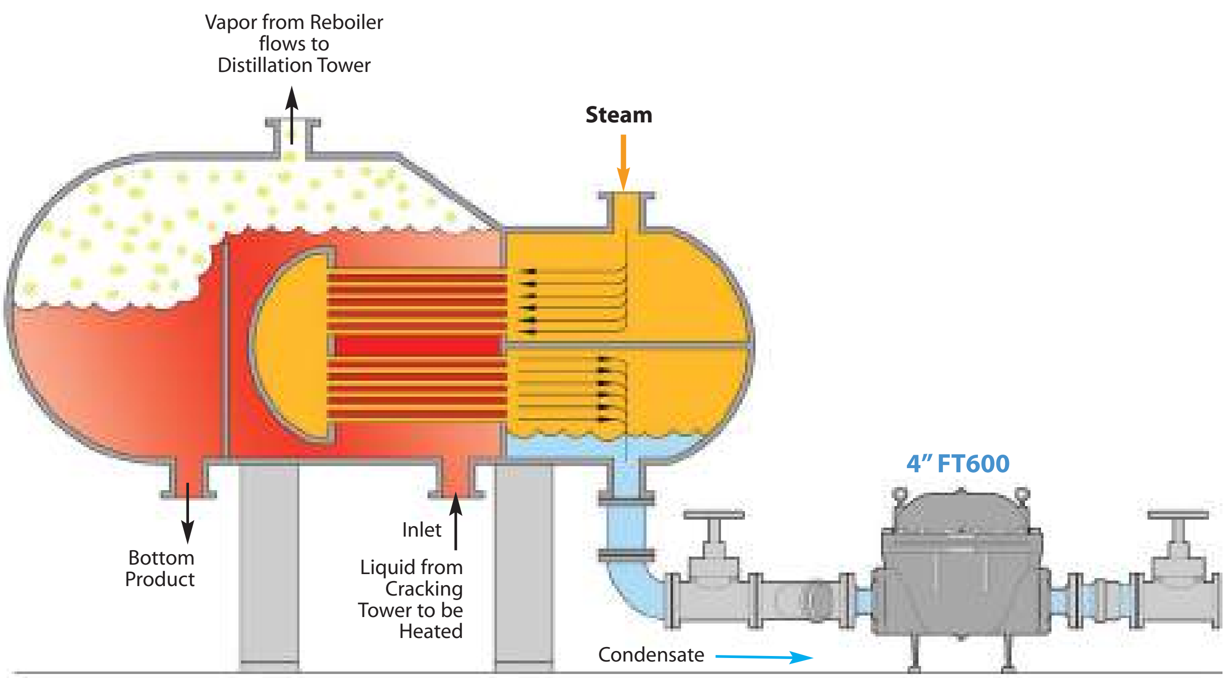
FT600 & FT601:
3″ & 4″



DIMENSIONS & WEIGHTS – *inches*					
				Weight (lbs)	
Model*	**Size**	**A**	**AA**	**Connection**	**FLG**
FT600	**3"**	27	39	587 (NPT, SW)	626
FT600	**4"**	27	39	587 (SW)	654

*** Chart is applicable for both Models FT600 & FT601**

FT600: 3″ - 4″ :
Process: Refinery Reboiler Application



Steam Traps
Float & Thermostatic Steam Trap

FT Series
Float & Thermostatic

Model	**FT**
Sizes	**3/4″, 1″, 1 1/4″, 1 1/2″, 2″**
Connections	**NPT**
Body Material	**Cast Iron**
PMO Max. Operating Pressure	**75 PSIG**
TMO Max. Operating Temperature	**Saturated Steam Temperature**
PMA Max. Allowable Pressure	**75 PSIG up to 450°F**
TMA Max. Allowable Temperature	**450°F @ 75 PSIG**

Typical Applications

DRIP, PROCESS: FT Series steam traps are designed for operating pressures up to 75 PSIG. These float and thermostatic traps are used for lower pressure HVAC and light industrial process applications. They are used on unit heaters, water heaters, pressing machines, heat exchangers and coils. For drip applications, such as draining steam mains and steam supply lines, use 3/4″ FT-075 (FT73-075-13-N). F&T traps have excellent air-handling capability, which make them a better choice than Inverted Bucket traps for most process applications. FT Series traps have a dual inlet-outlet H-Pattern connection allowing for additional flexibility in installation.

How It Works

Float and thermostatic traps contain a float and seat mechanism with a separate thermostatic element which work together to remove both condensate and air from the steam system. The float, which is attached to a valve, rises and opens the valve when condensate enters the trap. This allows the condensate to discharge. Air is discharged through the thermostatic air vent to the outlet side of the trap. Steam entering the trap causes the thermostatic element to expand, closing the air vent and trapping the steam.

Sample Specification

The trap shall be of float and thermostatic design with cast iron body. Thermostatic element to be welded stainless steel. Float and seating material to be stainless steel. Trap must be in-line repairable.

Features

- H-pattern design allows piping from either side of the steam trap (there are two inlet ports at top and two outlet ports at bottom)
- F&T traps have excellent air handling capability allows air to be discharged rapidly and steam to enter the system quickly during start-up
- Welded stainless steel thermostatic air vent resists shock from waterhammer
- In-line repairable (all internals are attached to cover)

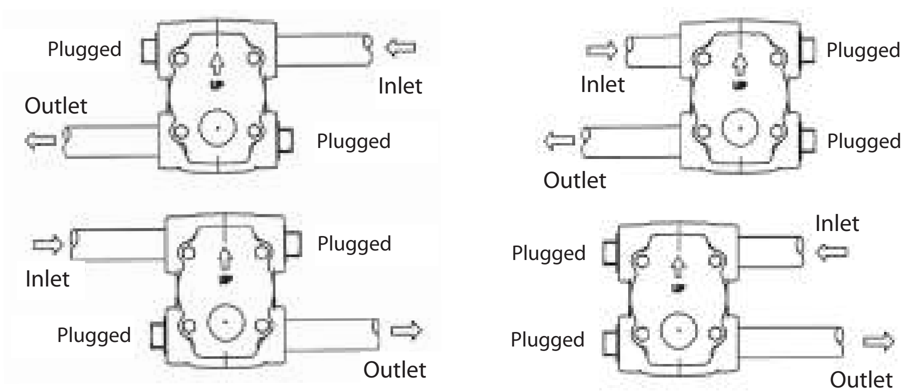
Installation and Maintenance

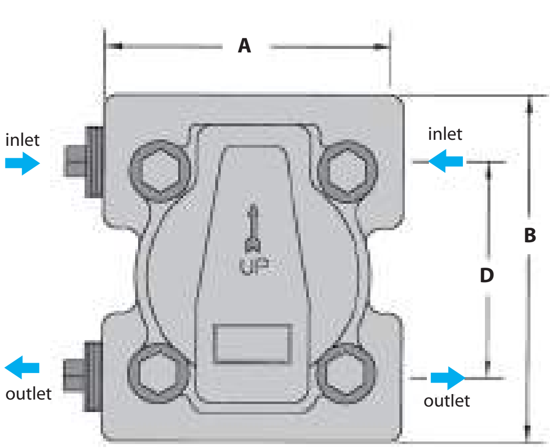
The trap must be installed upright and level for the float mechanism to operate properly. All internal components can be replaced with the trap body piped in-line. Repair kit includes thermostatic element, valve seat and disc, float and sealing gasket.

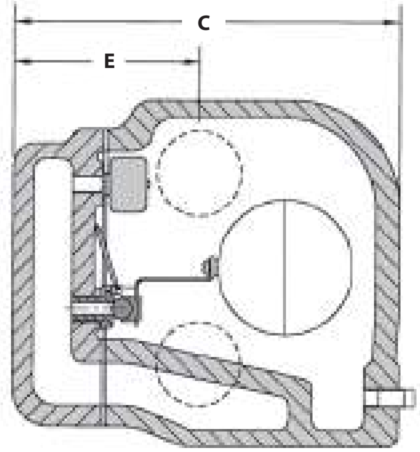
Helpful Selection Information

Select a model that can handle the maximum working pressure of the steam system. For example, the FT3-015 has a maximum working pressure of 15 PSI. Consult capacity tables to properly size unit. Available in 3/4″ through 2″ NPT connections. Select these models for steam systems with maximum working pressure of 75 PSIG.

Demonstration of H-Style piping connections:







DIMENSIONS & WEIGHTS – *inches/pounds*

Model	A	B	C	D	E	Weight
FT-3, FT-4, FT-33 FT-34, FT-73, FT-74	4.125	5.00	5.125	3.125	2.75	7.50
FT-6, FT-35, FT-36 FT-75, FT-76	5.00	6.81	6.47	4.125	3.43	13.0
FT-7, FT-37L, FT-77L	6.375	7.68	8.218	5.25	4.41	21.0
FT-8, FT-38, FT-78 FT-S8-15, FT-S8-75	6.50	11.0	8.968	7.468	4.531	40.0

MATERIALS

Body & Cover	Cast Iron, ASTM A-126 Class B
Nuts & Bolts	High-Tensile Steel
Gasket	Grafoil/Garlock
Float	Stainless Steel
Valve & Seat	Stainless Steel
Thermostatic Assembly	Stainless Steel Bellows & Valve

How to Size / Order

The maximum operating pressure (PMO) rating of model selected must meet or exceed the maximum steam pressure or the trap may not open. For example; the FT-35-030 has a PMO of 30 psi. For drip applications, a 3/4″ FT size is sufficient to exceed warm-up loads with a 2X safety factor. The condensate loads (lbs/hr) for process applications are normally calculated at the maximum steam pressure; then a safety margin is applied in order to select a trap with sufficient capacity at lower pressures. Reference full explanation of Safety Load Factors in Steam Traps Introduction section.

For Example: Process application has a maximum steam inlet pressure of 50 psi, a maximum condensate load of 1,700 lbs/hr and is discharging to a condensate return line with a possible back pressure of 10 psig. ΔP = 50-10 = 40 PSI

To select trap: If the Safety Load Factor is chosen to be 2X max capacity at max differential pressure, then Trap should be selected based on 3,400 lbs/hr (1,700 x 2 = 3,400) at 40 PSI differential pressure with a PMO in excess of 50 PSIG

Selection: **FT77L-075-16-N**, PMO=75 PSIG, 1 1/2″ NPT with a condensate capacity of 3,750 lbs/hr at 40 PSI differential pressure.

CAPACITIES – *Condensate (lbs/hr)*

Model Code	PMO (PSIG)	Pipe Size	Orifice Size	ΔP = Differential Pressure (PSI)														
				1/4	1/2	1	2	3	5	10	15	20	25	30	40	50	60	75
FT3-015-13-N	15	3/4″	9/32″	340	440	600	830	990	1280	1790	2150							
FT4-015-14-N	15	1″	9/32″	340	440	600	830	990	1280	1790	2150							
FT6-015-15-N	15	1 1/4″	25/64″	850	1100	1460	2000	2350	2950	4000	4800							
FT7-015-16-N	15	1 1/2″	1/2″	1300	1700	2050	2550	2900	3500	4400	5300							
FT8-015-17-N	15	2″	21/32″	2500	3150	4000	5700	6100	6800	8300	9800							
FTS8-015-17-N	15	2″	15/16″	4400	5850	7400	9200	10300	12600	15300	18100							
FT33-030-13-N	30	3/4″	11/64″	220	300	405	530	650	890	1210	1485	1705	1865	2010				
FT34-030-14-N	30	1″	11/64″	220	300	405	530	650	890	1210	1485	1705	1865	2010				
FT35-030-14-N	30	1″	1/4″	450	600	880	1205	1420	1845	2560	3230	3715	4100	4405				
FT36-030-15-N	30	1 1/4″	1/4″	450	600	880	1205	1420	1845	2560	3230	3715	4100	4405				
FT37L-030-16-N	30	1 1/2″	7/16″	600	800	1200	1680	2210	2600	3500	4500	5200	5700	6100				
FT38-030-17-N	30	2″	13/32″	1550	2045	2625	3560	4260	5660	7890	9440	10500	11360	12095				
FT73-075-13-N	75	3/4″	9/64″	140	195	265	360	430	580	770	990	1110	1210	1290	1430	1560	1680	1830
FT74-075-14-N	75	1″	9/64″	140	195	265	360	430	580	710	990	1110	1210	1290	1430	1560	1680	1830
FT75-075-14-N	75	1″	#16	270	360	485	660	780	1020	1430	1740	1980	2200	2420	2670	2910	3135	3370
FT76-075-15-N	75	1 1/4″	#16	270	360	485	660	780	1020	1430	1740	1980	2200	2420	2670	2910	3135	3370
FT77L-075-16-N	75	1 1/2″	5/16″	340	460	690	900	1200	1400	1900	2350	2700	3000	3250	3750	4150	4500	4700
FT78-075-17-N	75	2″	5/16″	800	1075	1300	1700	2000	2600	3750	4350	4700	5050	5400	5960	6500	6950	7550
FTS8-075-17-N	75	2″	13/32″	1360	1800	2100	2800	3300	4300	6300	7300	8000	8500	9000	10000	11000	11600	12500

Watson McDaniel

Inverted Bucket Steam Traps

Introduction

Inverted Bucket					
Model	Body Material	PMO (PSIG)	Sizes	Connections	Page No.
SIB/SIBH	Stainless Steel	**450**	1/2", 3/4"	NPT, SW	**86**
IB Series 103X/104X	Cast Iron	**250**	1/2" – 1$^{1}/_{2}$"	NPT	**88**

PMO = Maximum Operating Pressure

Inverted Bucket Traps

The Inverted Bucket Trap, with its rugged design, offers features that are advantageous in certain conditions. The discharge orifice of the IB is mounted at the top of the trap, making them less susceptible to failure from dirt and pipe scale when compared to other trap types. Although they are typically not the primary choice for process applications due to their lack of air venting capability, they are often used in drip applications. They can be used on less critical process applications which do not require venting of air during system start-up or when a secondary air vent is added to the system.

SIB Series Stainless Steel Body

SIB/SIBH

IB Series Cast Iron Body (No Strainer)

1031 **1032** **1033** **1034**

IB Series Cast Iron Body (with Strainer)

1041 **1042** **1044 & 1038S**

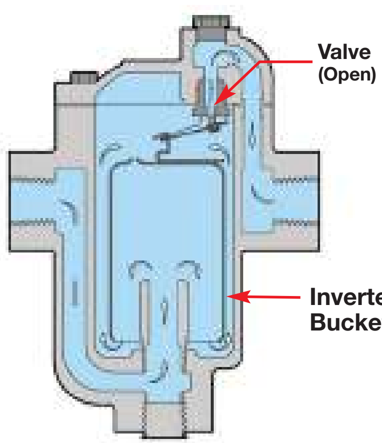
Introduction

INVERTED BUCKET TRAPS.

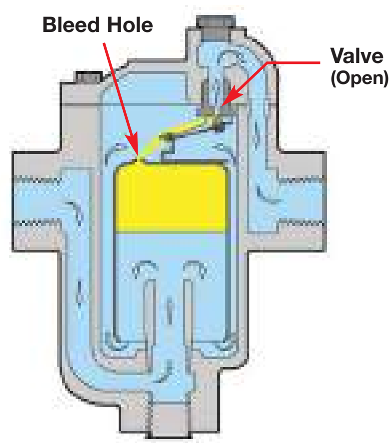
Operation:

Due to its weight, the inverted bucket within the trap will rest on the bottom of the trap body keeping the valve open and allowing condensate to be discharged (**Figure A**). In the top of the bucket there is a small bleed hole which allows air to escape from inside the bucket and exit through the outlet port (**Figure B**). When steam arrives through the inlet of the trap, it fills the inverted bucket which makes it buoyant and rise to the top of the trap, closing the valve (**Figure C**). As steam condenses and/or is bled through the small bleed hole in the top of the bucket, the bucket loses buoyancy which causes it to sink to the bottom of the trap. The valve then opens allowing condensate to be discharged from the system (**Figure A**). The bucket trap must maintain a certain amount of water (prime) in order to operate. If the trap loses its prime, the bucket will not be able to float when steam enters; keeping the valve in the open position which allows steam to escape (**Figure D**). Due to the balance of forces required between the incoming pressure and internal trap components, several orifice sizes are required to accommodate various differential pressure ranges. For this reason care must be used to select a trap model with an equal or higher PMO rating than the steam pressure.

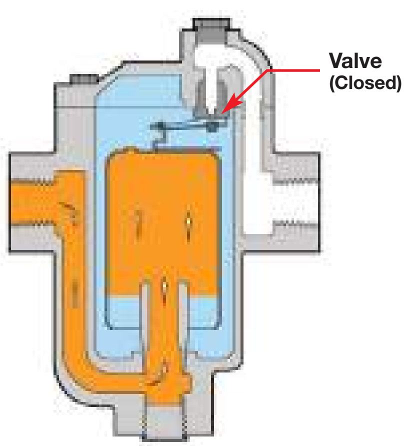
A) Discharging Condensate



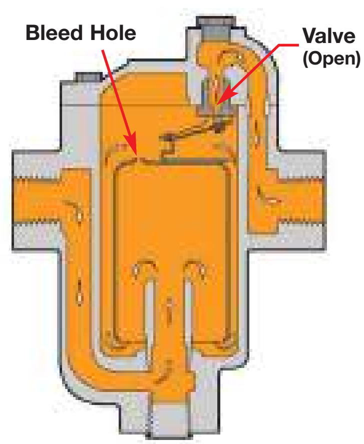
B) Discharging Air



C) Closed (Trapping Steam)



D) Potential Failure Mode
Loss of Prime



A) With condensate completely filling the trap, the bucket is in the down position with the valve open, allowing condensate to be discharged.

B) Small amounts of air will pass thru the bleed hole on top of the bucket and be discharged. (Note: Large amounts of air will lift the bucket and close off the trap, temporarily air locking the system.)

C) When steam enters the trap, the inverted bucket fills with steam and floats to the surface, closing off the valve, preventing steam from escaping.

D) Potential Failure Mode: Bucket traps must maintain a water prime to function properly. If the prime is lost, the bucket will remain in the down position with the valve open, and live steam will be discharged from the system.

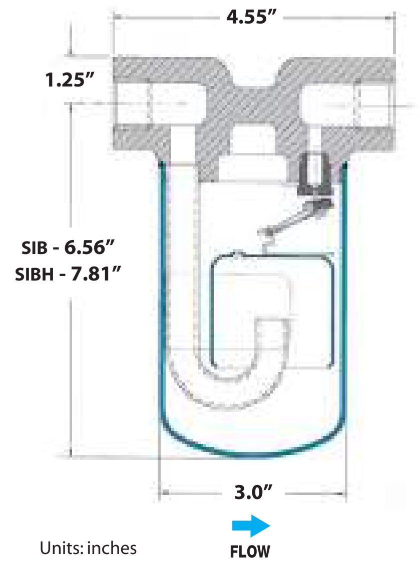
Air
Steam
Condensate

Inverted Bucket Steam Trap

SIB/SIBH
Inverted Bucket

Model	**SIB, SIBH**
Size	**1/2", 3/4"**
Connections	**NPT, SW**
Body Material	**Stainless Steel**
PMO Max. Operating Pressure	**450 PSIG***
TMO Max. Operating Temperature	**750°F**
PMA Max. Allowable Pressure	**720 PSIG @ 100°F**
TMA Max. Allowable Temperature	**750°F @ 400 PSIG**

SIB
Inverted Bucket
Steam Trap



Typical Applications

DRIP, TRACING: The **SIB & SIBH** Inverted Bucket Steam traps are suitable for removing condensate from steam mains and steam supply lines. They are also used on unit heaters, laundry equipment, and other smaller, low capacity and less critical process applications where slow start-up can be tolerated. The discharge orifice of the inverted bucket trap is mounted at the top of the trap body, which makes them less susceptible to failure from dirt and debris when compared to other trap types. The SIBH is physically larger and has a higher pressure capability for a particular orifice size than the SIB.

How It Works

When the trap is filled with condensate, the inverted bucket inside the steam trap loses its buoyancy and rests on the bottom of the trap. This pulls the disc off the seat allowing condensate to be discharged through the seat orifice located at the top of the trap. When steam enters, it fills the inverted bucket causing the bucket to float to the surface which closes the discharge valve, containing the steam in the system. Eventually, the steam is bled off through a small hole in the top of the bucket causing it to sink, which repeats the cycle.

Features

- All stainless steel body
- Acceptable for superheated steam (with check valve installed at inlet)
- Waterhammer resistant
- Valve & seat are located at the top of the trap body making them less prone to clogging from debris and pipe scale
- All stainless steel internals with hardened valve & seat

Sample Specification

Steam trap shall be an all stainless steel module design inverted bucket type with a frictionless valve lever assembly.

Option

Internal Check Valve

Installation and Maintenance

Trap must be installed in upright position to function properly. The stainless steel body is seal welded and therefore non-repairable. If a new trap is required, remove and replace. Bucket traps require an internal water seal to operate. Applications with superheated steam can cause the water seal to flash into steam and trap to fail in open position. A check valve installed at trap inlet will help prevent the loss of prime.

MATERIALS	
Body	Stainless Steel GR CF3
Cover	304L Stainless Steel
Internals	300 Series Stainless Steel
Valve Plug & Seat	420F Stainless Steel

CAPACITIES – *Condensate (lbs/hr)*

Model	Orifice Size	PMO (PSIG)	Differential Pressure (PSI) 5	10	15	20	25	30	40	50	60	70	80	100	125	150	180	200	250	350	450
SIB-20	3/16"	20	450	560	640	690															
SIB-80	1/8"	80	300	350	400	440	460	500	550	580	635	660	690								
SIB-150	#38	150	210	250	280	300	320	350	380	400	420	450	470	500	550	570					
SIB-450	.057	450	31	50	70	84	95	105	120	133	145	152	160	174	187	198	208	215	228	248	263
SIBH-15	1/4"	15	830	950	1060																
SIBH-30	3/16"	30	530	700	820	880	950	1000													
SIBH-70	5/32"	70	380	500	560	620	680	710	770	840	90	950									
SIBH-125	1/8"	125	285	375	440	485	530	560	620	670	720	780	800	860	950						
SIBH-200	7/64"	200	205	265	315	350	385	410	465	500	580	590	620	650	700	810	840	860			
SIBH-250	#38	250	155	205	240	270	295	320	360	400	500	530	550	580	630	660	690	710	760		
SIBH-450	.057	450	31	50	70	84	95	105	120	133	145	152	160	174	187	198	208	215	228	248	263

Helpful Selection Information

The PMO (maximum operating pressure) rating of model selected must meet or exceed the maximum steam pressure or the trap may not open. For example; the **SIB-12-N-150** has a PMO of 150 PSI. Condensate capacity (lbs/hr) of the trap is based on the differential pressure across the trap.

SIB
Inverted Bucket
Steam Trap

SIBH
Inverted Bucket
Steam Trap

Size/ Connection	Model Code	PMO PSI	Weight lbs	Cross Reference	
				Spirax Sarco	Armstrong
1/2" NPT	**SIB-12-N-20**	20	5.0	SIB30	1810
3/4" NPT	**SIB-13-N-20**				
1/2" SW	**SIB-12-SW-20**				
3/4" SW	**SIB-13-SW-20**				
1/2" NPT	**SIB-12-N-80**	80	5.0	SIB30	1810
3/4" NPT	**SIB-13-N-80**				
1/2" SW	**SIB-12-SW-80**				
3/4" SW	**SIB-13-SW-80**				
1/2" NPT	**SIB-12-N-150**	150	5.0	SIB30	1810
3/4" NPT	**SIB-13-N-150**				
1/2" SW	**SIB-12-SW-150**				
3/4" SW	**SIB-13-SW-150**				
1/2" NPT	**SIB-12-N-450**	450	5.0	SIB30	1810
3/4" NPT	**SIB-13-N-450**				
1/2" SW	**SIB-12-SW-450**				
3/4"SW	**SIB-13-SW-450**				
1/2" NPT	**SIBH-12-N-15**	15	5.5	SIB30H	1811
3/4" NPT	**SIBH-13-N-15**				
1/2" SW	**SIBH-12-SW-15**				
3/4" SW	**SIBH-13-SW-15**				
1/2" NPT	**SIBH-12-N-30**	30	5.5	SIB30H	1811
3/4" NPT	**SIBH-13-N-30**				
1/2" SW	**SIBH-12-SW-30**				
3/4" SW	**SIBH-13-SW-30**				
1/2" NPT	**SIBH-12-N-70**	70	5.5	SIB30H	1811
3/4" NPT	**SIBH-13-N-70**				
1/2" SW	**SIBH-12-SW-70**				
3/4" SW	**SIBH-13-SW-70**				
1/2" NPT	**SIBH-12-N-125**	125	5.5	SIB30H	1811
3/4" NPT	**SIBH-13-N-125**				
1/2" SW	**SIBH-12-SW-125**				
3/4" SW	**SIBH-13-SW-125**				
1/2" NPT	**SIBH-12-N-200**	200	5.5	SIB30H	1811
3/4" NPT	**SIBH-13-N-200**				
1/2" SW	**SIBH-12-SW-200**				
3/4" SW	**SIBH-13-SW-200**				
1/2" NPT	**SIBH-12-N-250**	250	5.5	SIB30H	1811
3/4" NPT	**SIBH-13-N-250**				
1/2" SW	**SIBH-12-SW-250**				
3/4" SW	**SIBH-13-SW-250**				
1/2" NPT	**SIBH-12-N-450**	450	5.5	SIB30H	1811
3/4" NPT	**SIBH-13-N-450**				
1/2" SW	**SIBH-12-SW-450**				
3/4" SW	**SIBH-13-SW-450**				

Model	**1031, 1032, 1033, 1034, 1041, 1042, 1044, 1038S**
Sizes	**1/2", 3/4", 1", 1$^1/_4$", 1$^1/_2$"**
Connections	**NPT**
Body Material	**Cast Iron**
Options	**Internal check valve, Thermic vent**
PMO Max. Operating Pressure	**250 PSIG**
TMO Max. Operating Temperature	**450°F**
PMA Max. Allowable Pressure	**250 PSIG up to 450°F**
TMA Max. Allowable Temperature	**450°F @ 250 PSIG**


1031/1032
1033/1034
(No Strainer)


1041/1042
1044/1038S
(with Strainer)

Typical Applications

DRIP, TRACING PROCESS: IB Series inverted bucket steam traps are used in drip applications to remove condensate from steam mains and steam supply lines. For drip applications, the smaller sized units have adequate capacity. The discharge orifice of the inverted bucket trap is mounted at the top of the trap body, which makes them less susceptible to failure from dirt and debris when compared to other trap types. Since Inverted Bucket traps have poor air-handling capability, they are normally not recommended for most process applications. However, they can be used on certain process applications such as unit heaters and laundry equipment, where discharging air during system start-up is not a critical factor. F&T traps are the preferred choice for systems where air *must* be quickly discharged.

How It Works

When the trap is filled with condensate, the inverted bucket inside the steam trap loses its buoyancy and rests on the bottom of the trap. This pulls the disc off the seat allowing condensate to be discharged through the seat orifice located at the top of the trap. When steam enters, it fills the inverted bucket causing the bucket to float to the surface which closes the discharge valve, containing the steam in the system. Eventually, the steam is bled off through a small hole in the top of the bucket causing it to sink, which repeats the cycle.

Features

- Waterhammer resistant
- Suitable for superheated steam (use internal check valve option to eliminate loss of prime)
- In-line repairability is simplified by having all internals attached to the cover
- Valve & seat are located at the top of the trap body making them less prone to clogging from debris and pipe scale
- All stainless steel internals with hardened valve & seat

Sample Specification

The steam trap shall be of an inverted bucket trap design.

Installation and Maintenance

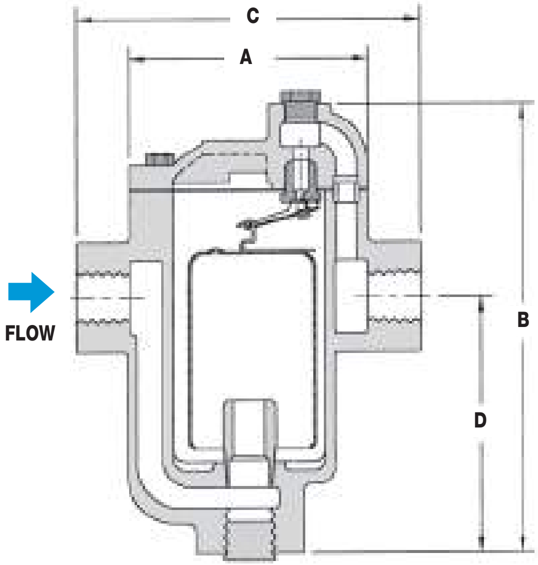
Trap must be installed in upright position to function properly. All working components can be replaced with the trap body remaining in-line. With superheated steam, a check valve should be installed at inlet or trap may lose prime. A replacement kit containing the lever and seat assembly is a more economical option than replacing the entire steam trap. Also available are replacement screens, gaskets and buckets. When ordering replacement lever and seat assemblies, specify model and operating pressure. See Replacement Parts and Kits Section for exact cross-reference to Armstrong PCA (Pressure Change Assembly) kits.

Helpful Selection Information

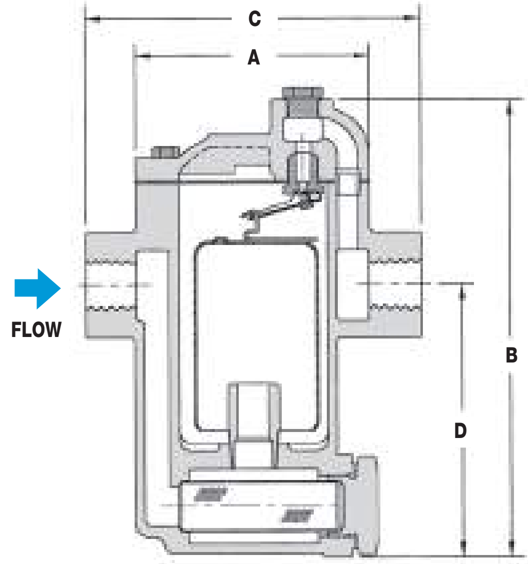
Select a model with a higher maximum operating pressure (PMO) that meet or exceed the maximum steam pressure or the trap may not open. For example, the **IB-1032-14-N-250** has a PMO of 250 PSI. Choose a model that will handle the capacity requirement based on the differential pressure across the trap. Reference capacity charts.

Options

Strainer and Blowdown valve connection available on 1041, 1042, 1044 & 1038S. Thermic vent to improve air handling capability. Internal check valve for superheated or condensate backflow applications.



1031/1031S/1032/1033/1034
without Strainer (except 1031S)



1041/1042/1044/1038S
with Strainer

DIMENSIONS & WEIGHTS – *inches*

Model	A	B	C	D	Weight (lbs)
1031	3.75	5.875	5.00	2.75	5
1031S*	3.75	5.875	5.00	2.75	5
1032	3.75	6.875	5.00	4.25	6
1033	5.625	9.06	6.50	5.375	15
1034	7.00	11.75	7.75	7.03	27
1041*	3.75	6.06	5.00	3.43	5
1042*	3.75	7.06	5.00	4.43	6
1044*	7.00	12.375	7.125	7.375	30
1038S*	7.00	12.375	7.125	7.375	30

*** With Integral Strainer**

MATERIALS

Body & Cover	Cast Iron, ASTM A-278 Class 30
Nuts & Bolts	High-Tensile Steel
Gasket	Garlock
Bucket	Stainless Steel
Lever & Seat Assembly	Stainless Steel
Valve & Seat	Hardened Stainless Steel
Integral Strainer*	Stainless Steel

** 1031S, 1038S, 1041, 1042, 1044 models only.*

How to Order Options: (reference model code chart)

Check Valve (suffix **CV**)
Built-in Inlet Check Valve is recommended when used on Superheated Steam
Example: **IB1032-12-N-125-CV**

Thermic Vent (suffix **TV**)
A Thermic Vent is recommended when using a Bucket Trap on any type of process application or where the removal of air from the system is critical.
Example: **IB1032-12-N-125-TV**

Thermic Vent & Check Valve (suffix **TCV**)
For both Check Valve & Thermic Vent Options use Suffix Code
Example: **IB1032-12-N-125-TCV**

Blowdown Valve (add **B** to Model Code)
Blowdown connection is available on Models IB1038S, 1041, 1042 and 1044
Example: **IB1041B-13-N-150**
(Model IB1041, 3/4" NPT, 150 PSI max operating pressure with Blowdown & Strainer)

How to Size / Order

From the capacity chart, select the model that can handle the working pressure of the system (PMO). Select the appropriate trap that will meet the capacity requirements at the differential pressure. Example:

Application: 1000 lbs/hr at 75 PSIG working pressure and 2 PSI differential pressure

Note: Specify Model, PMO and Connection Size

Size/Model: **IB-1034, 80 PSIG**, Specify pipe size (3/4", 1"), or **IB-1044, 80 PSIG**, Specify pipe size (3/4", 1")

Cross Reference Chart

NO STRAINER		STRAINER	
Watson McDaniel	Armstrong	Watson McDaniel	Armstrong
1031	**800**	**1041**	**880**
1032	**811**	**1042**	**881**
1033	**812**	**1044**	**883**
1034	**813**		

Inverted Bucket Steam Trap

IB Series
Inverted Bucket

NO STRAINER

Conn. NPT	Model Code	PMO PSI	Weight lbs	Cross Ref. Armstrong
1/2"	IB1031-12-N-20	20	7	800
3/4"	IB1031-13-N-20			
1/2"	IB1031-12-N-80	80	7	800
3/4"	IB1031-13-N-80			
1/2"	IB1031-12-N-125	125	7	800
3/4"	IB1031-13-N-125			
1/2"	IB1031-12-N-150	150	7	800
3/4"	IB1031-13-N-150			
1/2"	IB1032-12-N-15	15	8	811
3/4"	IB1032-13-N-15			
1"	IB1032-14-N-15			
1/2"	IB1032-12-N-30	30	8	811
3/4"	IB1032-13-N-30			
1"	IB1032-14-N-30			
1/2"	IB1032-12-N-70	70	8	811
3/4"	IB1032-13-N-70			
1"	IB1032-14-N-70			
1/2"	IB1032-12-N-125	125	8	811
3/4"	IB1032-13-N-125			
1"	IB1032-14-N-125			
1/2"	IB1032-12-N-200	200	8	811
3/4"	IB1032-13-N-200			
1"	IB1032-14-N-200			
1/2"	IB1032-12-N-250	250	8	811
3/4"	IB1032-13-N-250			
1"	IB1032-14-N-250			
1/2"	IB1033-12-N-15	15	17	812
3/4"	IB1033-13-N-15			
1/2"	IB1033-12-N-30	30	17	812
3/4"	IB1033-13-N-30			
1/2"	IB1033-12-N-70	70	17	812
3/4"	IB1033-13-N-70			
1/2"	IB1033-12-N-125	125	17	812
3/4"	IB1033-13-N-125			
1/2"	IB1033-12-N-200	200	17	812
3/4"	IB1033-13-N-200			
1/2"	IB1033-12-N-250	250	17	812
3/4"	IB1033-13-N-250			
3/4"	IB1034-13-N-15	15	30	813
1"	IB1034-14-N-15			
3/4"	IB1034-13-N-30	30	30	813
1"	IB1034-14-N-30			
3/4"	IB1034-13-N-60	60	30	813
1"	IB1034-14-N-60			
3/4"	IB1034-13-N-80	80	30	813
1"	IB1034-14-N-80			
3/4"	IB1034-13-N-125	125	30	813
1"	IB1034-14-N-125			
3/4"	IB1034-13-N-180	180	30	813
1"	IB1034-14-N-180			
3/4"	IB1034-13-N-250	250	30	813
1"	IB1034-14-N-250			


1031


1032


1033


1034

WITH STRAINER

Conn. NPT	Model Code	PMO PSI	Weight lbs	Cross Ref. Armstrong
1/2"	IB1041-12-N-20	20	7	880
3/4"	IB1041-13-N-20			
1/2"	IB1041-12-N-80	80	7	880
3/4"	IB1041-13-N-80			
1/2"	IB1041-12-N-125	125	7	880
3/4"	IB1041-13-N-125			
1/2"	IB1041-12-N-150	150	7	880
3/4"	IB1041-13-N-150			
1/2"	IB1042-12-N-15	15	8	881
3/4"	IB1042-13-N-15			
1/2"	IB1042-12-N-30	30	8	881
3/4"	IB1042-13-N-30			
1/2"	IB1042-12-N-70	70	8	881
3/4"	IB1042-13-N-70			
1/2"	IB1042-12-N-125	125	8	881
3/4"	IB1042-13-N-125			
1/2"	IB1042-12-N-200	200	8	881
3/4"	IB1042-13-N-200			
1/2"	IB1042-12-N-250	250	8	881
3/4"	IB1042-13-N-250			
3/4"	IB1044-13-N-15	15	37	883
1"	IB1044-14-N-15			
3/4"	IB1044-13-N-30	30	37	883
1"	IB1044-14-N-30			
3/4"	IB1044-13-N-60	60	37	883
1"	IB1044-14-N-60			
3/4"	IB1044-13-N-80	80	37	883
1"	IB1044-14-N-80			
3/4"	IB1044-13-N-125	125	37	883
1"	IB1044-14-N-125			
3/4"	IB1044-13-N-180	180	37	883
1"	IB1044-14-N-180			
3/4"	IB1044-13-N-250	250	37	883
1"	IB1044-14-N-250			
1-1/4"	IB1038S-15-N-15	15	37	883
1-1/2"	IB1038S-16-N-15			
1-1/4"	IB1038S-15-N-30	30	37	883
1-1/2"	IB1038S-16-N-30			
1-1/4"	IB1038S-15-N-60	60	37	883
1-1/2"	IB1038S-16-N-60			
1-1/4"	IB1038S-15-N-80	80	37	883
1-1/2"	IB1038S-16-N-80			
1-1/4"	IB1038S-15-N-125	125	37	883
1-1/2"	IB1038S-16-N-125			
1-1/4"	IB1038S-15-N-180	180	37	883
1-1/2"	IB1038S-16-N-180			
1-1/4"	IB1038S-15-N-250	250	37	883
1-1/2"	IB1038S-16-N-250			


1041


1042


1044 & 1038S

Helpful Selection Information

Select a model with a higher maximum operating pressure (PMO) that meet or exceed the maximum steam pressure or the trap may not open. For example, the **IB-1032-14-N-250** has a PMO of 250 PSI. Choose a model that will handle the capacity requirement based on the differential pressure across the trap. Reference capacity charts.

CAPACITIES – *Condensate (lbs/hr)*

Model	Pipe Size	Orifice Size	PMO (PSIG)	Differential Pressure (PSI)																		
				1/4	1/2	1	2	5	10	15	20	30	50	60	70	80	100	125	150	180	200	250
1031 1041 1031S *	1/2″, 3/4″	3/16″	20	139	200	270	340	450	560	640	690											
	1/2″, 3/4″	1/8″	80	75	115	150	190	300	350	400	440	500	580	635	660	690						
	1/2″, 3/4″	7/64″	125	50	80	100	145	240	280	320	350	410	490	520	560	580	640	680				
	1/2″, 3/4″	#38	150	35	50	75	105	150	250	280	300	350	400	420	450	470	500	550	570			
1032	1/2″, 3/4″,1″	1/4″	15	191	300	450	590	830	950	1060												
	1/2″, 3/4″,1″	3/16″	30	150	235	325	410	530	700	820	880	1000										
	1/2″, 3/4″,1″	5/32″	70	85	145	220	275	380	500	560	620	710	840	900	950							
	1/2″, 3/4″,1″	1/8″	125	70	110	160	210	285	375	440	485	560	670	720	780	800	860	950				
	1/2″, 3/4″,1″	7/64″	200	45	75	110	145	205	265	315	350	410	500	550	580	620	650	700	810	840	860	
	1/2″, 3/4″,1″	#38	250	15	40	80	105	155	205	240	270	320	400	500	530	550	580	630	660	690	710	760
1042	1/2″, 3/4″	1/4″	15	191	300	450	590	830	950	1060												
	1/2″, 3/4″	3/16″	30	150	235	325	410	530	700	820	880	1000										
	1/2″, 3/4″	5/32″	70	85	145	220	275	380	500	560	620	710	840	900	950							
	1/2″, 3/4″	1/8″	125	70	110	160	210	285	375	440	485	560	670	720	780	800	860	950				
	1/2″, 3/4″	7/64″	200	45	75	110	145	205	265	315	350	410	500	550	580	620	650	700	810	840	860	
	1/2″, 3/4″	#38	250	15	40	80	105	155	205	240	270	320	400	500	530	550	580	630	660	690	710	760
1033	1/2″, 3/4″	5/16″	15	350	570	850	1140	1600	1900	2100												
	1/2″, 3/4″	1/4″	30	270	400	640	810	1000	1300	1600	1800	2050										
	1/2″, 3/4″	3/16″	70	195	300	480	610	750	950	1200	1375	1600	1900	2000	2200							
	1/2″, 3/4″	5/32″	125	130	205	320	415	595	775	910	900	1100	1380	1480	1600	1650	1800	2000				
	1/2″, 3/4″	1/8″	200	75	120	200	255	365	490	585	630	700	900	980	1080	1120	1220	1400	1500	1560	1600	
	1/2″, 3/4″	7/64″	250	30	80	130	170	250	335	400	470	525	665	600	700	800	900	1000	1100	1180	1220	1300
1034 1044	3/4″, 1″	1/2″	15	950	1410	1880	2300	2900	3500	3900												
	3/4″, 1″	3/8″	30	600	960	1300	1640	2200	2800	3300	3500	4000										
	3/4″, 1″	5/16″	60	490	800	1090	1400	1750	2200	2600	2900	3500	4100	4400								
	3/4″, 1″	9/32″	80	330	580	720	1070	1450	1800	2100	2400	2800	3300	3600	3800	4000						
	3/4″, 1″	1/4″	125	260	430	620	810	1150	1650	1800	1900	2200	2600	2800	3000	3200	3600	3900				
	3/4″, 1″	7/32″	180	200	310	470	610	880	1170	1380	1510	1800	2100	2300	2500	2700	2900	3200	3500	3700		
	3/4″, 1″	3/16″	250	170	250	380	490	700	940	1100	1250	1450	1700	1800	2000	2100	2300	2700	2800	3100	3200	3500
1038S	1 1/4″, 1 1/2″	1/2″	15	1188	1763	2350	2875	3625	4375	4875												
	1 1/4″, 1 1/2″	3/8″	30	760	1190	1625	2050	2750	3500	4125	4375	5125										
	1 1/4″, 1 1/2″	5/16″	60	615	1000	1375	1750	2188	2750	3250	3625	4375	5125	5500								
	1 1/4″, 1 1/2″	9/32″	80	420	720	900	1340	1810	2250	2625	3000	3500	4125	4500	4750	5000						
	1 1/4″, 1 1/2″	1/4″	125	330	540	775	1010	1440	2063	2250	2375	2750	3250	3500	3750	4000	4500	4875				
	1 1/4″, 1 1/2″	7/32″	180	250	390	590	760	1100	1470	1725	1890	2063	2375	2875	3125	3375	3625	4000	4375	4625		
	1 1/4″, 1 1/2″	3/16″	250	210	320	470	610	875	1170	1380	1560	1800	2125	2250	2500	2625	2875	3375	3500	3875	4000	4375

** 1031S only available @ PMO = 125 PSIG.*

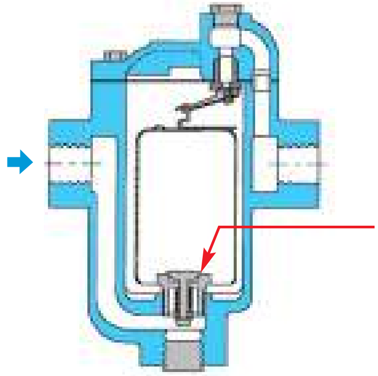
Replacement Kits

A replacement kit containing the lever and seat assembly is a more economical option than replacing the entire steam trap. Also available are replacement screens, gaskets and buckets.

When ordering replacement lever and seat assemblies specify model and operating pressure. See Replacement Parts and Kits Section for exact cross-reference to Armstrong PCA (Pressure Change Assembly) Kits.

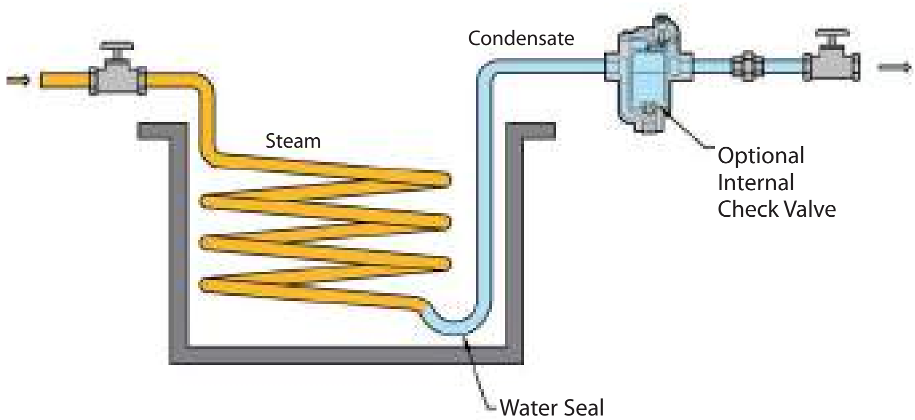
Why use a Check Valve Option ?

The optional internal check valve allows the bucket trap to retain its prime even when exposed to superheated steam. The IB Trap must retain hot condensate inside the trap body to operate. Superheated steam or a sudden drop in inlet pressure can flash off the hot condensate inside the trap body causing the trap to lose its prime. If the steam pressure falls below the discharge pressure on the outlet side of the steam trap, the internal check valve will stop the back flow of condensate into the steam system. When discharging to a condensate return line, a check valve is always recommended.



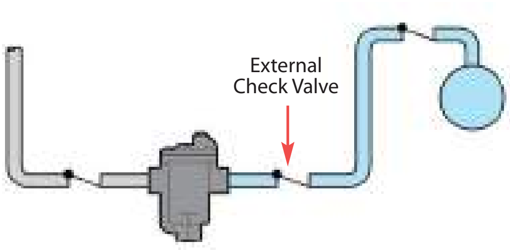
Steam Trap Installed Above Condensate Collection Point

In this example, condensate must travel upwards to reach the trap. Under this condition, it is possible for condensate to flow from the condensate return line into the steam coils, thereby flooding the system. The internal check valve, inside the IB trap, prevents the back flow of condensate.



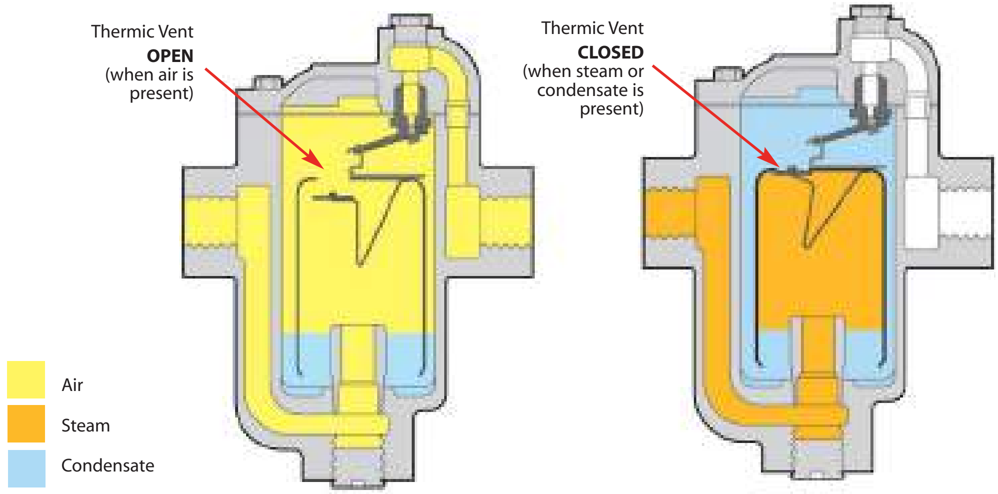
Steam Trap Discharging into Elevated Condensate Return Line

When a steam trap discharges condensate to an elevated location,a check valve should be used to stop condensate from flowing backwards into the steam system.



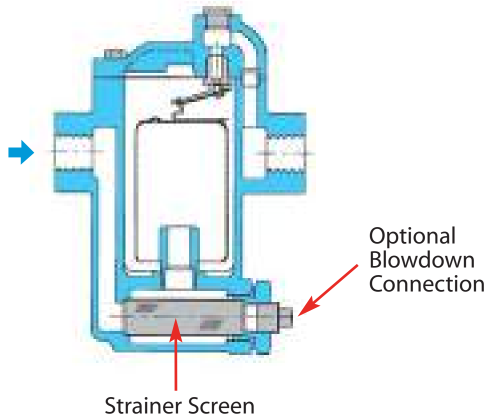
Why use a Thermic Vent ?

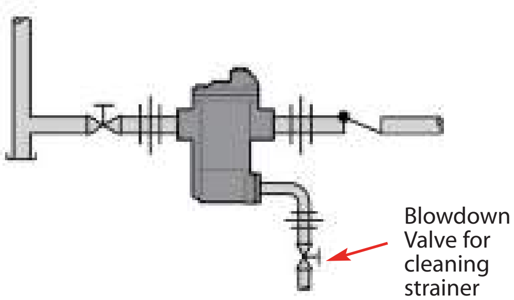
The Thermic Vent is used for discharging air from the steam system during start-up.



Blowdown Valve Connection

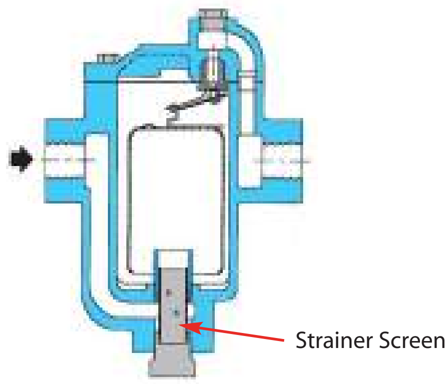
A Blowdown Valve connection is available as an option on the **1041**, **1042**, **1044**, and **1038S** models. This simplifies maintenance by allowing the strainer to be cleaned without removal. User to supply blowdown valve.





1031S

The **1031S** is equipped with a small protection screen to guard against dirt in the steam system. It is a more economical alternative than the 1041 which has a full-port strainer. Specifically designed for use in laundries. Available in 125 PSIG model only.

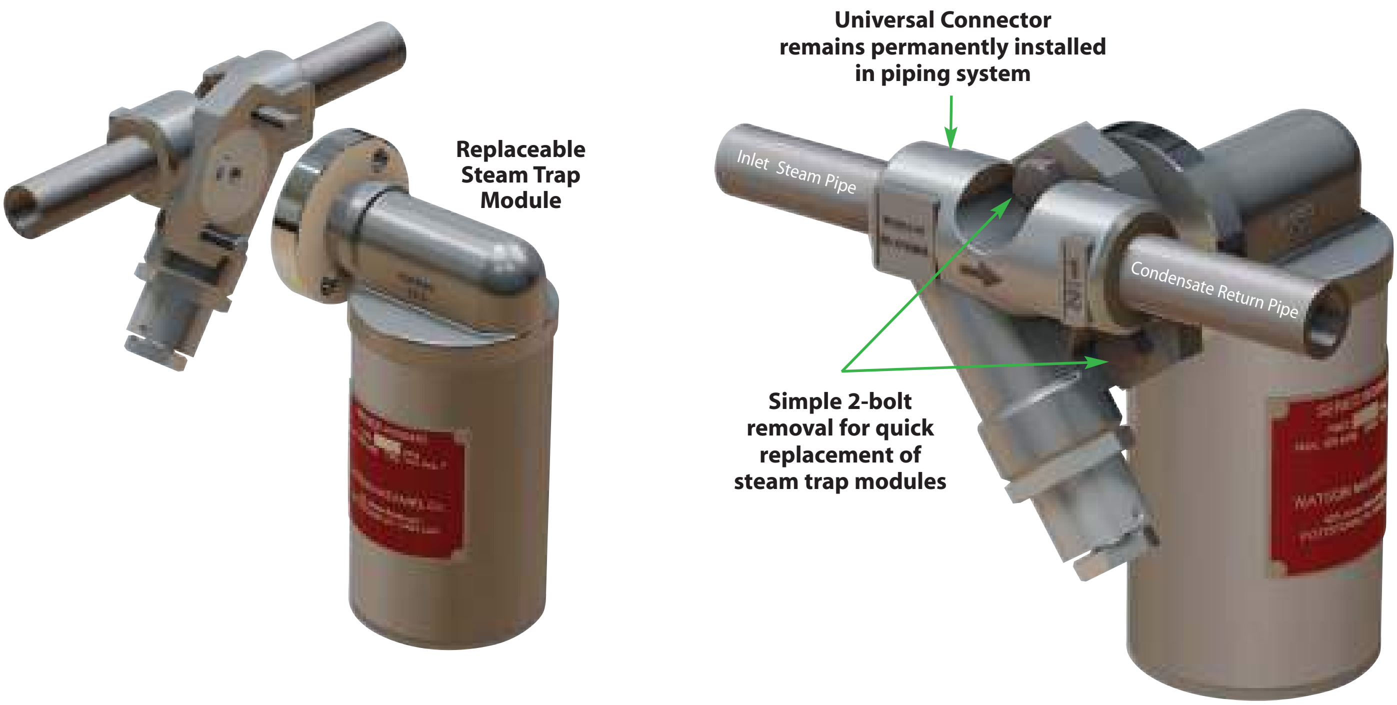


UC450 Series
Quick-Change Universal Style Trap-Connector System

The **UC450 Series QUICK-CHANGE Universal Trap-Connector System** with multiple choices for trap modules and multiple choices for connectors are used in steam systems where a simplified and economical maintenance program of steam traps is desired. These Universal Style quick replacement steam traps can be used on steam supply lines as well as for tracing and small process applications. They are commonly used in chemical plants, petrochemical refineries, paper mills and other industrial facilities.

The All Stainless Steel Universal Style Steam Traps feature a permanent installation of the Universal Connector with a 2-bolt mounting arrangement for the Universal Steam Trap Module, allowing the Steam Trap to be removed and replaced in minutes:

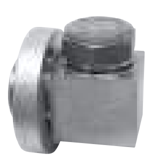
- Steam trap is replaced without having to unthread piping
- By removing only 2 bolts with a socket or open-end wrench
- Trap module can swivel 360º on the universal connector allowing proper orientation



"QUICK-CHANGE" Universal Trap Modules

STEP 1: Select an appropriate Universal **STEAM TRAP MODULE**

UTD450
Thermodynamic
"Top Mount"



UTD450SM
Thermodynamic
"Side Mount"

UT450
Thermostatic Bellows

UB450
Thermostatic Adjustable Bi-Metal

USIB450
Inverted Bucket

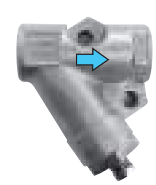
UFT450
Float & Thermostatic

"QUICK-CHANGE" Universal Connectors

STEP 2:
Select appropriate Universal **CONNECTOR**.
Any Universal Connector (shown right) will work with any Universal Steam Trap Module. (Including those of other manufacturers. See product catalog for full offering of Connectors.)
Trap orientation must be considered.

UC450

UC450S



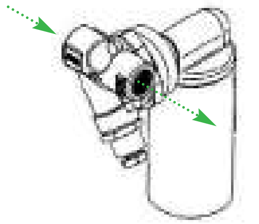
UC450SR

Why Use the UC450 Series "QUICK-CHANGE" Universal Style Trap-Connector System ?

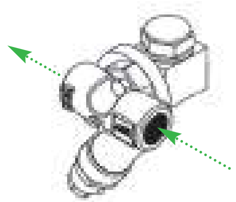
Quick-Change Steam Traps
are recommended in any application – particularly those which require simple and frequent replacement of steam traps

Universal Connectors
These Connectors remain permanently installed in the piping system. The convenient 2-bolt mounting system allows the Trap Module to be replaced quickly and easily using a socket or open-end wrench without having to unthread piping.

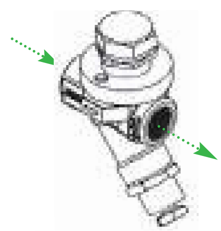
Quick-Change Steam Trap Modules with Universal Connectors



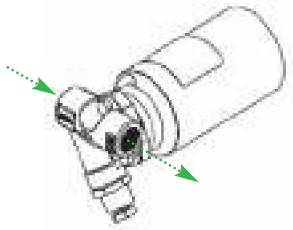
Inverted Bucket Trap
USIB450 Steam Trap
(shown with)
UC450S Connector



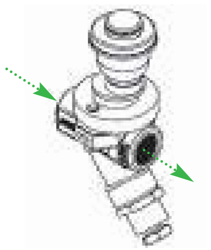
Thermodynamic "side-mount" Trap
UTD450SM Steam Trap
(shown with)
UC450SBL Connector



Thermodynamic "top-mount" Trap
UTD450 Steam Trap
(shown with)
UC450SB Connector



Float & Thermostatic Trap
UFT450 Steam Trap
(shown with)
UC450SBR Connector



Thermostatic Trap
UT450 Steam Trap
(shown with)
UC450SB Connector

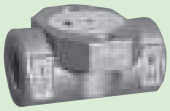
4 basic configurations of connectors are available:

UC450, UC450S & UC450R/UC450L.

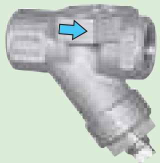
Choice is based on strainer orientation or if a piping interference exists.

The UC450SR is the standard connector choice.

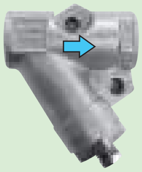
The R & L versions are a mirror image of each other and are strictly a user's preference based on piping orientation.



UC450



UC450S



UC450SR

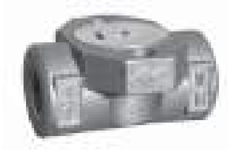
UC450 Series

Universal Style **Quick-Change Connectors**

(For use with Universal Quick-Change **Trap** Modules)

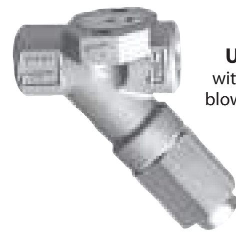
Model	**UC450, UC450S, UC450SB** **UC450SR, UC450SBR, UC450SL, UC450SBL**
Sizes	**1/2", 3/4", 1"**
Connections	**NPT, SW, FLG**
Body Material	**Stainless Steel**
PMO Max. Operating Pressure	**(trap module dependent)**
TMO Max. Operating Temperature	**(trap module dependent)**
PMA Max. Allowable Pressure	**750 PSIG @ 100ºF**
TMA Max. Allowable Temperature	**800ºF @ 400 PSIG**

Steam Trap Modules that mount to Universal Connectors are shown on the following pages.
Trap modules available in: Inverted Bucket, Float & Thermostatic, Thermodynamic, Thermostatic and Bi-metallic type.

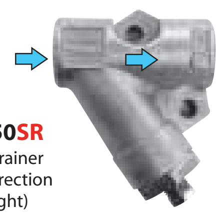


UC450
no strainer

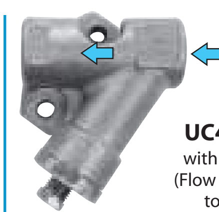
UC450S
with strainer



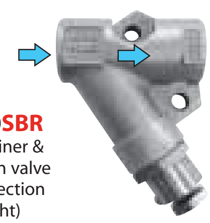
UC450SB
with strainer & blowdown valve



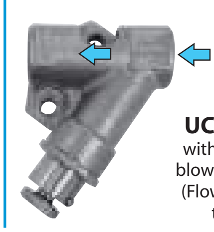
UC450SR
with strainer
(Flow direction to Right)



UC450SL
with strainer
(Flow direction to Left)



UC450SBR
with strainer & blowdown valve
(Flow direction to Right)



UC450SBL
with strainer & blowdown valve
(Flow direction to Left)

Note: Optional Flanged units available.

Typical Applications

DRIP, TRACER: UC450 Series Universal Trap Connectors reduce the time and manpower to replace steam traps. The stainless steel Connector remains permanently in-line allowing steam trap module to be replaced in minutes. These universal connectors can be used for drip service on steam mains and steam supply lines, tracing, or for small process equipment. Industrial standard 2-bolt universal connectors are commonly used in chemical plants, petrochemical refineries, paper mills, and other industrial facilities. The UC450 connectors conform to industrial standards, making them compatible with other manufacturers' universal steam trap modules.

Used with the following Watson McDaniel Steam Trap Modules:

- **USIB450** - Inverted Bucket
- **UTD450** - Thermodynamic
- **UTD450SM** - Thermodynamic
- **UTD600LSM** - Thermodynamic
- **UT450** - Thermostatic
- **UFT450** - Float & Thermostatic
- **UB450** - Bi-Metallic

How It Works

Universal connectors remain permanently installed in the piping system. The convenient 2-bolt mounting system allows the trap module to be removed and replaced quickly and easily using a socket or open-end wrench without disturbing the existing piping.

Features

- Universal connector with 2-bolt mounting allows for fast, easy replacement of trap module making it more cost-effective than replacing conventional type steam traps
- All stainless steel construction
- Trap module can rotate 360º on the universal connector allowing any orientation during installation
- Compatible with other manufacturers' trap modules
- Available with integral strainer and blowdown valve

Sample Specification

The Universal Connector shall be all stainless steel construction with a two-bolt 360 degree swivel mount flange design and available with integral strainer and blowdown valve.

Installation and Maintenance

The universal connector can be installed in vertical or horizontal piping and available in 1/2", 3/4" and 1" threaded NPT and socket weld (SW). In horizontal installations, orientation of connecter body may be dependent on the specific type of trap module used. These connectors remain permanently installed in the piping system. The convenient 2-bolt mounting system allows the trap module to be easily replaced using a socket or open-end wrench without having to unthread piping.

MATERIALS	
Body	Stainless Steel, AISI 316
Strainer	40 Mesh Stainless Steel, AISI 304
Blowdown Valve	Stainless Steel, AISI 303

How to Size / Order

Connectors and Trap Modules are ordered separately. See following pages for the Trap Modules.

UC450 Series

Universal Style Quick-Change Connectors

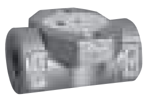
(For use with Universal Quick-Change **Trap** Modules)

Helpful Selection Information
Choose the desired style connector:
UC450, UC450S
UC450SR (flow to right)
UC450SL (flow to left)

Four basic configurations of connectors are available: UC450, UC450S, and UC450S**R**/UC450S**L**. The UC450SR (with strainer, flow to right) is the most common connector choice. Choice is based upon strainer orientation or if a piping interference exists. All connector styles operate with any trap module. The **R** and **L** versions are mirror images of each other and are selected based on which side the user prefers the trap mounted on.

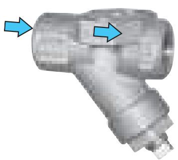
UC450 Type

UC450
No Strainer

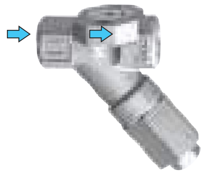


UC450S Type

UC450S
Strainer



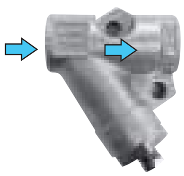
UC450SB
Strainer &
Blowdown Valve



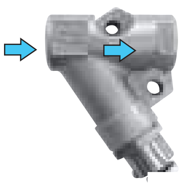
Size	Model Code Threaded - NPT	Model Code Socket Weld	Weight lbs
Connector			
1/2"	**UC450-12-N**	**UC450-12-SW**	1.5
3/4"	**UC450-13-N**	**UC450-13-SW**	1.5
1"	**UC450-14-N**	**UC450-14-SW**	3.0
Connector (with Strainer)			
1/2"	**UC450S-12-N**	**UC450S-12-SW**	2.5
3/4"	**UC450S-13-N**	**UC450S-13-SW**	2.5
1"	**UC450S-14-N**	**UC450S-14-SW**	3.5
Connector (with Strainer & Blowdown Valve)			
1/2"	**UC450SB-12-N**	**UC450SB-12-SW**	2.5
3/4"	**UC450SB-13-N**	**UC450SB-13-SW**	2.5
1"	**UC450SB-14-N**	**UC450SB-14-SW**	4.5

UC450SR Type — Flow to Right (as viewed)

UC450SR
Strainer



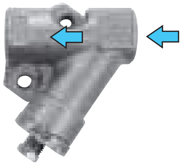
UC450SBR
Strainer &
Blowdown Valve



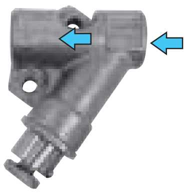
Size	Model Code Threaded - NPT	Model Code Socket Weld	Weight lbs
Connector (with Strainer) FLOW TO RIGHT			
1/2"	**UC450SR-12-N**	**UC450SR-12-SW**	2.5
3/4"	**UC450SR-13-N**	**UC450SR-13-SW**	2.5
1"	**UC450SR-14-N**	**UC450SR-14-SW**	2.5
Connector (with Strainer & Blowdown Valve) FLOW TO RIGHT			
1/2"	**UC450SBR-12-N**	**UC450SBR-12-SW**	2.5
3/4"	**UC450SBR-13-N**	**UC450SBR-13-SW**	2.5
1"	**UC450SBR-14-N**	**UC450SBR-14-SW**	2.5

UC450SL Type — Flow to Left (as viewed)

UC450SL
Strainer



UC450SBL
Strainer &
Blowdown Valve



Size	Model Code Threaded - NPT	Model Code Socket Weld	Weight lbs
Connector (with Strainer) FLOW TO LEFT			
1/2"	**UC450SL-12-N**	**UC450SL-12-SW**	2.5
3/4"	**UC450SL-13-N**	**UC450SL-13-SW**	2.5
1"	**UC450SL-14-N**	**UC450SL-14-SW**	2.5
Connector (with Strainer & Blowdown Valve) FLOW TO LEFT			
1/2"	**UC450SBL-12-N**	**UC450SBL-12-SW**	2.5
3/4"	**UC450SBL-13-N**	**UC450SBL-13-SW**	2.5
1"	**UC450SBL-14-N**	**UC450SBL-14-SW**	.5

UC450 Series

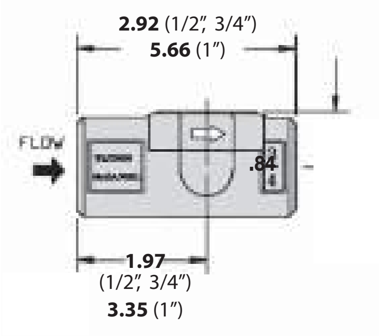
Universal Style Quick-Change Connectors

Dimensions

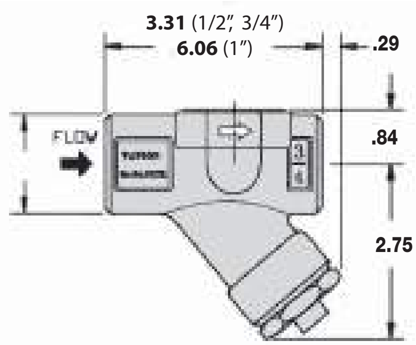
UC450, UC450S, UC450SB Universal Connectors

Connectors available in 1/2", 3/4" and 1" sizes in NPT or Socket-Weld Connections

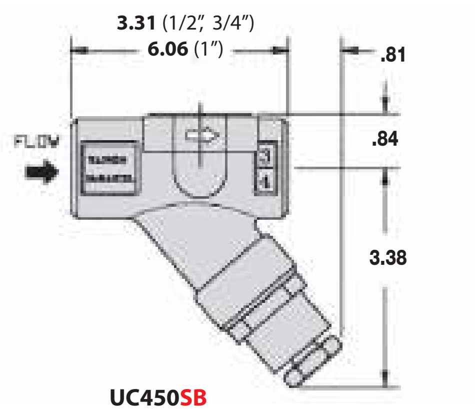
Note: Optional Flange units available.



UC450
(No Strainer)



UC450S
(Strainer)



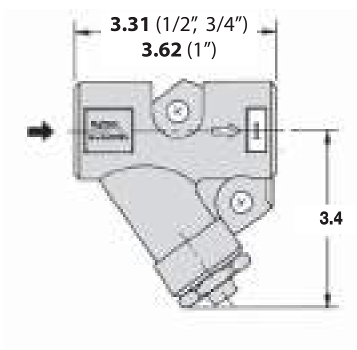
UC450SB
(Strainer & Blowdown)

UC450SR & UC450SBR Universal Connectors

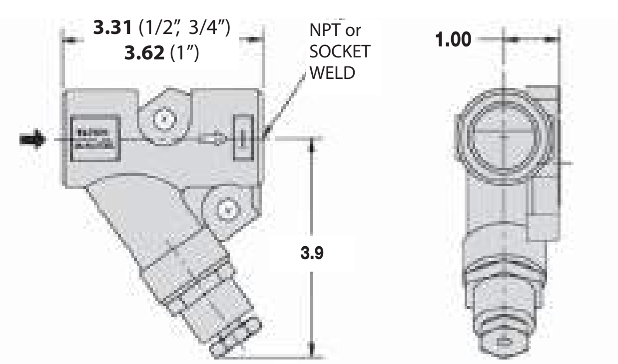
Flow Direction - To RIGHT

Connectors available in 1/2", 3/4" and 1" sizes in NPT or Socket-Weld Connections

Note: Optional Flange units available.



UC450SR
(Strainer)



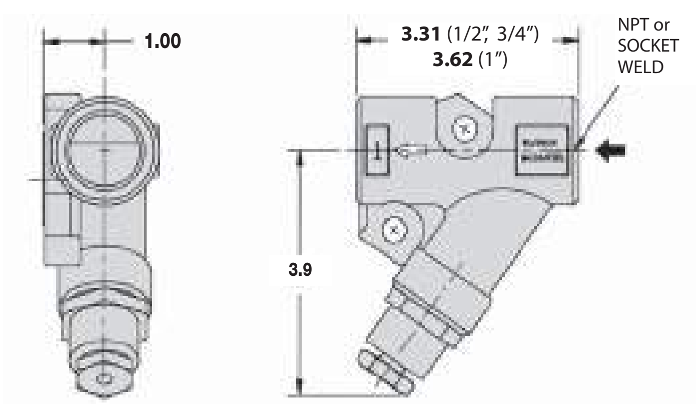
UC450SBR
(Strainer & Blowdown)

UC450SL & UC450SBL Universal Connectors

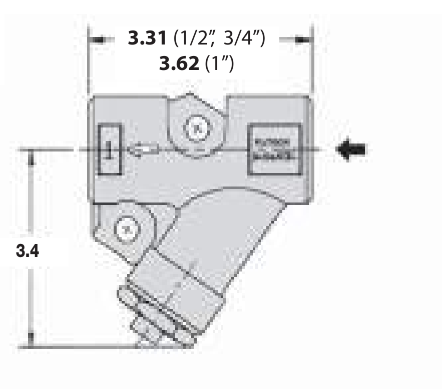
Flow Direction - To LEFT

Connectors available in 1/2", 3/4" and 1" sizes in NPT or Socket-Weld Connections

Note: Optional Flange units available.



UC450SBL
(Strainer & Blowdown)



UC450SL
(Strainer)

Trap Modules with **UC450**-Connectors

UC450SBR
Connector

USIB450
Trap Module

UTD450
Trap Module

UC450SB
Connector

UC450SL
Connector

UT450
Trap Module

UC450SBL
Connector

UB450
Trap Module

USIB450

Universal Style
Quick-Change Trap Module

Inverted Bucket Steam Trap Module (mounts to UC450 Universal Connectors)

Model	**USIB450, USIB450H**
Connections	**Fits UC450 Series Universal Connectors**
Body Material	**Stainless Steel**
PMO Max. Operating Pressure	**450 PSIG***
TMO Max. Operating Temperature	**800ºF**
PMA Max. Allowable Pressure	**720 PSIG @ 100ºF**
TMA Max. Allowable Temperature	**800ºF @ 400 PSIG**

750ºF @ operating pressures below 400 PSIG. See installation note regarding using trap in superheated applications.

Steam trap modules can be used with other manufacturers' Universal Connectors.

Typical Applications

DRIP, TRACER: The **USIB450** inverted bucket steam trap modules must be mounted to a universal connector. They are typically used for drip applications such as draining condensate from steam mains or steam supply lines as well as for steam tracing applications. **USIB450H** is the higher capacity model.

How It Works

The UC450 universal connector is permanently installed into the pipeline where the steam trap would normally be placed. The trap module, which functions like any standard inverted bucket steam trap, is fastened to the universal connector with two bolts. When a new trap module is needed, it can be easily removed and replaced with a standard open-end or socket wrench without disturbing the existing piping.

Sample Specification

The steam trap shall be an all stainless steel modular design, inverted bucket type with a frictionless valve lever assembly. The trap shall have a 360 degree swivel mount on a stainless steel Universal Connector that is available with integral strainer and blowdown valve options.

Options

Universal Connectors are available with an integral strainer and blowdown valve. Connector is purchased separately. See the UC450 Universal Connectors section for more information.

Installation and Maintenance

Universal connector is first permanently threaded or welded into piping system. The USIB trap module is attached to the universal connector with two bolts. When a new trap is needed, it can be easily removed and replaced with a standard open-end or socket wrench without disturbing the existing piping. Trap must be installed in upright position as shown to function properly. With superheated steam, a check valve must be installed at inlet of trap to prevent the loss of prime. In vertical piping installations with upward flow, use of a blowdown valve is not recommended because discharge would be in upward and possibly unsafe direction.

Features

- Trap module can be easily removed and replaced in minutes without having to disconnect any piping
- Hardened stainless steel valves and seat
- Freeze resistant
- Connectors available with integral strainers and blowdown valves
- 360º swivel design for convenient installation

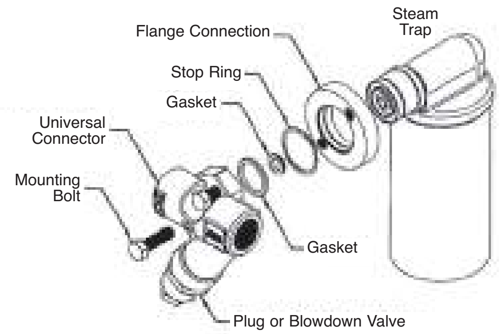
MATERIALS	
Body	Stainless Steel GR CF3
Cover	304L Stainless Steel
Internals	300 Series Stainless Steel
Valve Plug & Seat	420F Stainless Steel
Bolts	ASTM A193 GR B7
Gasket	Spiral-Wound 304 Stainless Steel with Grafoil Filler
Swivel Flange	303 Stainless Steel

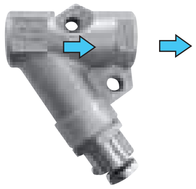
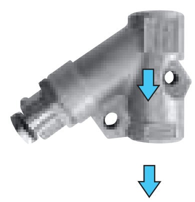
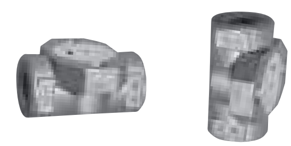
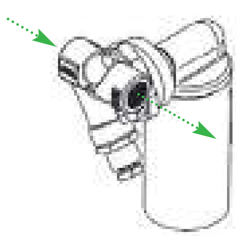
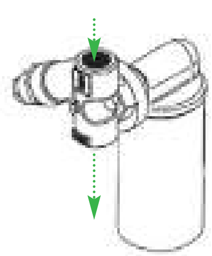
CAPACITIES – *Condensate (lbs/hr)*

Model	Orifice Size	PMO (PSIG)	Differential Pressure (PSI) 5	10	15	20	25	30	40	50	60	70	80	100	125	150	180	200	250	350	450
USIB450-20	3/16″	20	450	560	640	690															
USIB450-80	1/8″	80	300	350	400	440	460	500	550	580	635	660	690								
USIB450-150	#38	150	210	250	280	300	320	350	380	400	420	450	470	500	550	570					
USIB450-450	.057	450	31	50	70	84	95	105	120	133	145	152	160	174	187	198	208	215	228	248	263
USIB450H-15	1/4″	15	830	950	1060																
USIB450H-30	3/16″	30	530	700	820	880	950	1000													
USIB450H-70	5/32″	70	380	500	560	620	680	710	770	840	900	950									
USIB450H-125	1/8″	125	285	375	440	485	530	560	620	670	720	780	800	860	950						
USIB450H-200	7/64″	200	205	265	315	350	385	410	465	500	580	590	620	650	700	810	840	860			
USIB450H-250	#38	250	155	205	240	270	295	320	360	400	500	530	550	580	630	660	690	710	760		
USIB450H-450	.057	450	31	50	70	84	95	105	120	133	145	152	160	174	187	198	208	215	228	248	263

USIB450

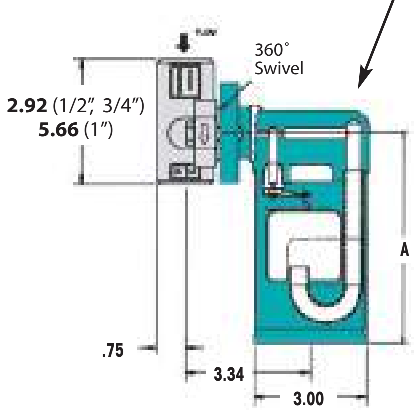
Inverted Bucket Steam Trap Module (mounts to UC450 Universal Connectors)



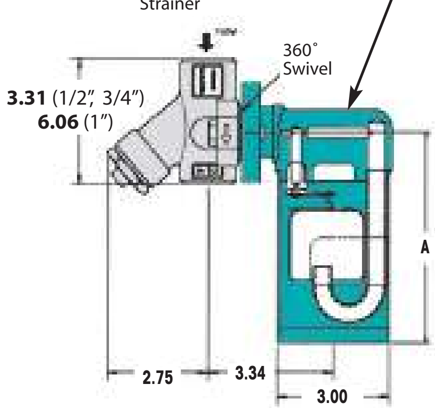
Horizontal Piping (Connector with Strainer)	Vertical Piping (Connector with Strainer)	Vertical or Horizontal Piping (No Strainer)
Steam Flow to the Right (Standard)	**Steam Flow Downward**	**Steam Flow Any Direction**
		
Trap shown with **UC450SR** Connector (Use **L** Style if a Piping Constraint exists)	Trap shown with **UC450SR** Connector	Trap shown with **UC450** Connector
		

Connectors available in 1/2", 3/4" and 1" sizes in NPT or Socket-Weld Connections

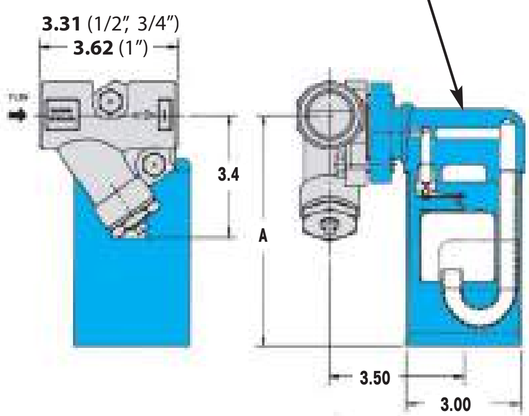
UC450 CONNECTOR — **USIB450 Trap Module**



UC450S CONNECTOR Strainer — **USIB450 Trap Module**



UC450SR CONNECTOR Strainer — **USIB450 Trap Module**



USIB450	A-Dimension = 5.81"
USIB450H	A-Dimension = 6.81"

USIB450	A-Dimension = 6.12"
USIB450H	A-Dimension = 7.12"

UFT450

Universal Style
Quick-Change Trap Module

Float & Thermostatic Steam Trap Module (mounts to UC450 Universal Connectors)

Model	**UFT450**
Connections	**Fits UC450 Series Universal Connectors**
Body Material	**Stainless Steel**
PMO Max. Operating Pressure	**225 PSIG**
TMO Max. Operating Temperature	**397°F**
PMA Max. Allowable Pressure	**720 PSIG @ 100°F**
TMA Max. Allowable Temperature	**800°F @ 400 PSIG**

Steam trap modules can be used with other manufacturers' Universal Connectors.

UFT450
Float & Thermostatic
Steam Trap Module

Typical Applications

PROCESS, DRIP: The **UFT450** Float & Thermostatic steam trap module can be used on small process equipment which generate light condensate loads. F&T traps have excellent air handling capability. These F&T trap modules can also be used in drip service on steam mains and steam supply lines. Mounts to any universal connector.

How It Works

The UC450 universal connector is permanently installed into the pipeline where the steam trap would normally be placed. The trap module, which functions like any F&T steam trap, is fastened to the universal connector with two bolts. When a new trap module is needed, it can be easily removed and replaced with a standard open-end or socket wrench without disturbing the existing piping.

Sample Specification

The steam trap shall be an all stainless steel modular design, float & thermostatic unit. The thermostatic air vent to be pressure balanced welded bellows. The trap shall have a 360 degree swivel mount on a stainless steel Universal Connector that is available with integral strainer and blowdown valve options.

Installation and Maintenance

Universal connector is first permanently threaded or welded into piping system. The UFT450 mounts to any 2-Bolt Quick-Change Universal Connector. Trap module must be installed in orientation shown. The trap module is bolted to the universal connector with two bolts. When a new trap module is needed, it can be easily removed and replaced with a standard open-end or socket wrench without disturbing the existing piping.

Features

- Trap module can be easily removed and replaced in minutes without having to disconnect any piping
- Hardened stainless steel valves and seat
- Freeze-resistant
- Connectors available with integral strainers and blowdown valves
- 360° swivel design for convenient installation

Options

Universal Connectors are available with an integral strainer and blowdown valve. Connector is purchased separately. See the Universal Connectors section for more information.

Helpful Selection Information
Select a model with a PMO (maximum operating pressure) that meets or exceeds the steam pressure of the system. For example, the UFT450-65 has a maximum operating pressure of 65 PSI. Any universal connector can be used. Recommended connector: UC450SR

MATERIALS

Body	Stainless Steel GR CF3
Cover	304L Stainless Steel
Internals	300 Series Stainless Steel
Valve Disc	420F Stainless Steel
Valve Seat	17-4 PH Stainless Steel
Bolts	ASTM A193 GR B7
Gasket	Spiral-Wound 304 Stainless Steel with Grafoil Filler
Swivel Flange	303 Stainless Steel

CAPACITIES – *Condensate (lbs/hr)*

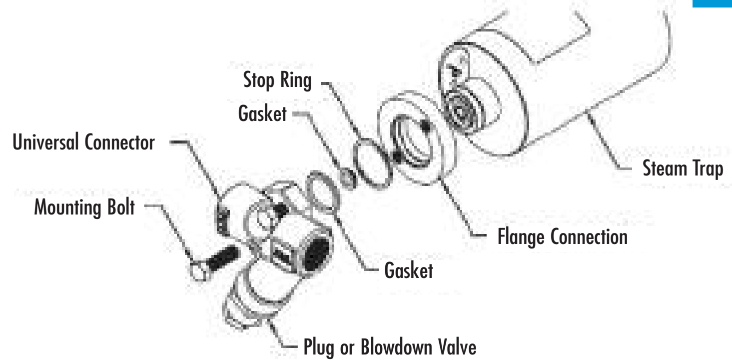
Model	PMO (PSIG)	Differential Pressure (PSI) 1/4	1/2	1	2	5	10	15	20	30	40	50	65	75	100	125	145	200	225
UFT450-15	**15**	390	490	620	780	1050	1320	1500											
UFT450-65	**65**	115	155	205	270	390	520	610	685	810	910	995	1110						
UFT450-145	**145**	55	75	100	135	200	270	320	365	435	490	540	600	640	725	795	850		
UFT450-225	**225**	40	50	70	95	135	185	220	245	290	330	360	405	430	485	530	565	645	680

UFT450

Universal Style
Quick-Change Trap Module

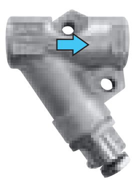
Float & Thermostatic Steam Trap Module (mounts to UC450 Universal Connectors)

UFT450 Trap Module must be oriented Horizontally, as shown.

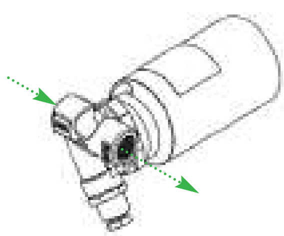


Horizontal Piping (Connector with Strainer)

Steam Flow to the Right
UC450SBR Connector (with Blowdown Valve) shown below

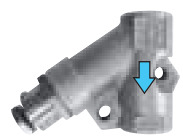


Trap shown with **UC450SBR** Connector
(Use **L** Style Connector to reverse orientation as an alternative if a Piping Constraint exists)

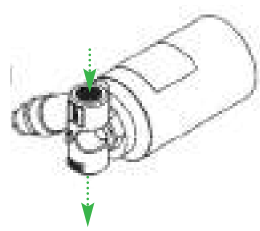


Vertical Piping (Connector with Strainer)

Steam Flow Downward
UC450SBR Connector (with Blowdown Valve) shown below

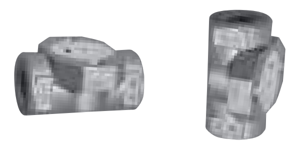


Trap shown with **UC450SBR** Connector

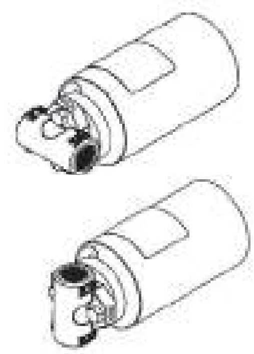


Vertical or Horizontal Piping (No Strainer)

Steam Flow Any Direction
UC450 Connector shown below



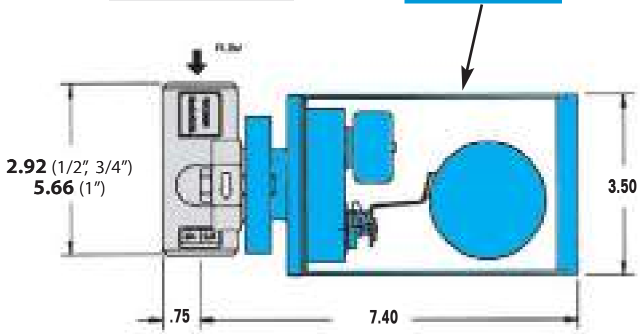
Trap shown with **UC450** Connector



Connectors available in 1/2", 3/4" and 1" sizes in NPT or Socket-Weld Connections

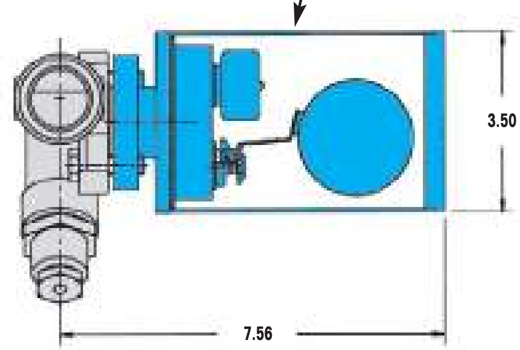
UC450 CONNECTOR

UFT450 Trap Module



UC450SB CONNECTOR

UFT450 Trap Module



UTD450
UTD600

Universal Style
Quick-Change Trap Module

Thermodynamic Steam Trap Module (mounts to UC450 Universal Connectors)

Model *(Side Mount Style)*	UTD450LSM UTD450SM	UTD600LSM
Connections	Fits UC450 Series Universal Connectors	
Body Material	Stainless Steel	Stainless Steel
PMO Max. Operating Pressure	450 PSIG	600 PSIG
TMO Max. Operating Temperature	750ºF	750ºF
PMA Max. Allowable Pressure	720 PSIG @ 100ºF	720 PSIG @ 100ºF
TMA Max. Allowable Temperature	800ºF @ 400 PSIG	800ºF @ 600 PSIG

Steam trap modules can be used with other manufacturers' Universal Connectors.

UTD450 & UTD600
Thermodynamic Steam Trap Module
(Side Mount Style)
For vertical or horizontal piping installations.

Typical Applications

DRIP, TRACER: Designed for drip applications for the draining of condensate from steam mains and other steam supply lines as well as for tracing applications. The **UTD450 & UTD600** Steam Trap Modules can be used anywhere conventional thermodynamic steam traps are used. This trap module can be used on either vertical or horizontal piping installations and can mount to any 2-bolt Quick-Change Universal Connector.

How It Works

The UC450 universal connector is permanently installed into the pipeline where the steam trap would normally be placed. The trap module, which functions like any thermodynamic steam trap, is fastened to the universal connector with two bolts. When a new trap module is needed, it can be easily removed and replaced with a standard open-end or socket wrench without disturbing the existing piping.

Features

- Trap module can be easily removed and replaced in minutes without having to disconnect any piping
- Trap modules can be used with most manufacturers' 2-bolt universal connector
- All stainless steel construction with hardened seat

Sample Specification

The steam trap module shall be designed to attach to the industry standard two-bolt universal connector. Trap module shall be of a thermodynamic design. Universal connector shall conform to the two bolt industry standard with integral strainer and blowdown options.

Installation and Maintenance

Universal connector is first permanently installed (threaded, welded, flanged) into piping system. Trap module should be installed in orientation shown with cap facing upwards. The trap module is fastened to the universal connector using two bolts. If the trap fails for any reason, replace only the trap module. In vertical piping installations with upward flow, use of a blowdown valve is not recommended. Discharge would be in upward and unsafe direction.

Options

Universal Connectors are available with an integral strainer and blowdown valve. Connector is purchased separately. See the Universal Connectors section for more information.

Helpful Selection Information
Connector selection to use with the UTD450SM and UTD600LSM: UC450 (no strainer), UC450SR (strainer), UC450SBR (strainer and blowdown).

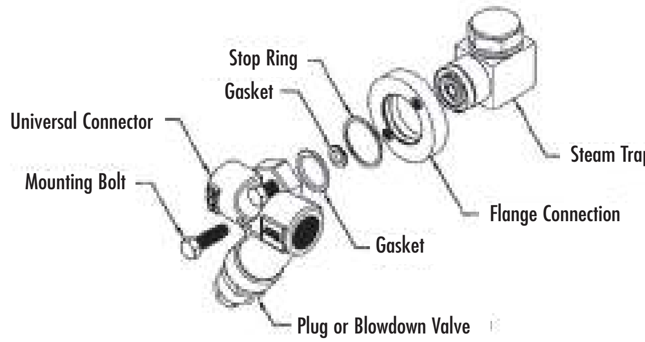
MATERIALS

Body	Stainless Steel, AISI 420
Disc	Stainless Steel, AISI 420
Cap	Stainless Steel, AISI 416
Insulation Cover	Stainless Steel, AISI 304
Bolts	Steel, ASTM A193 GR B7
Gaskets (2)	Spiral Wound 304 Stainless Steel with Grafoil Filler

CAPACITIES – *Condensate (lbs/hr)*

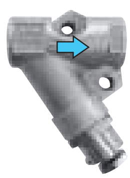
	Differential Pressure (PSI)																
Model	4	10	15	20	25	30	40	50	75	100	150	200	250	300	400	450	600
UTD450LSM	140	215	242	270	295	320	355	390	455	510	600	670	730	790	880	925	
UTD450SM	247	370	420	475	520	560	625	685	800	900	1060	1185	1300	1400	1560	1630	
UTD600LSM											465	500	550	600	632	675	730

Thermodynamic Steam Trap Module (mounts to UC450 Universal Connectors)

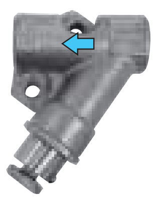


UTD450/UTD600 Trap Module should be oriented with cap facing Upwards, As shown.

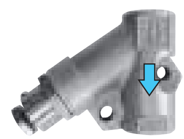
Horizontal Piping (Connector with Strainer)	Vertical Piping (Connector with Strainer)	Vertical or Horizontal Piping (No Strainer)
Steam Flow to the Right or to the Left	Steam Flow Downward	Steam Flow Vertically or Horizontally



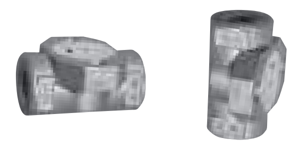
Trap shown with **UC450SBR** Connector



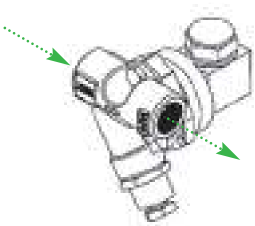
Trap shown with **UC450SBL** Connector

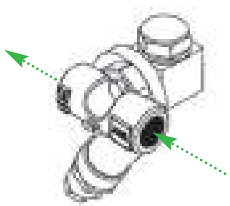


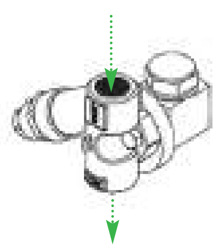
Trap shown with **UC450SBR** Connector

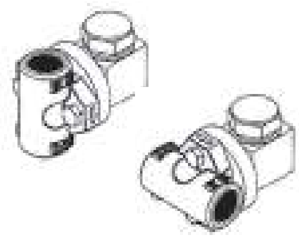


Trap shown with **UC450** Connector

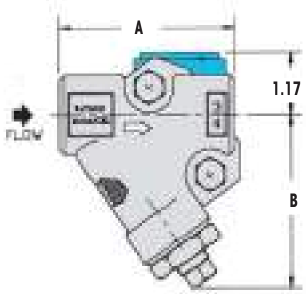


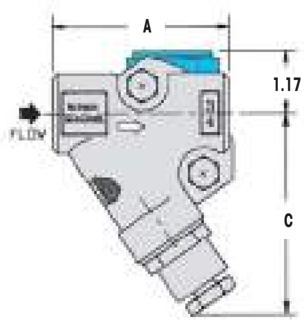


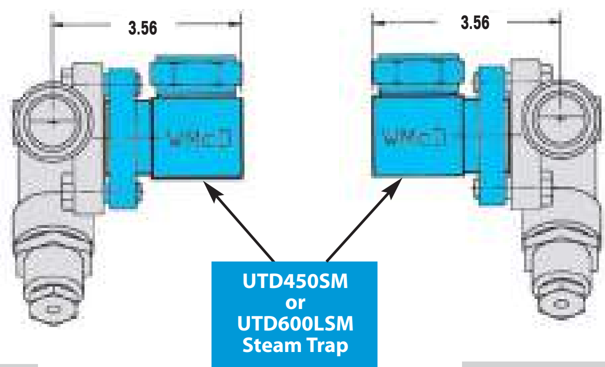




Connectors available in 1/2", 3/4" and 1" sizes in NPT and Socket-Weld Connections







UC450SR
CONNECTOR
Strainer

UC450SBR
CONNECTOR
Strainer & Blowdown

UC450SBL
CONNECTOR
Strainer & Blowdown

DIMENSIONS – *inches*

Size	A	B	C
1/2"	3.31	3.25	3.78
3/4"	3.31	3.25	3.78
1"	3.62	3.44	3.95

UTD450

Universal Style Quick-Change Trap Module

Thermodynamic Steam Trap Module (mounts to UC450 Universal Connectors)

Model *(Top Mount Style)*	**UTD450** **UTD450L**
Connections	**Fits UC450 Series Universal Connectors**
Body Material	**Stainless Steel**
PMO Max. Operating Pressure	**450 PSIG**
TMO Max. Operating Temperature	**750°F**
PMA Max. Allowable Pressure	**720 PSIG @ 100°F**
TMA Max. Allowable Temperature	**800°F @ 400 PSIG**

Steam trap modules <u>can be used</u> with other manufacturers' Universal Connectors.

UTD450
Thermodynamic Steam Trap Module
(Top Mount Style)
Recommended for horizontal piping installations only so that cap can be oriented upwards as shown.

Typical Applications

DRIP, TRACER: Designed to work as a drip trap for the draining of condensate from steam mains and other steam supply lines, the **UTD450** Thermodynamic Steam Trap Module can be used anywhere conventional thermodynamic steam traps are used. Can also be used on tracing applications. This model is only recommended for horizontal piping installations to allow the cap to be oriented upwards. The UTD450 mounts to any 2-bolt Quick-Change Universal Connector.

The UTD450 is recommended for horizontal piping only so that cap can be oriented upwards, as shown.

How It Works

The UC450 universal connector is permanently installed into the pipeline where the steam trap would normally be placed. The trap module, which functions like any thermodynamic steam trap, is fastened to the universal connector with two bolts. When a new trap module is needed, it can be easily removed and replaced with a standard open-end or socket wrench without disturbing the existing piping.

Features

- Trap module can be easily removed and replaced in minutes without having to disconnect any piping
- Trap modules can be used with most manufacturers' 2-bolt universal connector
- All stainless steel construction with hardened seat

Sample Specification

The steam trap module shall be designed to attach to the industry standard two-bolt universal connector. Trap module shall be of a thermodynamic design. Universal connector shall conform to the two bolt industry standard with integral strainer and blowdown options.

Installation and Maintenance

The UTD450 Trap module was intended for horizontal piping installations so the trap can be installed with cap facing upwards. Trap module is attached to the connector using two bolts. If the trap fails for any reason, replace only the trap module. When a new trap module is needed, it can be easily removed and replaced with a standard open-end or socket wrench without disturbing the existing piping.

Options

Universal Connectors are available with an integral strainer and blowdown valve. Connector is purchased separately. See the Universal Connectors section for more information.

Helpful Selection Information
Connector selection to use with the UTD450: UC450 (no strainer), UC450S (strainer), UC450SB (strainer and blowdown). Select this model for steam systems with maximum working pressure of 450 PSIG.

MATERIALS	
Body	Stainless Steel, AISI 420
Disc	Stainless Steel, AISI 420
Cap	Stainless Steel, AISI 416
Insulation Cover	Stainless Steel, AISI 304
Bolts	Steel, ASTM A193 GR B7
Gaskets (2)	Spiral Wound 304 Stainless Steel with Grafoil Filler

CAPACITIES – *Condensate (lbs/hr)*

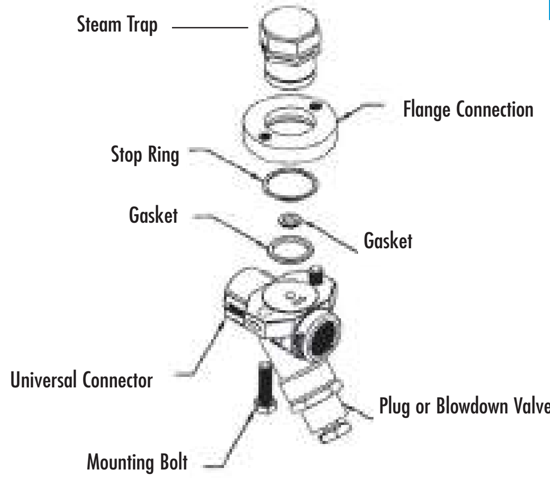
Model	Differential Pressure (PSI)																
	4	10	15	20	25	30	40	50	75	100	150	200	250	300	350	400	450
UTD450L	140	215	242	270	295	320	355	390	455	510	600	670	730	790	840	880	925
UTD450	247	370	420	475	520	560	625	685	800	900	1060	1185	1300	1400	1485	1560	1630

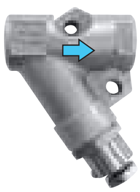
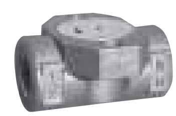
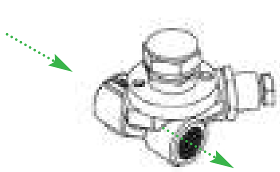
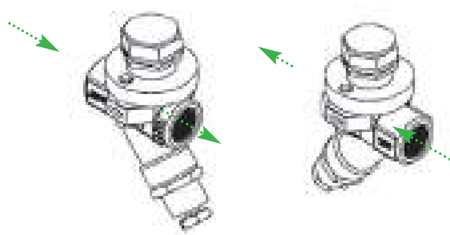
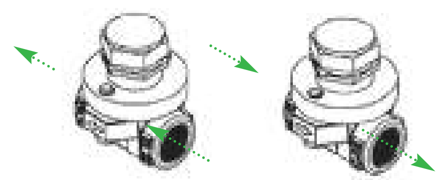
UTD450

Universal Style
Quick-Change Trap Module

Thermodynamic Steam Trap Module (mounts to UC450 Universal Connectors)

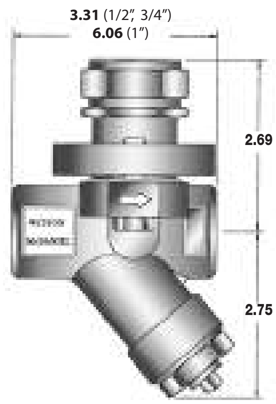
UTD450 Trap Module should be oriented with cap facing Upwards. Therefore it should only be used with Horizontal Piping, as shown.



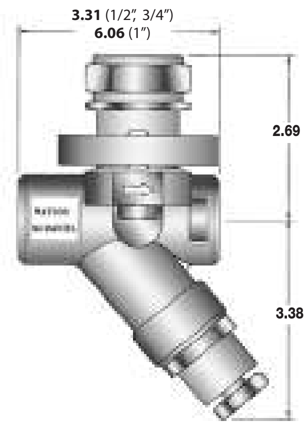
Horizontal Piping (Connector with Strainer)		Horizontal Piping (No Strainer)
Steam Flow to the Right or to the Left UC450SBR & UC450SB Connector (with Blowdown Valve) shown below		**Steam Flow Horizontally** UC450 Connector shown below
		
Trap shown with **UC450SBR** Connector Strainer & Blowdown Valve is directed to the side	Trap shown with **UC450SB** Connector Strainer & Blowdown Valve is directed downwards	Trap shown with **UC450** Connector
		

Connectors available in 1/2", 3/4" and 1" sizes in NPT and Socket-Weld Connections

UTD450 Trap Module with **UC450** Connector



UTD450 Trap Module with **UC450S** Connector (Strainer)



UTD450 Trap Module with **UC450SB** Connector (Strainer & Blowdown)

UT450

Universal Style Quick-Change Trap Module

Thermostatic Steam Trap Module (mounts to UC450 Universal Connectors)

Model	**UT450**
Connections	**Fits UC450 Series Universal Connectors**
Body Material	**Stainless Steel**
PMO Max. Operating Pressure	**450 PSIG**
TMO Max. Operating Temperature	**Saturated Steam Temp.**
PMA Max. Allowable Pressure	**720 PSIG @ 100°F**
TMA Max. Allowable Temperature	**800°F @ 400 PSIG**

Steam trap modules can be used with other manufacturers' Universal Connectors.

UT450
Thermostatic
Steam Trap
Module

Typical Applications

DRIP, TRACER, PROCESS: The **UT450** Thermostatic Steam Trap Module can be used anywhere conventional thermostatic steam traps are used. Used for drip, tracing and light process applications. Trap module mounts to any 2-bolt Quick-Change Universal Connector.

How It Works

The UC450 universal connector is permanently installed into the pipeline where the steam trap would normally be placed. The trap module is fastened to the universal connector with two bolts. When a new trap module is needed, it can be easily removed and replaced with a standard open-end or socket wrench without disturbing the existing piping.

Features

- Trap module can be easily removed and replaced in minutes without having to disconnect any piping
- Trap modules can be used with most manufacturers' 2-bolt universal connector
- All stainless steel construction with hardened seat

Sample Specification

The steam trap module shall be designed to attach to the industry standard two-bolt universal connector. Trap module shall be of a thermostatic design. The universal connector shall conform to the two-bolt industry standard with integral strainer and blowdown options.

Installation and Maintenance

Mounts to any two-bolt quick change universal connector. Trap module is attached to the connector using two bolts and two sealing gaskets. When a new trap module is needed, it can be easily removed and replaced with a standard open-end or socket wrench without unthreading the existing piping. In vertical piping installations with upward flow, use of a blowdown valve is not recommended. Discharge would be in upward and unsafe direction.

Options

Universal Connectors are available with an integral strainer and blowdown valve. Connector is purchased separately. See the Universal Connectors section for more information.

Helpful Selection Information
Connector selection to use with the UT450: UC450 (no strainer), UC450SR (strainer), UC450SBR (strainer and blowdown). Select this model for steam systems with maximum working pressure of 450 PSIG.

MATERIALS

Body	Stainless Steel, AISI 420
Thermal Element	Stainless Steel, AISI 302
Disc & Seat	Stainless Steel, AISI 420
Insulation Cover	Stainless Steel, AISI 304
Bolts	Steel, ASTM A193 GR B7
Gaskets (2)	Spiral Wound 304 Stainless Steel with Grafoil Filler

CAPACITIES – *Condensate (lbs/hr)*

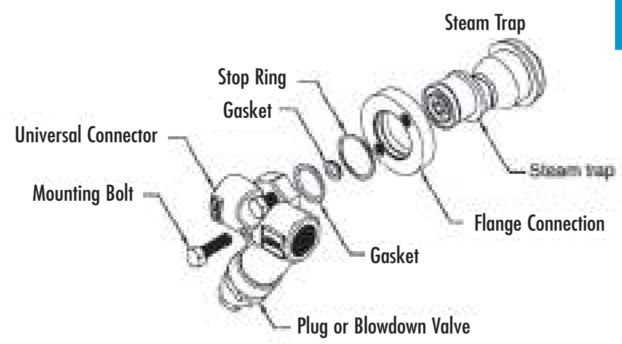
Model	Orifice Size	Steam Inlet Pressure (PSIG)												
		5	10	20	50	100	125	150	200	250	300	350	400	450
UT450	3/16"	441	625	882	1391	1827	1969	2095	2305	2483	2636	2777	2903	3019

Note: *5/64" low capacity orifice is available upon request.*

UT450

Thermostatic Steam Trap Module (mounts to UC450 Universal Connectors)

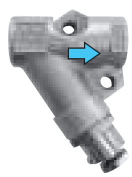
UT450
Thermostatic
Steam Trap
Module
shown with
UC450SL
Connectors



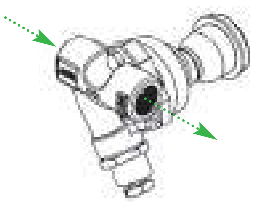
UT450 Trap Module may be mounted in any orientation

Horizontal Piping (Connector with Strainer)

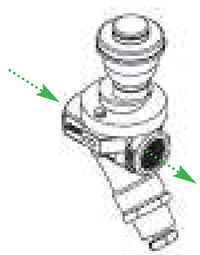
Steam Flow to the Right or to the Left
UC450SBR & UC450SB Connector shown below



Trap shown with
UC450SBR Connector

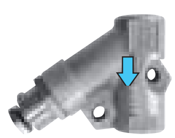


Trap shown with
UC450SB Connector

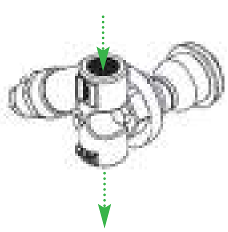


Vertical Piping (Connector with Strainer)

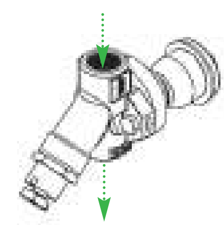
Steam Flow Downward
UC450SBR & UC450SB Connector shown below



Trap shown with
UC450SBR Connector

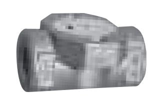


Trap shown with
UC450SB Connector



Vertical or Horizontal Piping (No Strainer)

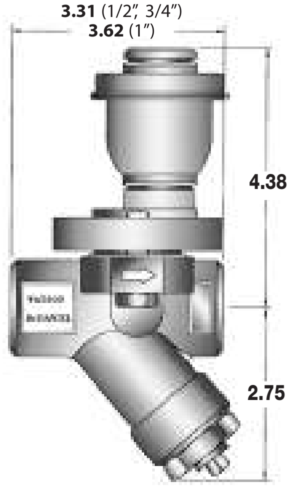
Steam Flow Vertically or Horizontally
UC450 Connector shown below



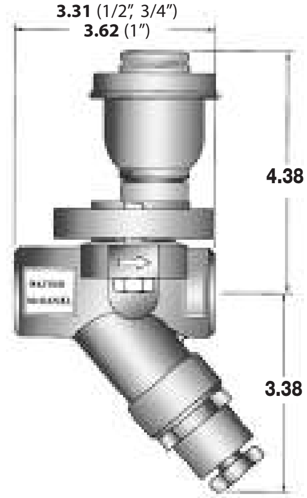
Trap shown with **UC450** Connector

Connectors available in 1/2", 3/4" and 1" sizes in NPT and Socket-Weld Connections

UT450 Trap Module
with **UC450** Connector



UT450 Trap Module with **UC450S** Connector
(Strainer)



UT450 Trap Module
with **UC450SB** Connector
(Strainer & Blowdown)

Universal Style
UB450 Quick-Change Trap Module

Bi-Metallic Steam Trap Module (mounts to UC450 Universal Connectors)

Model	UB450
Connections	Fits UC450 Series Universal Connectors
Body Material	Stainless Steel
PMO Max. Operating Pressure	450 PSIG
TMO Max. Operating Temperature	662°F
PMA Max. Allowable Pressure	720 PSIG @ 100°F
TMA Max. Allowable Temperature	800ºF @ 400 PSIG

Steam trap modules can be used with other manufacturers' Universal Connectors.

UB450
Bi-Metallic Steam Trap Module

Field-adjustable discharge temperature

UB450
Bi-Metallic Steam Trap Module shown with **UC450SBL** connector

Typical Applications

The **UB450** Series Bi-Metallic Steam Trap Modules are used in steam tracing applications (for process line heating, instrumentation and winterization, general steam jacketing). In tracing applications, the externally-adjustable (temperature adjustment) bi-metal element provides accurate control of condensate discharge temperature as required to maintain a specific product temperature as well provide maximum usage of energy.

How It Works

Bi-metallic plates of dissimilar metals which are connected to the valve seat assembly respond to temperature variations. At relatively cool conditions, the trap is open for the discharge of condensate. When the temperature of the condensate is equal to or higher than the set temperature, the metals react and expand, closing the trap. External field-adjustability of the bi-metal element allows control of the condensate discharge temperature. Trap module is fastened to the universal connector using 2 bolts.

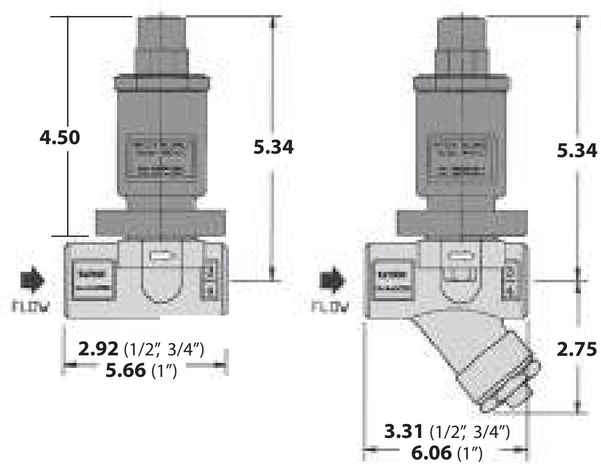
Features

- Excellent for various steam tracing and small process applications where maximum energy usage is desired
- Field-adjustable bimetal element allows control of ondensate discharge temperature, providing maximum use of additional energy in the condensate
- Internal screen and seat/plug design help prevent pipe scale and debris from accumulating on seating surfaces to provide trouble-free operation

Installation and Maintenance

Universal connector is first permanently threaded or welded into piping system. Trap module is attached to the universal connector using two bolts. If the trap fails for any reason, replace only the trap module. In vertical piping installations with upward flow, use of a blowdown valve is not recommended. Discharge would be in upward and unsafe direction.

MATERIALS	
Body and Cover	Stainless Steel, A-351, Gr. CF8
Bimetal Element	GB14
Valve Seat	17-4 Ph Stainless Steel
Gaskets (2)	Spiral Wound 304 Stainless Steel with Grafoil Filler



Shown with UC450 & UC450S Connectors

Maximum Trap Capacities at Various Inlet Pressures and Set Temperatures – *Condensate (lbs/hr)*

	Steam Inlet Pressure (PSIG)											
Set Temperature	15	30	50	100	125	150	200	250	300	350	400	450
220°F	56	70	102	144	161	177	204	228	250	270	289	306
240°F	116	164	212	300	336	368	425	475	520	562	600	637
260°F	134	190	245	346	387	424	490	548	600	648	693	735
280°F	143	202	261	370	413	453	523	584	640	691	739	784

Notes: 1) *Capacities in chart are based on discharging condensate to atmosphere with a condensate temperature of 200° F.*
2) *Contact factory for additional information including other condensate set and discharge temperatures.*
3) *To ensure proper operation and eliminate possible steam loss, the Set Temperature should be lower than 27 °F subcool (degrees below inlet steam saturation temperature).*

Introduction

What is Clean Steam or Pure Steam?

Clean Steam is steam that is made from deionized or distilled water in specialty boilers or steam generators. It is typically used in pharmaceutical applications such as sterilizers, fermenters and bioreactors as well as in the food production industries, distilleries and hospitals. Clean Steam should be used on any process that utilizes steam in such a way that it may come into direct contact with the end product and cause contamination. Industrial grade steam (most common grade of steam) is unsuitable for direct product contact because it contains contaminants from boiler additives, rust, and other heat transfer equipment. Pure Steam is clean steam that is produced to be virtually free of pyrogens and endotoxins, and is defined as "Water For Injection" or WFI.

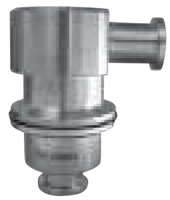
Materials of construction

The Ultra-Pure water that is used to make clean steam has been depleted of all of its ions during the purification process, making it very chemically aggressive to metals, or "ion hungry." Therefore, only corrosion resistant metals such as 316 Stainless Steel can be used in products that handle clean steam. It's often required that the Stainless Steel in contact with Clean Steam must be passivated, a chemical process that removes any residual surface iron and promotes Chrome Oxide formation, further improving corrosion resistance.

Surface Finish

Smoothing the surfaces by means of polishing reduces the ridges and crevices where micro-organisms (bacteria) may grow. While mechanical polishing will reduce the surface ridges significantly, electro-polishing is required to meet the standards of sanitary systems. Electro-polishing is an electro-chemical process that smoothes the surface of a metal object by removing surface metal ion by ion. Ra is measured in microinches and refers to the smoothness of a surface. The lower the Ra number, the smoother the surface and the less chance for surface contamination and microorganism growth.

FDA300



FDA400

FDA500

FDA600

FDA800

Clean Steam					**62-65**
Model	Body Material	PMO (PSIG)	Sizes	Connections	Page No.
FDA300	Stainless Steel	**90**	1 1/2"	Tri-Clamp	**113**
FDA400	Stainless Steel	**90**	1/2", 3/4"	Tri-Clamp	**114**
FDA500	Stainless Steel	**90**	1/2", 3/4", 1"	Tri-Clamp, NPT, TW	**116**
FDA600	Stainless Steel	**110**	1/2", 3/4", 1"	Tri-Clamp, NPT, TW	**118**
FDA800	Stainless Steel	**150**	1/2"	Tri-Clamp, NPT, TW	**119**

Sanitary Steam Traps Vs. Clean Steam Traps

Steam traps to be installed in sanitary piping systems must adhere to stringent design standards beyond traps merely suitable for clean steam applications.

Sanitary Steam Traps are designed to offer free flow through internal passages by incorporating very smooth internal finishes. The internal electro-polish finish on a sanitary steam trap must be between 20-25 Ra while the external finish is usually between 25-32 Ra. Because the system must be periodically passivated to provide sterilization, these traps offer a sanitary tri-clamp connection on the body to allow for removal of the thermal element. Removal of the element allows unobstructed flow through the trap during passivation. The FDA300, FDA400 & FDA500 are Sanitary Steam Traps.

Clean Steam Traps are steam traps designed for the same functionality as the sanitary traps, but do not offer the same level of surface finish, RA. Therefore clean steam traps cannot be used when a sanitary specified application is required.

Clean-in-place (CIP) & Sterilization-in-place (SIP)

CIP is a system which allows the automatic cleaning and disinfecting of plant equipment without dismantling, using cleaning fluids such as detergents, acids, alkalis, and water. CIP uses a high flow, highly turbulent solution to remove soil in the system. Chemicals are used to break up and remove the remaining soil. Sanitizer is then used to kill remaining microorganisms.

SIP is the process of sterilizing plant equipment without dismantling, usually following CIP procedures. SIP uses low pressure steam for sterilization purposes – typically 30 – 35 psig. The steam trap bodies must be passivated to remove any residual iron deposits as well as to promote a chrome oxide layer to enhance corrosion resistance of the stainless steel.

Connections

Because different facilities may identify different areas of potential contamination in a piping system, various end connections are available to satisfy customer needs.

Sanitary Tri-Clamp - A quick disconnect type fitting that meets sanitary piping standards allowing piping systems or products to be easily dismantled.

Tube Weld (TW) – a connection offered where welding of the steam trap is preferred for sanitary applications

NPT – a standard national pipe thread taper connection offered for applications with less stringent requirements, often considered on main line drip applications

Manufacturing and Design Standards

ASME BPE – Provides requirements of equipment used in bioprocessing, pharmaceutical and other applications that require high hygienic levels.

USP 24 – Standard for Pharmaceutical Grade Water which specifies the chemical composition of the allowable number of contaminants.

FDA CFR Title 21-177.1550 – Standard for perfluorocarbon resins that may be safely used as components intended to contact food.

3A Sanitary Standards – Standards provide material specifications, design criteria and other necessary information for equipment types to satisfy public health concerns where a high degree of sanitation is required.

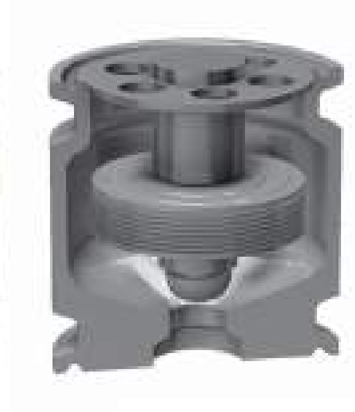
Clean Steam Thermostatic Steam Trap (Repairable)

FDA300

Thermostatic Clean Steam

High-Capacity Sanitary

Model	**FDA300**
Sizes	**1 1/2”**
Connections	**Tri-Clamp**
Body Material	**Stainless Steel**
PMO Max. Operating Pressure	**90 PSIG**
TMO Max. Operating Temperature	**Saturated Steam Temperature**
PMA Max. Allowable Pressure	**145 PSIG up to 338°F**
TMA Max. Allowable Temperature	**350°F @ 132 PSIG**



Typical Applications

PROCESS: **FDA300 Series** high-capacity thermostatic clean steams traps are used on clean steam applications, and for condensate drainage on CIP/SIP systems and various process vessels.

How It Works

This trap contains a welded 316L stainless steel thermal element that expands when heated and contracts when cooled. When air and subcooled condensate are present, the trap is in an open discharge position. When steam reaches the trap, the element expands, closing the trap tightly.

Features

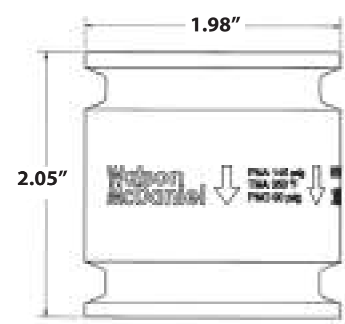
- All wetted parts are 316L stainless steel
- Electro-polish finish of 20-25 microinches RA on internal surfaces of body
- Electro-polish finish of 25-32 microinches RA on external surfaces of body
- Operates close to saturation curve to minimize condensate back-up
- Completely self-draining in the vertical downward flow orientation

Sample Specification

The steam Trap shall be all 316L stainless steel thermostatic type with a balanced pressure bellows that operates close to saturated steam temperatures. Internal body parts shall have an electro-polish finish of 20-25 microinches RA internally and a 25-32 finish externally. The unit shall have a split-body sanitary clamp design for easy maintenance. Trap shall be completely self-draining when mounted vertically.

Installation and Maintenance

This trap is designed for installation in a vertical, downward flow orientation to ensure that the self-draining clean steam requirement is satisfied.



Size/Connection Inlet x Outlet	Model Code	Orifice Size	Weight lbs
1 1/2” TC x TC	**FDA300-16-TCTC**	0.394	2.25

MATERIALS	
Body	Stainless Steel, AISI 316L
Element Plate	Stainless Steel, AISI 316L
Thermal Element	Stainless Steel, AISI 316L
Clamp	Stainless Steel, AISI 304

CAPACITIES – *Condensate (lbs/hr)*

Model	Orifice (inches)	Differential Pressure (PSI) 5	10	20	50	75	90
FDA300	**0.394**	216	368	702	2214	4300	5904

Note: Capacities at 9°F below saturated steam temperature

Clean Steam Thermostatic Steam Trap

(Repairable)

FDA400

Thermostatic Clean Steam

Model	**FDA401, FDA402, FDA403**
Sizes	**1/2", 3/4"**
Connections	**Tri-clamp**
Body Material	**Stainless Steel**
PMO Max. Operating Pressure	**90 PSIG**
TMO Max. Operating Temperature	**Saturated Steam Temperature**
PMA Max. Allowable Pressure	**145 PSIG up to 338°F**
TMA Max. Allowable Temperature	**350°F @ 132 PSIG**

Sanitary Clamp for Trap Body

Typical Applications

DRIP, PROCESS: **FDA400 Series** thermostatic clean steam traps are used in clean steam applications such as drainage for CIP/SIP systems and various process vessels. The universal horizontal connection allows the trap body to swivel to any angle. The FDA400 Series allows for a 90 degree connection on either the inlet or outlet capable of 360 degree orientation. Available with 2°F sub-cool bellows.

How It Works

This trap contains a welded 316L stainless steel thermal element that expands when heated and contracts when cooled. When air and sub-cooled condensate are present, the trap is in an open discharge position. When steam reaches the trap, the element expands, closing the trap tightly.

Features

- Universal horizontal connection swivels to any angle
- All wetted parts are 316L stainless steel
- Electro-polish finish of 20-25 microinches RA on internal surfaces of body
- Electro-polish finish of 25-32 microinches RA on external surfaces of body
- Operates close to saturation curve to minimize condensate back-up
- Completely self-draining in the vertical downward flow orientation

Size/Connection Inlet x Outlet	Model Code	Port Configuration Inlet	Outlet	Weight lbs
9/64" Orifice (0.141)				
1/2" TC x TC	**FDA401-12-TCTC**	90°	90°	3
1/2" TC x TC	**FDA402-12-TCTC**	90°	Straight	3
1/2" TC x TC	**FDA403-12-TCTC**	Straight	90°	3
5/16" Orifice (0.312)				
3/4" TC x TC	**FDA411-13-TCTC**	90°	90°	3
3/4" TC x TC	**FDA412-13-TCTC**	90°	Straight	3
3/4" TC x TC	**FDA413-13-TCTC**	Straight	90°	3

MATERIALS	
Body	Stainless Steel, AISI 316L
Gasket	Teflon/Encapsulated Viton
Element Plate	Stainless Steel, AISI 316L
Thermal Element	Stainless Steel, AISI 316L
Clamp	Stainless Steel, AISI 304

CAPACITIES – *Condensate (lbs/hr)*

Model	Orifice (inches)	Differential Pressure (PSI) 5	10	20	50	75	90
FDA400	**9/64**	140	240	400	690	850	950
FDA410	**5/16**	850	1200	1695	2690	3165	3400

Note: Capacities at 10°F below saturation.

Sample Specification

The Steam Trap shall be all 316L stainless steel thermostatic type with a balanced pressure bellows that operates close to saturated steam temperatures. Inlet, outlet or both connections must contain a 90° swivel arrangement capable of 360° orientation. Internal body parts shall have an electro-polish finish of 20-25 microinches RA internally and a 25-32 finish externally. The unit shall have a split-body sanitary clamp design for easy maintenance. Trap shall be completely self-draining when mounted vertically.

Installation and Maintenance

Trap is designed for installation in a vertical, downward flow orientation to ensure that the self-draining clean steam requirement is satisfied.

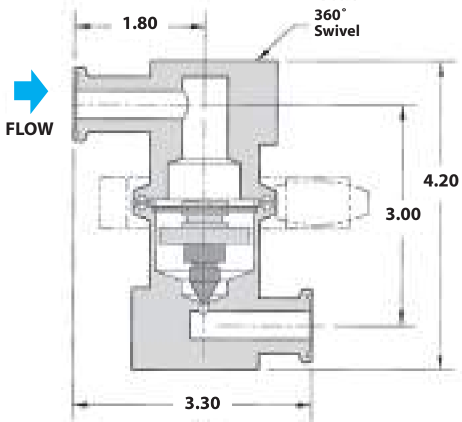
Clean Steam Thermostatic Steam Trap
(Repairable)

FDA400
Thermostatic Clean Steam

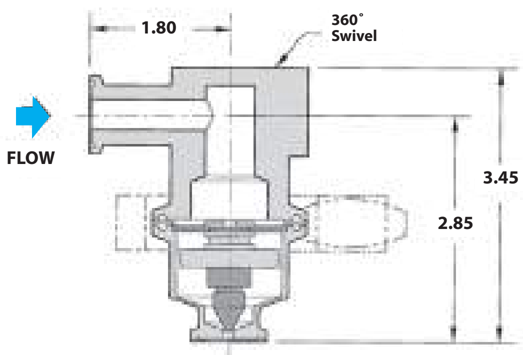
FDA400 Series **Connections: 1/2" & 3/4"**

Units: inches

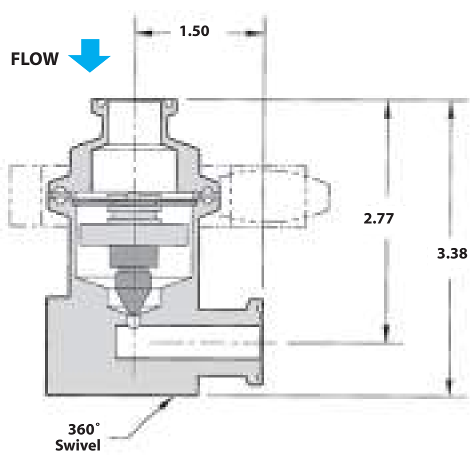
FDA401	9/64" Orifice (0.141)	**Inlet: 90˚ Angle**
FDA411	5/16" Orifice (0.312)	**Outlet: 90˚ Angle**



FDA402	9/64" Orifice (0.141)	**Inlet: 90˚ Angle**
FDA412	5/16" Orifice (0.312)	**Outlet: Straight**



FDA403	9/64" Orifice (0.141)	**Inlet: Straight**
FDA413	5/16" Orifice (0.312)	**Outlet: 90˚ Angle**



Clean Steam Thermostatic Steam Trap
(Repairable)

FDA500
Thermostatic Clean Steam

Model	**FDA500, FDA510**
Sizes	**1/2", 3/4", 1", 1 1/2"**
Connections	**Tri-clamp, NPT, Tube Weld**
Body Material	**Stainless Steel**
PMO Max. Operating Pressure	**90 PSIG**
TMO Max. Operating Temperature	**Saturated Steam Temperature**
PMA Max. Allowable Pressure	**145 PSIG up to 338°F**
TMA Max. Allowable Temperature	**350°F @ 132 PSIG**

Sanitary Clamp for Trap Body

Typical Applications

DRIP, PROCESS: **FDA500 Series** thermostatic clean steam traps are used in clean steam applications as drip traps on piping runs as well as for drainage for CIP/SIP systems and various process vessels. Available with 2°F sub-cool bellows.

How It Works

This trap contains a welded 316L stainless steel thermal element that expands when heated and contracts when cooled. When air and sub-cooled condensate are present, the trap is in an open discharge position. When steam reaches the trap, the element expands, closing the trap tightly.

Features

- All wetted parts are 316L stainless steel
- Electro-polish finish of 20-25 microinches RA on **internal** surfaces of body. Consult factory for 15RA max surface finish option.
- Electro-polish finish of 25-32 microinches RA on **external** surfaces of body
- Operates close to saturation curve to minimize condensate back-up
- Completely self-draining in the vertical downward flow orientation

Sample Specification

The steam Trap shall be all 316L stainless steel thermostatic type with a balanced pressure bellows that operates close to saturated steam temperatures. Internal body parts shall have an electro-polish finish of 20-25 microinches RA internally and a 25-32 finish externally. The unit shall have a split-body sanitary clamp design for easy maintenance. Trap shall be completely self-draining when mounted vertically.

Installation and Maintenance

This trap is designed for installation in a vertical, downward flow orientation to ensure that the self-draining clean steam requirement is satisfied. If purchased with tube weld connections with the intention of welding in-line, the thermal element and gasket must be removed during the welding process or heat damage may occur.

Size/Connection Inlet x Outlet	Model Code	Orifice Size	Weight lbs
1/2" TC x TC	**FDA500-12-TCTC**	9/64"	2.00
3/4" TC x TC	**FDA500-13-TCTC**	9/64"	2.00
1" TC x TC	**FDA500-14-TCTC**	9/64"	2.25
1 1/2" TC x TC	**FDA500-16-TCTC**	9/64"	2.25
1/2" TC x TC	**FDA510-12-TCTC**	5/16"	2.00
3/4" TC x TC	**FDA510-13-TCTC**	5/16"	2.00
1" TC x TC	**FDA510-14-TCTC**	5/16"	2.25
1 1/2" TC x TC	**FDA510-16-TCTC**	5/16"	2.25
1/2" TC x NPT	**FDA500-12-TCNP**	9/64"	2.00
3/4" TC x NPT	**FDA500-13-TCNP**	9/64"	2.00
1" TC x NPT	**FDA500-14-TCNP**	9/64"	3.00
1 1/2" TC x NPT	**FDA500-16-TCNP**	9/64"	2.25
1/2" TC x NPT	**FDA510-12-TCNP**	5/16"	2.25
3/4" TC x NPT	**FDA510-13-TCNP**	5/16"	2.25
1" TC x NPT	**FDA510-14-TCNP**	5/16"	2.25
1 1/2" TC x NPT	**FDA510-16-TCNP**	5/16"	2.25
1/2" TW x TW	**FDA500-12-TWTW**	9/64"	2.25
1/2" TW x TW	**FDA510-12-TWTW**	5/16"	2.25

MATERIALS

Body	Stainless Steel, AISI 316L
Gasket	Teflon/Encapsulated Viton
Element Plate	Stainless Steel, AISI 316L
Thermal Element	Stainless Steel, AISI 316L
Clamp	Stainless Steel, AISI 304

CAPACITIES – *Condensate (lbs/hr)*

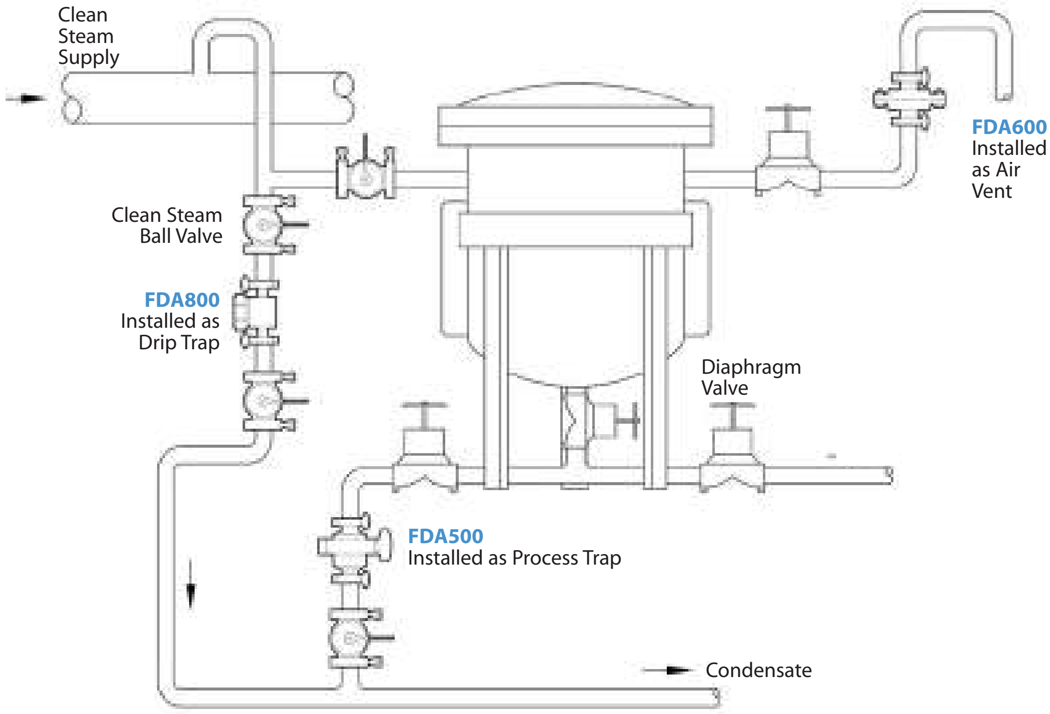
Model	Orifice (inches)	Differential Pressure (PSI) 5	10	20	50	75	90
FDA500	**9/64**	140	240	400	690	850	950
FDA510	**5/16**	850	1200	1695	2690	3165	3400

Note: Capacities at 10°F below saturation.

Clean Steam Thermostatic Steam Trap
(Repairable)

FDA500
Thermostatic Clean Steam

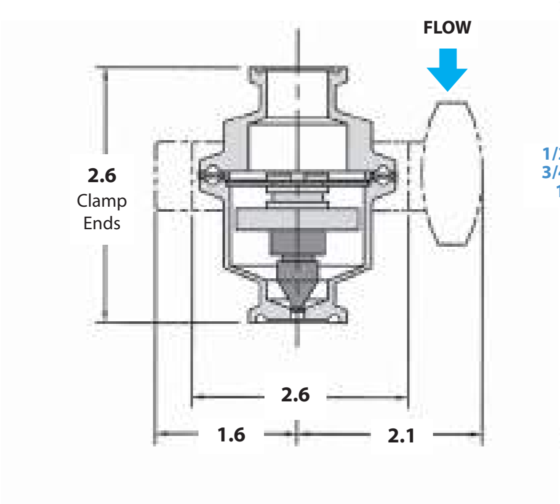
Typical Clean Steam Application



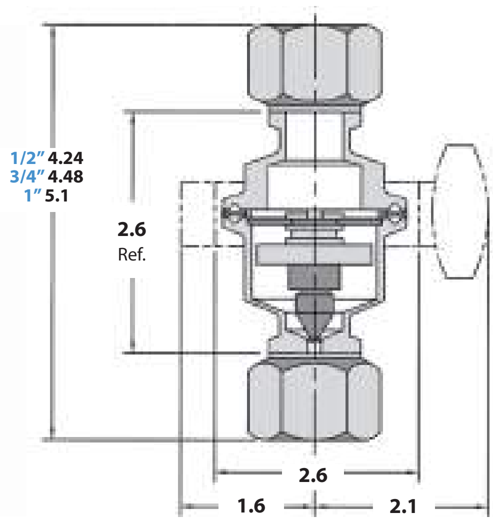
FDA500 Series **Connections: 1/2", 3/4" & 1"**

Units: inches

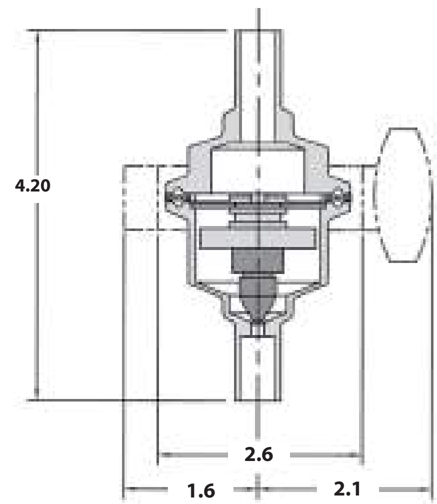
Tri-Clamp Connection: TC x TC



Connection: NP x NP or TC x NP



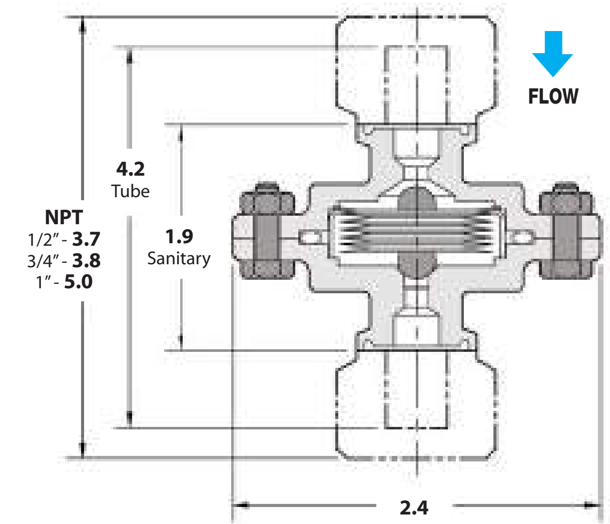
Tube-weld Connection: TW x TW



Steam Traps
Clean Steam Thermostatic Steam Trap
(Repairable)

FDA600
Thermostatic Clean Steam

Model	**FDA600**
Sizes	**1/2", 3/4", 1"**
Connections	**Tri-clamp, NPT, Tube Weld**
Body Material	**Stainless Steel**
PMO Max. Operating Pressure	**110 PSIG**
TMO Max. Operating Temperature	**Saturated Steam Temperature**
PMA Max. Allowable Pressure	**145 PSIG up to 338°F**
TMA Max. Allowable Temperature	**350°F @ 132 PSIG**



Units: Inches

Typical Applications

DRIP, PROCESS: **FDA600 Series** thermostatic clean steam traps are used as drip traps on piping runs on clean steam applications and for drainage for CIP/SIP systems and various process vessels.

How It Works

This trap contains a welded 316L stainless steel thermal element that expands when heated and contracts when cooled. When air and subcooled condensate are present, the trap is in an open discharge position. When steam reaches the trap, the element expands, closing the trap tightly.

Features

- All wetted parts are 316L stainless steel
- Operates close to saturation curve to minimize condensate back-up
- Completely self-draining in the vertical downward flow orientation

Sample Specification

The Steam Trap shall be all 316L stainless steel thermostatic type with a balanced pressure bellows that operates close to saturated steam temperatures. The unit shall have a split-body design for easy maintenance. Trap shall be completely self-draining when mounted vertically.

Installation and Maintenance

Trap is designed to be installed in a vertical, downward flow orientation to ensure that the self-draining clean steam requirement is satisfied. If purchased with tube weld connections with the intention of welding in-line, the thermal element and gasket must be removed during the welding process or heat damage may occur.

Size/Connection Inlet x Outlet	Model Code	PMO PSI	Weight lbs
1/2" TC x TC	**FDA600-12-TCTC**	110	1.25
3/4" TC x TC	**FDA600-13-TCTC**	110	1.25
1" TC x TC	**FDA600-14-TCTC**	110	1.25
1/2" TC x NPT	**FDA600-12-TCNP**	110	1.25
3/4" TC x NPT	**FDA600-13-TCNP**	110	1.25
1" TC x NPT	**FDA600-14-TCNP**	110	1.25
1/2" NPT x NPT	**FDA600-12-NPNP**	110	1.25
3/4" NPT x NPT	**FDA600-13-NPNP**	110	1.25
1" NPT x NPT	**FDA600-14-NPNP**	110	1.25
1/2" TW X TW	**FDA600-12-TWTW**	110	1.25

MATERIALS

Body	Stainless Steel, AISI 316L
Thermal Element	Stainless Steel, AISI 316L
O-Ring, FDA Grade	Teflon Coated Silicone/FEP
Nuts & Bolts	Stainless Steel, AISI 316L

CAPACITIES – *Condensate (lbs/hr)*

Condensate Temp Below Saturation	Differential Pressure (PSI) 1	5	10	20	50	75	110
10 °F	32	105	175	290	615	805	1160
20 °F	42	115	225	440	1060	1500	1850
Cold Water	735	1070	1375	1900	3100	3500	4600

Clean Steam Thermodynamic Steam Trap

FDA800

Thermodynamic Clean Steam

Model	**FDA800**
Sizes	**1/2"**
Connections	**Tri-Clamp, NPT, Tube Weld**
Body Material	**Stainless Steel**
PMO Max. Operating Pressure	**150 PSIG**
TMO Max. Operating Temperature	**500ºF**
PMA Max. Allowable Pressure	**230 PSIG @ 850ºF**
TMA Max. Allowable Temperature	**850ºF @ 230 PSIG**


NPT


Tri-Clamp

Typical Applications

DRIP: The **FDA800 Series** thermodynamic clean steam traps are used as drip traps on steam mains in CIP/SIP systems and drainage for separators and filters.

How It Works

Using the thermodynamic properties of flash steam, this trap features a disc that is pushed open by incoming condensate, then closes tightly when steam enters the trap. Because it normally operates in an open position, condensate is continuously discharged from the line. Steam entering the trap creates an internal pressure that forces the valve to close tightly, preventing the steam from escaping.

Features

- Small and compact
- All 316L stainless steel components
- Works in any position (horizontal preferred)

Sample Specification

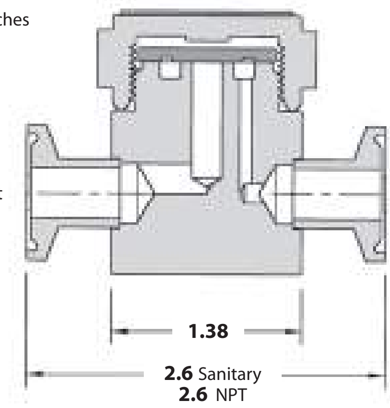
The steam trap shall be a thermodynamic disc type with an all 316L stainless steel construction and integral seat design. Unit shall be capable of installation in any orientation and self-draining when mounted vertically.

Installation and Maintenance

Can be installed in any position; however, horizontal is preferred. For self-draining requirements, the trap should be installed vertically. Installation should include a strainer before the trap inlet since dirt is a common cause of premature failure.

MATERIALS	
Body	Stainless Steel, AISI 316L
Disc	Stainless Steel, AISI 316L
Cap	Stainless Steel, AISI 316L

Size/Connection Inlet x Outlet	Model Code	PMO PSI	Weight lbs
1/2" TC x TC	**FDA800-12-TCTC**	150	1.5
1/2" TW x TW	**FDA800-12-TWTW**	150	1.5
1/2" NPT x NPT	**FDA800-12-NPNP**	150	1.5



CAPACITIES – *Condensate (lbs/hr)*

	Differential Pressure (PSI)											
Size	**3.5**	**5**	**10**	**15**	**20**	**25**	**30**	**40**	**50**	**75**	**100**	**150**
1/2"	180	185	190	195	200	215	220	230	250	310	375	500

Note: *Maximum back pressure not to exceed 80% of inlet pressure.*

Bi-Metallic Steam Trap

WPN Series
Bi-Metallic

Bi-Metallic Steam Traps

The **WPN Series Bi-Metallic Steam Traps** are used in steam tracing, steam main drips and non-critical process equipment. They can be used on outdoor applications that are subject to freezing. The WPN Series Traps are available in multiple sizes and pressures up to 2260 PSI.

Model	Body Material	PMO (PSIG)	Sizes	Connections	Pressure Controller	Max Diff. Pressure (PSI)
WPN-40	A105 Carbon Steel	**470**	1/2" – 2"	NPT, 150# or 300# FLG, SW, BW	**R22**	**320**
					R32	**460**
WPN-63	A182-F12CL2 Alloy Steel	**823**	1/2", 3/4", 1"	NPT, 300# FLG, SW, BW	**R56**	**810**
WPN-100	A182-F12CL2 Alloy Steel	**1220**	1/2", 3/4", 1"	NPT, 600# FLG, SW, BW	**R90**	**1200**
WPN-160	A182-F12CL2 Alloy Steel	**1620**	1/2", 3/4", 1"	NPT, 900# FLG, SW, BW	**R130**	**1600**
WPN-250	A182-F22CL3 Alloy Steel	**2260**	1/2", 3/4", 1"	NPT, 1500# FLG, SW, BW	**R150**	**2230**

Typical Applications

DRIP, TRACING: WPN Series Bi-metallic steam traps are used in steam tracing, steam main drips and non-critical process equipment. They are extremely robust and reliable, making them a suitable choice for high
pressure applications as well as outdoor applications that are subject to freezing. They are used in systems where a quick discharge of air, non-condensable gases and large quantities of cold water need to be dischargeat start-up.

How It Works

When the system is cold, the trap is fully open; discharging air and cold condensate. When the bi-metallic plates inside the trap heat up, they expand; pulling the seat closed and restricting flow. Prior to steam temperature being reached, the trap shuts off tightly. Cooler temperatures cause the seat to open further. Therefore, trap capacity will increase when colder condensate is in contact with the Bi-metal element. Trap capacity is therefore given at different temperatures below saturated steam temperature.

Features

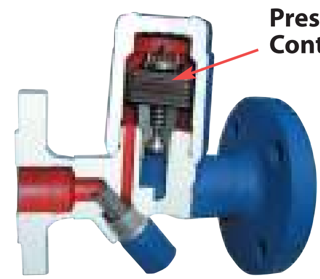
- Excellent for high-pressure and superheated steam applications
- Freeze-proof and resistant to waterhammer
- Suitable for superheated steam
- In-line repairable
- Trap can be welded into line

Sample Specification

Steam trap shall be Watson McDaniel WPN Series Bi-Metallic Steam Trap. Trap must be capable of being completely serviced while still in-line.

Installation and Maintenance

The trap can be installed in any orientation except with the cap facing downward. All internal components can be replaced while trap body remains in-line.



Max Differential Pressure for Pressure Controller

Pressure Controller	Max Diff. Pressure PSI
R22	320
R32	460
R56	810
R90	1200
R130	1600
R150	2230

How to select a A WPN Trap:

1) Select a Pressure Controller that has a max differential pressure within the range of your application.
2) Select a Trap Body depending on System Pressure; WPN40 thru WPN250.
3) Select Connection Type & Size
4) Configure Model Code (see Examples to right)

Example Model Codes:

WPN40-A-R22-14-F150-ES
(Model WPN40, 320 PSI Max Differential Pressure, 1" 150# Flanged with External Strainer)

WPN63-C-R56-14-F600
(Model WPN63, 810 PSI Max Differential Pressure, 1" 600# Flanged with Standard Internal Strainer)

Model Configuration Chart

Position 1	Position 2	Position 3	Position 4		Position 5	Position 6
Model	Body Material (Code)	Pressure Controller Code	Connection Size	Code	Connection Type Code	Strainer Selection Code
WPN-40	Carbon Steel A105 (A)	R22 or R32	1/2"	12	F150, F300, N, SW	Internal Strainer (IS)
			3/4"	13		
			1"	14		
			1 1/2"	16		
			2"	17		
			1/2"	12	F150, F300, N, SW, BW	External Strainer (ES)
			3/4"	13		
			1"	14		
			1 1/2"	16		
			2"	17		
WPN-63	Alloy Steel A182-F12CL2 (C)	R56	1/2"	12	F300, SW, BW	
			3/4"	13		
			1"	14		
WPN-100	Alloy Steel A182-F12CL2 (C)	R90	1/2"	12	F600, SW, BW	
			3/4"	13		
			1"	14		
WPN-160	Alloy Steel A182-F12CL2 (C)	R130	1/2"	12	F900, SW, BW	
			3/4"	13		
			1"	14		
WPN-250	Alloy Steel A182-F22CL3 (C)	R150	1/2"	12	F1500, SW, BW	
			3/4"	13		
			1"	14		

Model	WPN-40	
Sizes	1/2", 3/4", 1", 1 1/2", 2"	
Connections	NPT, 150# FLG, 300# FLG, SW, BW	
Body & Cover Material	A105 (C22.8)	
PMA ANSI Class 150 with 150# FLG	190 PSIG up to 437˚F	
PMA ANSI Class 300 with 300# FLG	460 PSIG up to 772˚F	
TMO Max. Operating Temperature (˚F)	Approx. 100˚F Superheat	
Pressure Controller	R22	R32
PMO Max. Operating Differential Pressure of Pressure Controller (PSI)	320	460

Note: SW = Socket Weld
BW = Butt-Weld

1) = 18˚F SUB-COOL
2) = 54˚F SUB-COOL
3) = 68˚F

The capacity charts show the maximum flow at factory setting.

Curve 1 Flow of Condensate at approx. 18°F below boiling temperature.

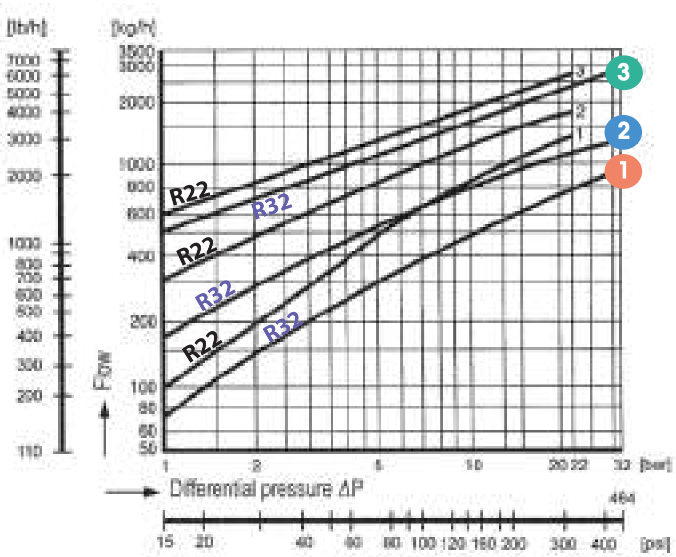
Curve 2 Flow of Sub-Cooled Condensate at approx. 54°F below boiling temperature.

Curve 3 Flow of Cold Condensate at about 68°F (during start-up of a cold system).

Cooler temperatures cause the seat in the controller to open wider; therefore, trap capacity will increase when colder condensate is in contact with the Bi-metal element. Trap capacity is given at different temperatures below saturated steam temperature

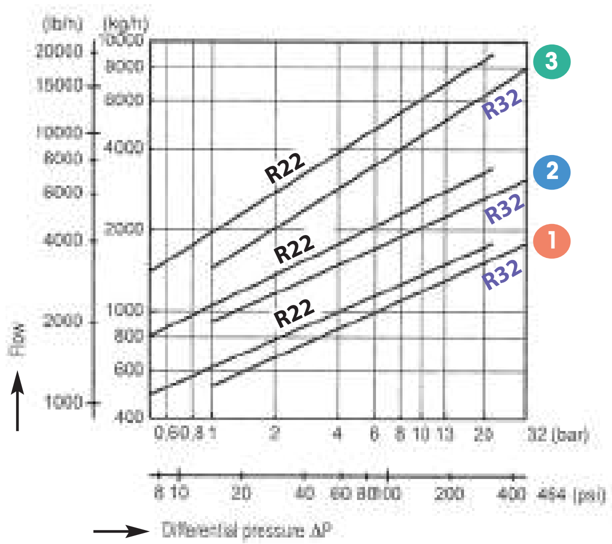
WPN-40 with **R22** & **R32** Controller

1/2", 3/4", 1"



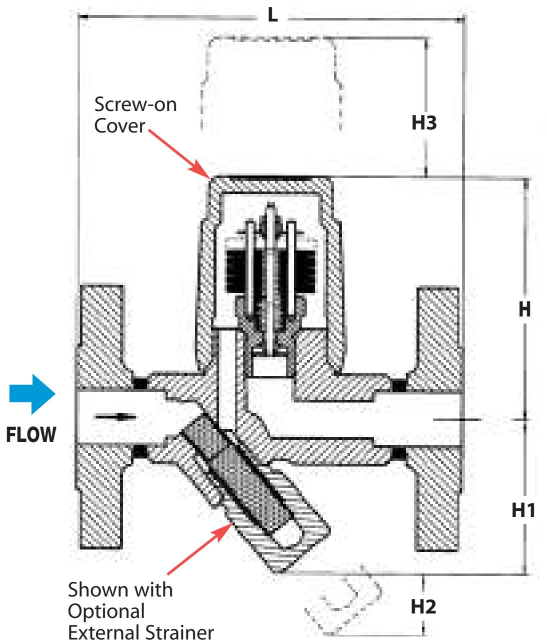
WPN-40 with **R22** & **R32** Controller

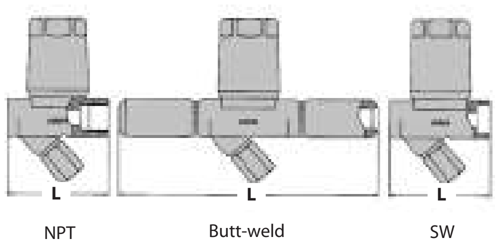
1 1/2", 2"



WPN-40 with **R22** or **R32** Controller **(screw-on cover)**

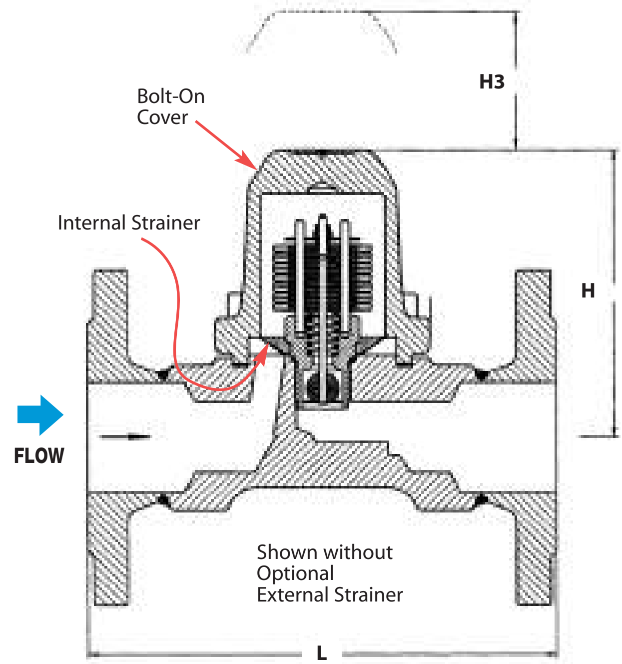
1/2", 3/4", 1"

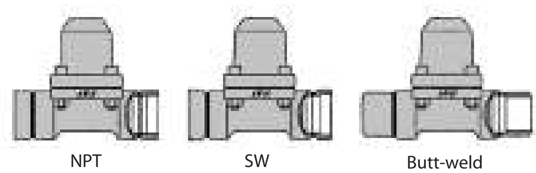




WPN-40 with **R22** or **R32** Controller **(bolt-on cover)**

1 1/2", 2"





DIMENSIONS & WEIGHTS – *inches*

Model	Size	Connection	L	H	H1	H2	H3	Weight (lbs)
WPN-40	1/2", 3/4"	150#/300# FLG	5.90	3.92	2.44	1.20	2.8	7.7
	1"	150#/300# FLG	6.30	3.92	2.44	1.20	2.8	9.2
	1 1/2", 2"	150#/300# FLG	9.05	5.76	2.67	1.97	3.6	25.0
	1/2", 3/4"	NPT, SW	3.74	3.92	2.44	1.20	2.8	3.7
	1"	NPT, SW	3.74	4.12	2.16	1.20	2.8	4.6
	1 1/2"	NPT	6.30	5.76	2.67	1.97	3.6	17.6
	1 1/2"	SW	5.12	5.76	2.67	1.97	3.6	17.6
	2"	NPT, SW	8.27	5.76	2.67	1.97	3.6	17.6
	1/2", 3/4", 1"	Butt-weld	9.84	3.92	2.44	1.20	2.8	5.0
	1 1/2", 2"	Butt-weld	9.84	5.76	2.67	1.97	3.6	21.0

Bi-Metallic Steam Trap

WPN Series
Bi-Metallic

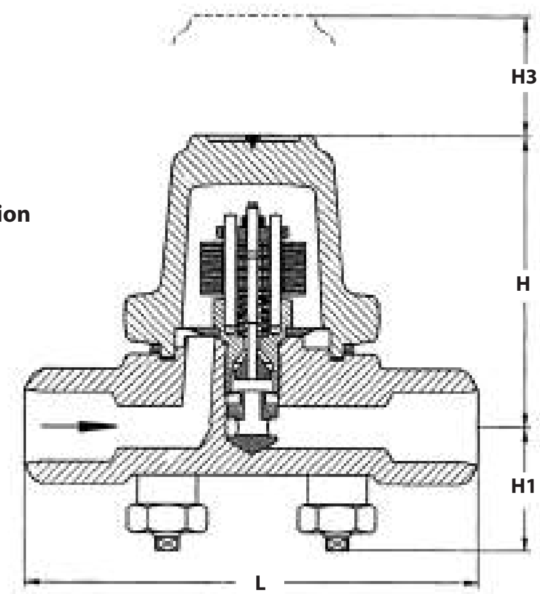
Model	WPN-63*	WPN-100	WPN-160	WPN-250
Sizes	1/2", 3/4", 1"	1/2", 3/4", 1"	1/2", 3/4", 1"	1/2", 3/4", 1"
Connections	300# FLG, SW, Butt-weld	600# FLG, SW, Butt-weld	900# FLG, SW, Butt-weld	1500# FLG, SW, Butt-weld
Body & Cover Material	Alloy Steel (A182-F12CL2)	Alloy Steel (A182-F12CL2)	Alloy Steel (A182-F12CL2)	Alloy Steel (A182-F22CL3)
Body Rating	ANSI 400	ANSI 600	ANSI 900	ANSI 1500
PMA Max. Allowable Pressure	810 PSIG up to 592˚F	1200 PSIG up to 610˚F	1600 PSIG up to 750˚F	2180 PSIG up to 905˚F
TMA Max. Allowable Temperature	1000˚F @ 261 PSIG	1000˚F @ 441 PSIG	1000˚F @ 595 PSIG	1000˚F @ 1305 PSIG
TMO Max. Operating Temperature	572˚F	842˚F	932˚F	932˚F
Pressure Controller	R56	R90	R130	R150
PMO Max. Operating Diff. Pressure of Pressure Controller	810 PSI	1200 PSI	1600 PSI	2230 PSI

WPN-63 / WPN-100 / WPN-160 / WPN-250

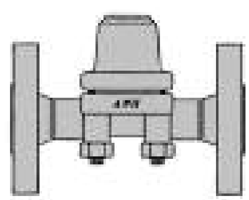
1/2", 3/4", 1"

Butt-weld Version (shown)

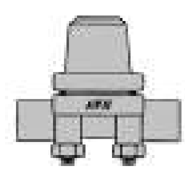
FLOW



FLG



SW



DIMENSIONS & WEIGHTS – *inches*

Model	Size	Connection	L	H	H1	H3	Weight (lbs)
WPN-63, WPN-100, WPN-160, WPN-250	1/2", 3/4"	FLG*	8.26	4.16	1.68	2.8	17.6
	1"	FLG*	9.05	4.16	1.68	2.8	17.6
	1/2", 3/4", 1"	SW	6.30	4.16	1.68	2.8	10.0
		Butt-weld	6.30	4.16	1.68	2.8	10.0

* WPN-63: 300# FLG
WPN-100: 600# FLG
WPN-160: 900# FLG
WPN-250: 1500# FLG

The capacity charts show the maximum flow at factory setting.

Curve 1 Maximum Flow quantity of Condensate at approximately 18 & 27°F below boiling temperature.

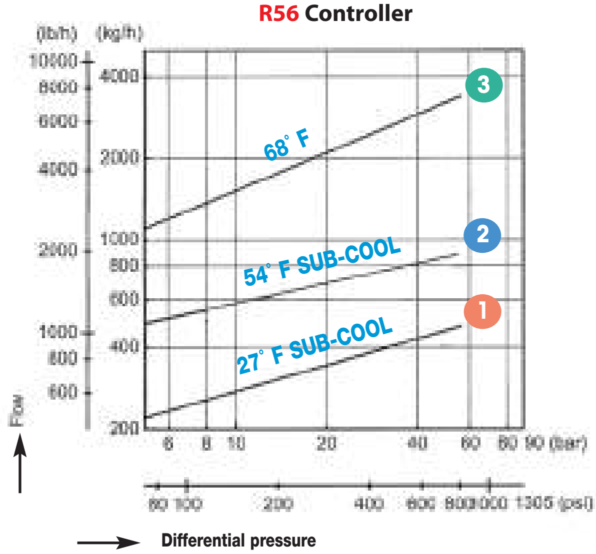
Curve 2 Maximum Flow of Sub-Cooled condensate at approx. 54°F below boiling temperature (through back up of condensate).

Curve 3 Maximum Flow quantity of Cold Condensate at about 68°F (during start-up of a cold system).

Cooler temperatures cause the seat in the controller to open wider; therefore, trap capacity will increase when colder condensate is in contact with the Bi-metal element. Trap capacity is given at different temperatures below saturated steam temperature.

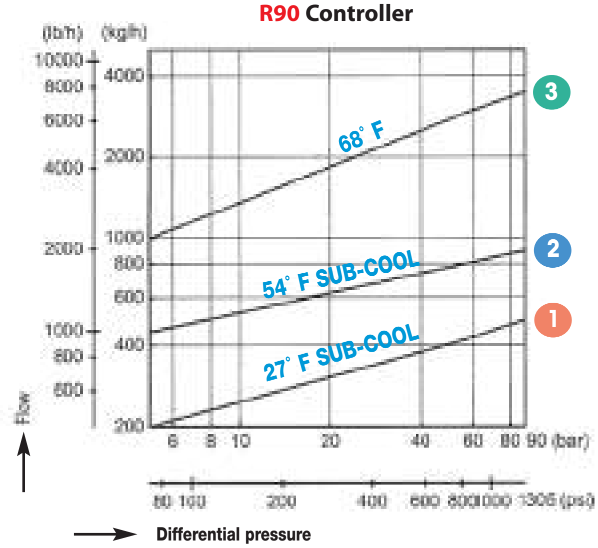
WPN-63 • 1/2", 3/4", 1"

R56 Controller



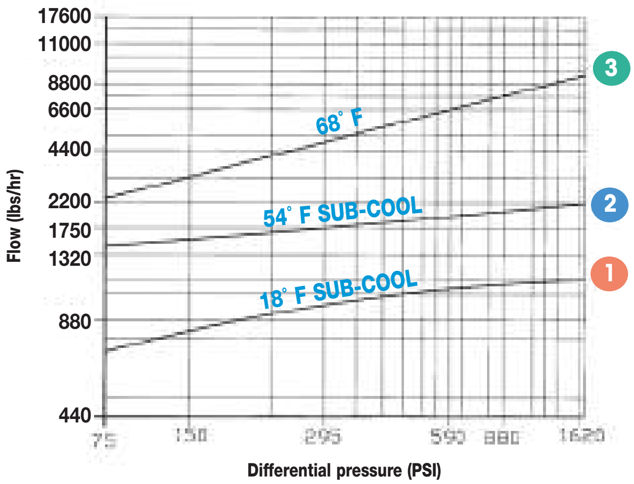
WPN-100 • 1/2", 3/4", 1"

R90 Controller



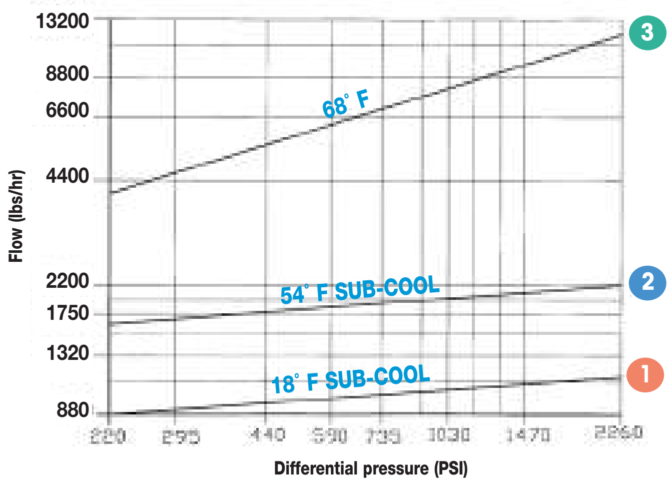
WPN-160 • 1/2", 3/4", 1"

R130 Controller



WPN-250 • 1/2", 3/4", 1"

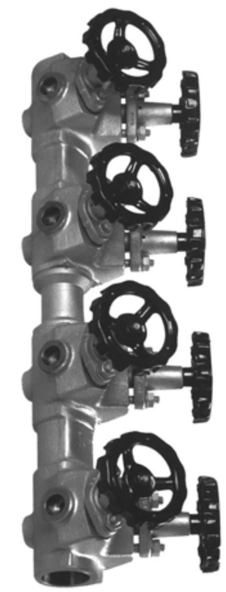
R150 Controller



Fabricated Carbon Steel • Forged Steel

Model	FM	FSM
Sizes	1/2”, 3/4”	1/2”, 3/4”
Connections	NPT, SW	NPT, SW
Body Material	Fabricated Carbon Steel	Forged Steel
PMO Max. Operating Pressure	720 PSIG	600 PSIG
Pressure/Temperature Rating	720 PSIG @ 508°F	600 PSIG @ 500°F

FM Manifold
(Carbon Steel)



FSM Manifold
(Forged Steel)

Typical Applications

FM / FSM manifolds are used for steam distribution TO the tracing system and for condensate collection FROM the tracing system. Commonly used in chemical and petrochemical facilities as well as in other industrial plants that have multiple tracing applications. Manifolding the steam distribution and condensate collection system not only cuts down on installation and maintenance costs, but also provides freeze protection. FSM Series manifolds have integral isolation valves.

Description FM

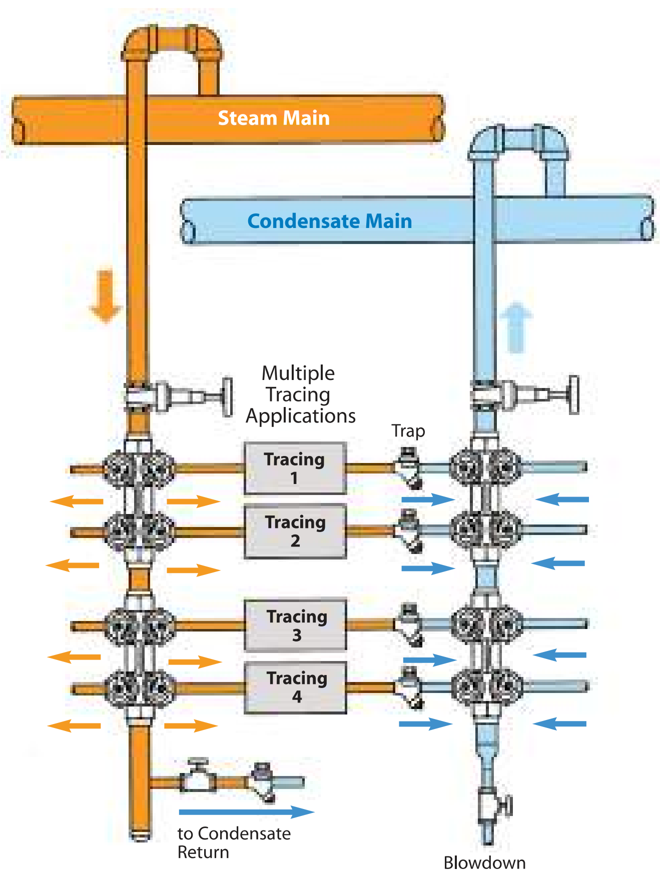
The **FM** manifold is fabricated from carbon steel and available with either NPT or Socket-weld connections. Condensate collection type are provided with a built-in siphon tube to minimize bi-phase flow, which reduces water hammer and allows flash steam space to prevent freeze damage.

Description FSM

The **FSM** manifold is manufactured from forged steel and is equipped with integral piston style valves. The unique sealing system of the valves utilize an austenitic stainless steel piston that slides into two rings composed of reinforced graphite ring stainless steel plates.

Features

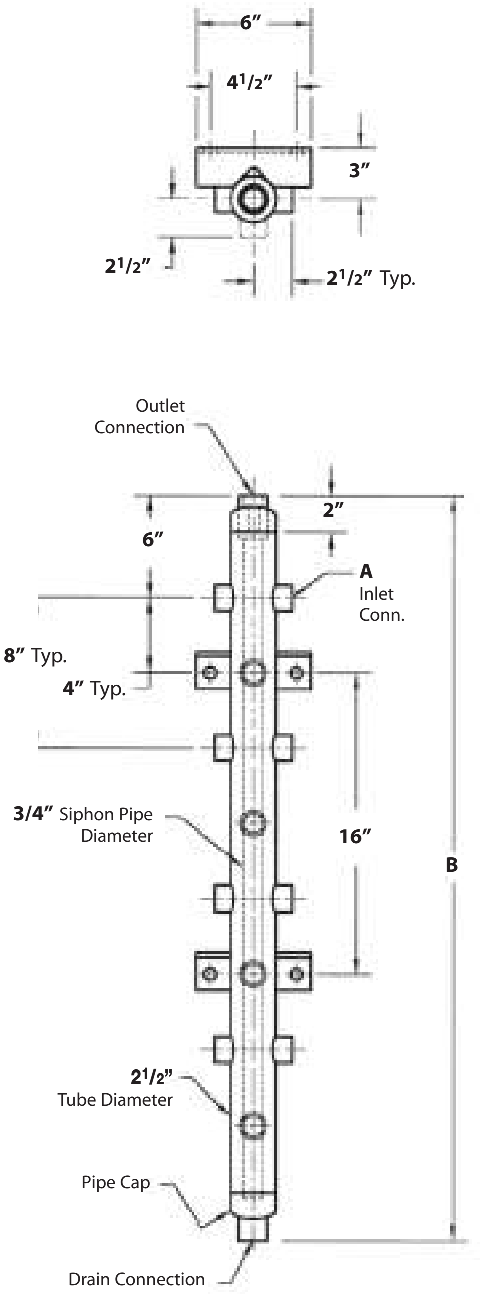
- Compact design saves valuable plant space
- Available in 4, 6, 8 & 12 branch designs
- Available with pre-assembled steam trap stations
- Standard designs or custom built manifolds available
- Provides freeze protection
- Reduces installation and maintenance time
- On FSM Model valve bonnets are long neck type to allow for installation of insulation, keeping surface temperatures low for protection of personnel



FSM Steam Distribution Manifold
Distributes Steam TO Tracing Applications

FSM Condensate Collection Manifold
Collects Condensate FROM Tracing Applications

Fabricated Carbon Steel



Description Vertical Mount	Model Code	Inlet (A) Size	Inlet (A) Type	# Front Conn.	# Side Conn.	Conn. Total	B Length (in)	Wt.. (lbs)
Condensate Collection (C) Manifolds								
4 side conn.	**FM4-12-N-C**	1/2"	NPT	4	0	4	24	25
4 side conn.	**FM4-13-N-C**	3/4"	NPT	4	0	4	24	27
4 side/2 front conn.	**FM6-12-N-C**	1/2"	NPT	4	2	6	24	27
4 side/2 front conn.	**FM6-13-N-C**	3/4"	NPT	4	2	6	24	29
8 side conn.	**FM8-12-N-C**	1/2"	NPT	8	0	8	40	40
8 side conn.	**FM8-13-N-C**	3/4"	NPT	8	0	8	40	42
8 side/4 front conn.	**FM12-12-N-C**	1/2"	NPT	8	4	12	40	46
8 side/4 front conn.	**FM12-13-N-C**	3/4"	NPT	8	4	12	40	48
12 side conn.	**FM12A-12-N-C**	1/2"	NPT	12	0	12	56	56
12 side conn.	**FM12A-13-N-C**	3/4"	NPT	12	0	12	56	58
Steam Distribution (D) Manifolds								
4 side conn.	**FM4-12-N-D**	1/2"	NPT	4	0	4	24	25
4 side conn.	**FM4-13-N-D**	3/4"	NPT	4	0	4	24	27
4 side/2 front conn.	**FM6-12-N-D**	1/2"	NPT	4	2	6	24	27
4 side/2 front conn.	**FM6-13-N-D**	3/4"	NPT	4	2	6	24	29
8 side conn.	**FM8-12-N-D**	1/2"	NPT	8	0	8	40	40
8 side conn.	**FM8-13-N-D**	3/4"	NPT	8	0	8	40	42
8 side/4 front conn.	**FM12-12-N-D**	1/2"	NPT	8	4	12	40	46
8 side/4 front conn.	**FM12-13-N-D**	3/4"	NPT	8	4	12	40	48
12 side conn.	**FM12A-12-N-D**	1/2"	NPT	12	0	12	56	56
12 side conn.	**FM12A-13-N-D**	3/4"	NPT	12	0	12	56	58

Connection Codes: **N** = NPT, **SW** = Socket Weld

For Socket Weld Connectionss: change **N** in Model code to **SW**. Example: **FM4-12-SW-C**

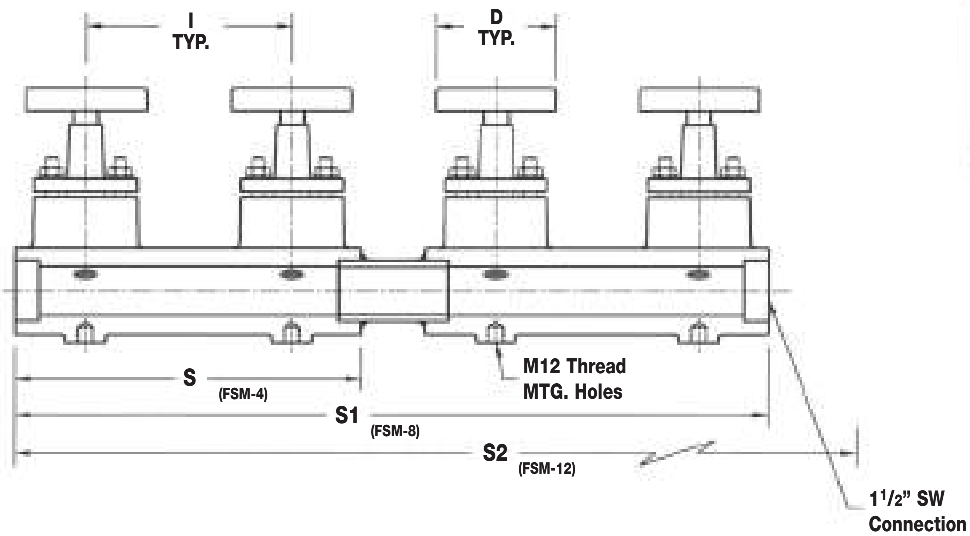
MATERIALS – FM	
Body	Fabricated Carbon Steel

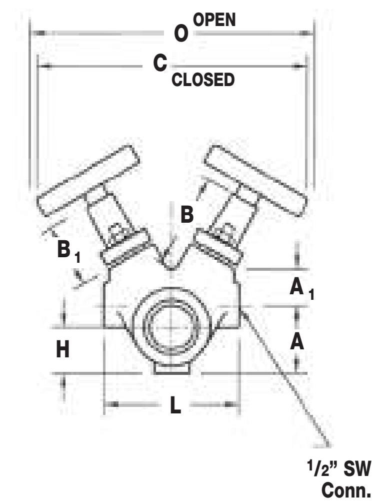
Steel Manifolds

Forged Steel

DIMENSIONS & WEIGHTS – *inches*

Model	L	H	D	C	O	I	S	S1	S2	A	A1	B	B1	No. of Valves	No. of Holes	Weight (lbs)
FSM-4	4.33"	1.61"	3.94"	8.97"	10.63"	6.30"	13.03"	-	-	2.79"	1.22"	3.23"	2.79"	4	2 (M12)	23
FSM-8	4.33"	1.61"	3.94"	8.97"	10.63"	6.30"	-	28.1"		2.79"	1.22"	3.23"	2.79"	8	4 (M12)	49
FSM-12	4.33"	1.61"	3.94"	8.97"	10.63"	6.30"	-	-	36.22"	2.79"	1.22"	3.23"	2.79"	12	6 (M12)	72





Description	Model Code	Connection Size	Connection Type	# of Branches
Condensate Collection (C) Manifolds				
4 Branches/4 Valves	**FSM4-12-N-C**	1/2"	NPT	4
4 Branches/4 Valves	**FSM4-13-N-C**	3/4"	NPT	4
8 Branches/8 Valves	**FSM8-12-N-C**	1/2"	NPT	8
8 Branches/8 Valves	**FSM8-13-N-C**	3/4"	NPT	8
12 Branches/12 Valves	**FSM12-12-N-C**	1/2"	NPT	12
12 Branches/12 Valves	**FSM12-13-N-C**	3/4"	NPT	12
Steam Distribution (D) Manifolds				
4 Branches/4 Valves	**FSM4-12-N-D**	1/2"	NPT	4
4 Branches/4 Valves	**FSM4-13-N-D**	3/4"	NPT	4
8 Branches/8 Valves	**FSM8-12-N-D**	1/2"	NPT	8
8 Branches/8 Valves	**FSM8-13-N-D**	3/4"	NPT	8
12 Branches/12 Valves	**FSM12-12-N-D**	1/2"	NPT	12
12 Branches/12 Valves	**FSM12-13-N-D**	3/4"	NPT	12

Connection Codes: **N** = NPT, **SW** = Socket Weld

For Socket Weld Connectionss: change **N** in Model code to **SW**.

Example: **FSM4-12-SW-C**

CAPACITIES

Pressure (PSIG)	Condensate (lbs/hr) [1]	Steam (lbs/hr) [2]
25	1850	160
50	1000	310
75	840	460
100	610	730
125	660	760
150	620	900
200	570	1200
250	535	1500
300	510	1800
400	470	2350
500	460	3000
600	440	3550

[1] *Saturated condensate discharging into 20 PSI back pressure*

[2] *Saturated Steam flow @ 5000 ft/min velocity*

MATERIALS – FSM

Body	Forged Steel, A105
Hand Wheel	Sheet Metal
Bonnet	Forged Steel, A105
Valve ring above	Graphite
Valve ring below	Graphite/Stainless Steel
Piston	Stainless Steel, A304

Watson McDaniel

Condensate Return System

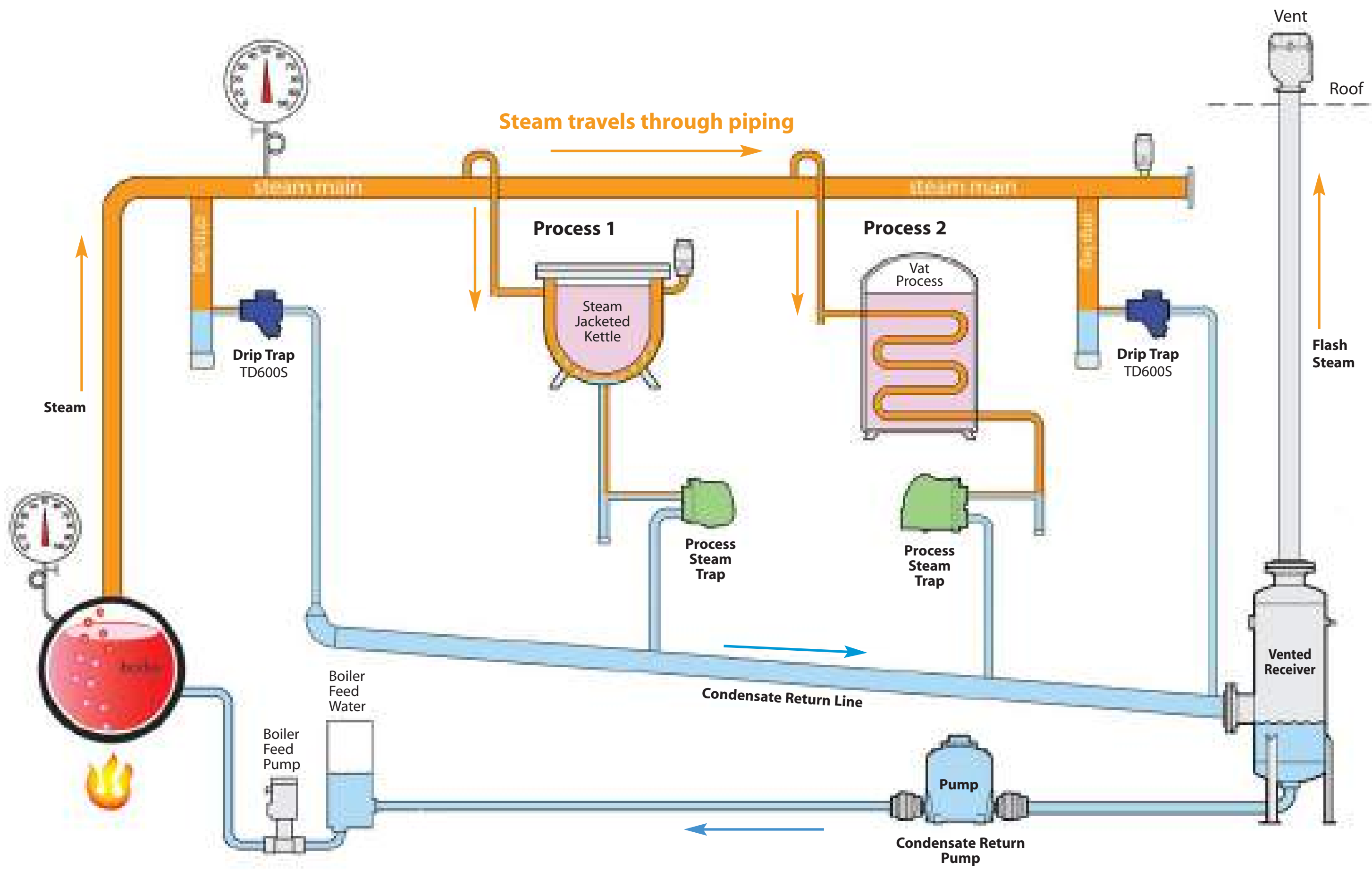
Shown below is a simplified view of a steam system from steam generation to condensate return. Steam generated by the boiler travels through the steam distribution lines supplying steam to various pieces of process equipment. The steam flowing to this equipment is separated from the condensate return lines by steam traps.

Relatively small steam traps, referred to as “Drip traps,” are used for optimization and protection of steam systems by draining condensate from steam distribution lines into the condensate return line.

Process Applications refer to draining condensate from the actual process using the steam into the condensate return line. The steam traps used in these applications have relatively high condensate capacity and are referred to as “Process traps”.

A large plant may have many separate pieces of process equipment and thousands of drip traps discharging condensate into the condensate return lines. On efficiently run steam systems, this condensate is returned back to the boiler for reuse.

Steam Distribution & Condensate Return System



What are Condensate Return Pumps & when are they required?

In certain cases, the steam pressure of the system may be sufficient to push the condensate through the steam traps and condensate return lines, back to the condensate holding tank in the boiler room. In most practical situations, however, one or more condensate return pumps are required to assist in overcoming gravity, pressure drops from long piping runs, and back pressures in return lines. Condensate Return Pumps are either electrically-driven centrifugal pumps or non-electric mechanical pumps that use steam pressure as the motive force to pump the condensate. Non-electric pumps are referred to as Pressure Motive Pumps (PMPs).

What is a Boiler Feed Pump? A facility will often have a separate area that contains various components required for the generation of steam, such as a boiler, condensate holding or deaerator (DA) tank, boiler feed pump, water treatment, etc. Regulated by the boiler control system, the boiler feed pump sends condensate from the holding tank back to the boiler.

Condensate Pumps

What are Pressure Motive Pumps (PMPs)?

Pressure Motive Pumps (PMPs) are non-electric pumps which return condensate back to the boiler room; using steam pressure as the motive force. PMPs can be supplied as stand-alone units – which include a pump tank, the internal operating mechanism, and a set of inlet and outlet check valves, or: as a packaged system – which also includes the vented receiver tank (to collect the condensate) mounted on a common base.

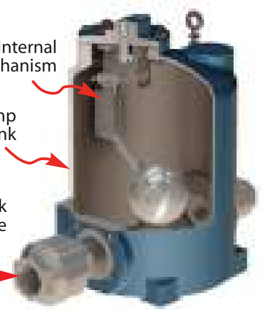
What is the purpose of a Vented Receiver?

Condensate from several different sources, at different pressures, are often discharging into the same return line. The discharge from one of the higher pressure sources could easily increase the pressure in the return line, which would stop the discharge from a critical process application operating at lower pressures.

By connecting the condensate return line to a vented receiver, the pressure in the return line will be effectively equalized to atmospheric pressure, allowing condensate to freely drain from all condensate sources. This is an extremely important and often overlooked aspect of any properly operating steam and condensate return system. The receiver and vent must be adequately sized to allow for the discharge of flash steam without building up excessive pressure. Higher condensate pressures or loads would require larger receiver and vent sizes. Condensate then flows by gravity from the vented receiver to the condensate return pump and is then returned back to the boiler room.

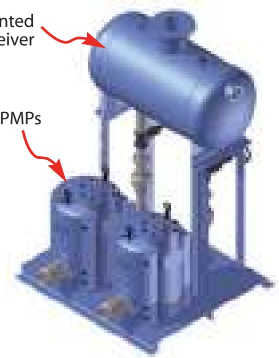
Mechanical & Electric Condensate Return Pumps

PMP
(stand-alone pump)



Mechanical stand-alone Pressure Motive Pumps (PMPs)

A stand-alone Pressure Motive Pump (PMP) consists of a pump tank with internal operating mechanism, and a set of inlet and outlet check valves. Pump tanks can be made from ductile iron (PMPC), fabricated steel (PMPF) or stainless steel (PMPSS). A PMP requires some form of a separate vented receiver tank that collects the condensate prior to entering the pump. This vented receiver is required to neutralize the pressure in the condensate return line by venting the flash steam to the atmosphere.



Pumps with Receiver Tanks (Standard Skid Systems)

Simplex, Duplex, and Triplex packaged systems include stand alone pumps and check valves with a vented receiver tank, mounted on a steel base and frame. Multiple pumping units can be used for increased capacity or for system redundancy. The stand-alone pumps are available in ductile iron, carbon steel and stainless steel; options include sight glasses, insulation jackets, cycle counters, motive and vent piping, pressure regulators, steam traps, strainers and ASME code stamp. All components of the system are properly sized and pre-piped together; requiring only four connections to be made in the field.

Electric Pumps

Electric Condensate Return Pumps are designed to work intermittently, discharging condensate only when the receiver tank is nearly full. This is accomplished with a float switch. A float connected to the switch assembly rises when condensate enters the tank. Once it rises above a set point, the switch energizes the motor on the pump, which runs until the water level drops below the bottom position of the float switch. The switch then de-energizes the motor to shut off the pump. Watson McDaniel electric pumps are offered in Simplex and Duplex models.

Why choose a PMP instead of an electric (centrifugal) condensate return pump?

Reliability is the primary purpose for selecting Mechanical type PMP's instead of Electric condensate pumps.

Electric pumps require a mechanical seal to prevent the leakage of liquid around the rotating shaft that drives the impeller. The liquid being pumped acts as a lubricant so the seal faces of the mechanical seal may rotate freely against each other. When the liquid remains relatively cool, the mechanical seal could last for many years. However, hot condensate can flash to steam between the seal faces leading to seal failure.

A centrifugal pump creates a low pressure zone at the eye of the impeller which draws the fluid into the pump. Hot condensate can flash into steam in the low pressure zone causing Cavitation. Cavitation happens when bubbles form in the liquid on the inlet side of the pump that will re-compress on the outlet side, causing erosion of the impeller and pump housing. When a pump cavitates, it often sounds like marbles or sand is being pumped. This flashing also blocks the flow of incoming condensate; causing the pump to run dry which decreases performance and also leads to seal failure.

1) **PMP's do not have any seals to fail.**
2) **No cavitation can occur** because the body of the pump is filled by the natural flow due to gravity from a vented receiver, and then discharged by steam pressure.

Therefore, Pressure Motive pumps are much more forgiving than centrifugal pumps when pumping hot condensate.

Installation of mechanical type PMP's vs. Electric pumps:

Standard **Electric Pumps** are supplied with a receiver tank and are intended for lower pressure steam systems. In these instances, the vent size on the receiver tank should be adequate to vent minimal flash steam, allowing condensate to freely enter the receiver and to adequately cool prior to being pumped. In higher pressure steam systems, the condensate temperature is hotter, resulting in more flash steam as the condensate is discharged through steam traps and into the return line. Additional options may be required for the electric pumps if condensate does not cool to suitable temperatures.

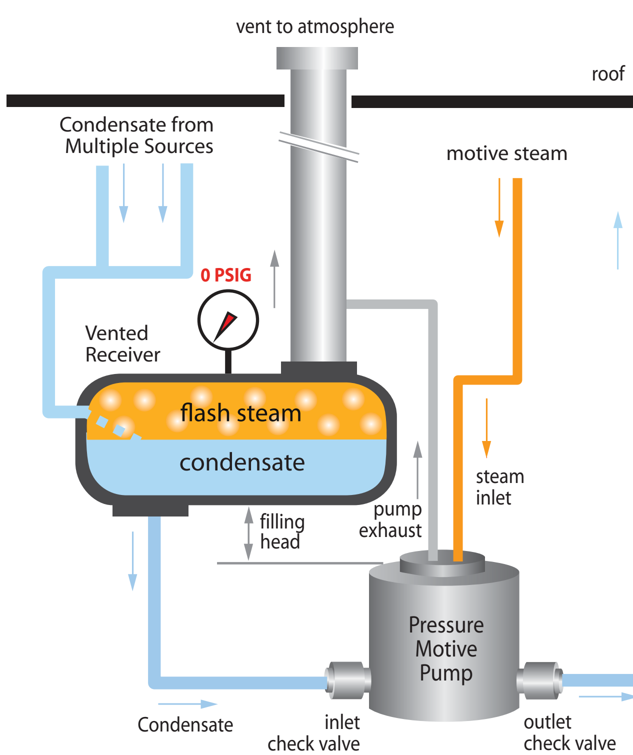
PMPs discharge high temperature condensate that drains from vented receivers. A **stand-alone PMP** pump tank cannot be used as the vented receiver since it is intermittently pressurized with steam or air to pump the condensate. PMPs require a separate vented receiver to collect the condensate and to vent the flash steam to atmosphere. The Simplex, Duplex or Triplex packaged systems include the separate vented receiver tank mounted on a common base along with the PMP(s).

Vented Receivers should generally be sized to maintain 0 psig in both the receiver and condensate return line upstream of the receiver. This helps ensure free drainage of condensate from sources that may be operating at both high and low pressure. Sizing criteria is based on condensate pressure and the amount of the flash steam created. Undersizing the receiver or the vent will increase the pressure in the receiver and condensate return line, possibly causing issues with condensate drainage from process equipment upstream. Undersizing of the vent will increase the velocity of flash steam in the pipe which could possibly draw condensate from the receiver and discharge it out of the vent.

Pump (PMP) with a Vented Receiver

A Vented Receiver (or Flash Tank) is used to collect the condensate generated from one or several different sources (drip & process applications) in the facility.

Pressure from the Flash steam generated by the hot condensate is vented to the atmosphere to maintain atmospheric pressure (0 PSIG) in the receiver tank. This assures that condensate will freely flow by gravity to the receiver tank and then to the pump tank, avoiding potential condensate back-up.



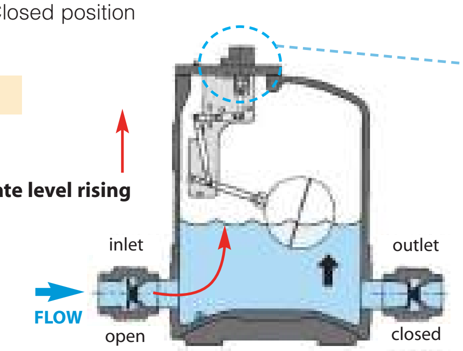
Operation of PMP Pressure Motive Pump

Vent Outlet: Open position, allowing any pressure in the pump tank to vent out and water to freely enter pump by gravity.

Motive Inlet: Closed position

Pump Filling

Condensate level rising



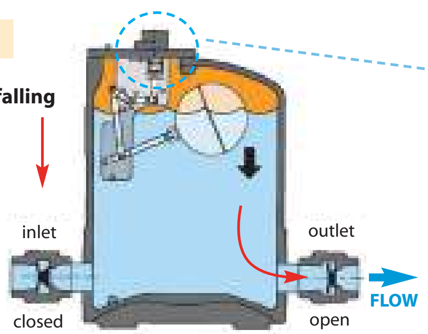
1 Condensate flows from the receiver tank through the inlet check valve and fills the pump tank. During the filling cycle the float inside the tank rises.

Vent Outlet: Closed

Motive Inlet: Open; steam pressure enters tank and discharges condensate

Pump Discharging

Condensate level falling



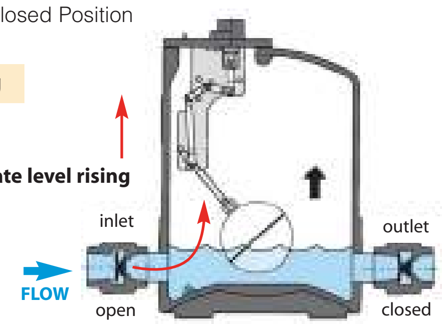
2 When the pump tank has filled to the trip point, the mechanism triggers, opening the motive gas inlet valve and simultaneously closing the vent valve. This allows motive pressure to enter the pump body, which drives the condensate thru the outlet check valve into the condensate return line. During the discharge cycle, the liquid level and the float inside the pump tank drop.

Vent Outlet: Open position, allowing any pressure in the pump tank to vent out and water to freely enter pump by gravity.

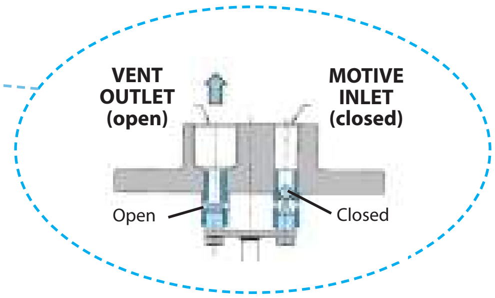
Motive Inlet: Closed Position

Pump Filling

Condensate level rising

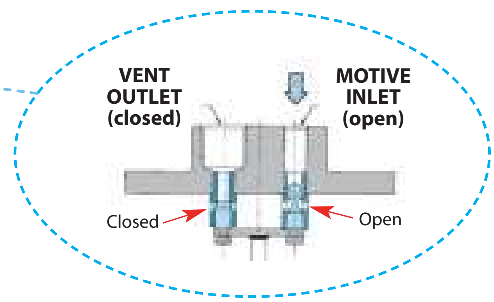


3 At the lower trip point, the mechanism triggers and the motive gas inlet valve to the pump tank closes and simultaneously the vent valve opens. The fill and discharge cycle then repeats.



The positions of the **Vent** and **Motive** valves control the filling and discharge of the pump. The Vent valve must be open during the filling cycle to allow air or steam in the pump tank to be displaced as water enters the pump. Since water flows into the pump tank by force of gravity, the pump tank pressure must be neutralized for the pump tank to fill.

When the pump tank reaches its fill point the vent valve closes and the motive valve opens. The incoming steam pressure rapidly forces the water out of the pump tank through the outlet check valve. When the pump tank empties, the vent valve opens and motive inlet valve closes.



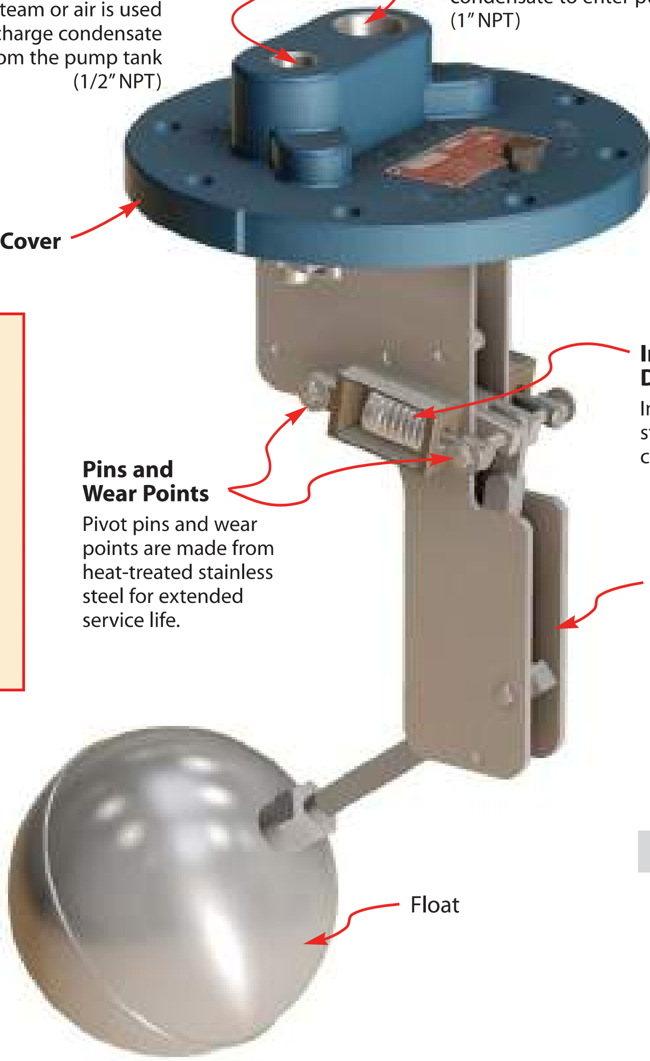
Check Valves

The inlet check valve on the PMP system must have a very low cracking pressure (opening pressure) so that the liquid will freely enter the pump tank. The proper check valve is very critical to the proper operation of the PMP system. Watson McDaniel recommends using spring-loaded stainless steel check valves with ¼ PSI cracking pressure.

The Internal Working Mechanism

The heart of the PMP is the internal working mechanism, which features the **Patented SNAP-ASSURE™** Design. This feature, exclusive to Watson McDaniel's PMPs, **Guarantees to extend pump life** even in the most demanding applications.

The environment inside a pump tank can be extremely harsh and volatile. Hot condensate can be very aggressive and may even corrode stainless steel springs when they are under tension or compression (high stress). This is known as stress corrosion-cracking. Additionally, condensate systems normally contain fine particles of rust and other contaminants, such as pipe scale, further aggravating mechanical components. The Watson McDaniel Pump Mechanism has been refined and developed over many years and has proven itself in its performance and reliability.



The Patented Snap-Assure Feature stops dirt and abrasive iron oxide particles from jamming the mechanism. The Snap-Assure Feature forces the internal toggle action to trigger ("**snap**") between vent and motive, "**assuring**" that fill and discharge cycles occur properly. Without Snap-Assure, the added friction of abrasive particles or worn components can inhibit a pump from operating.

All STAINLESS STEEL Internals

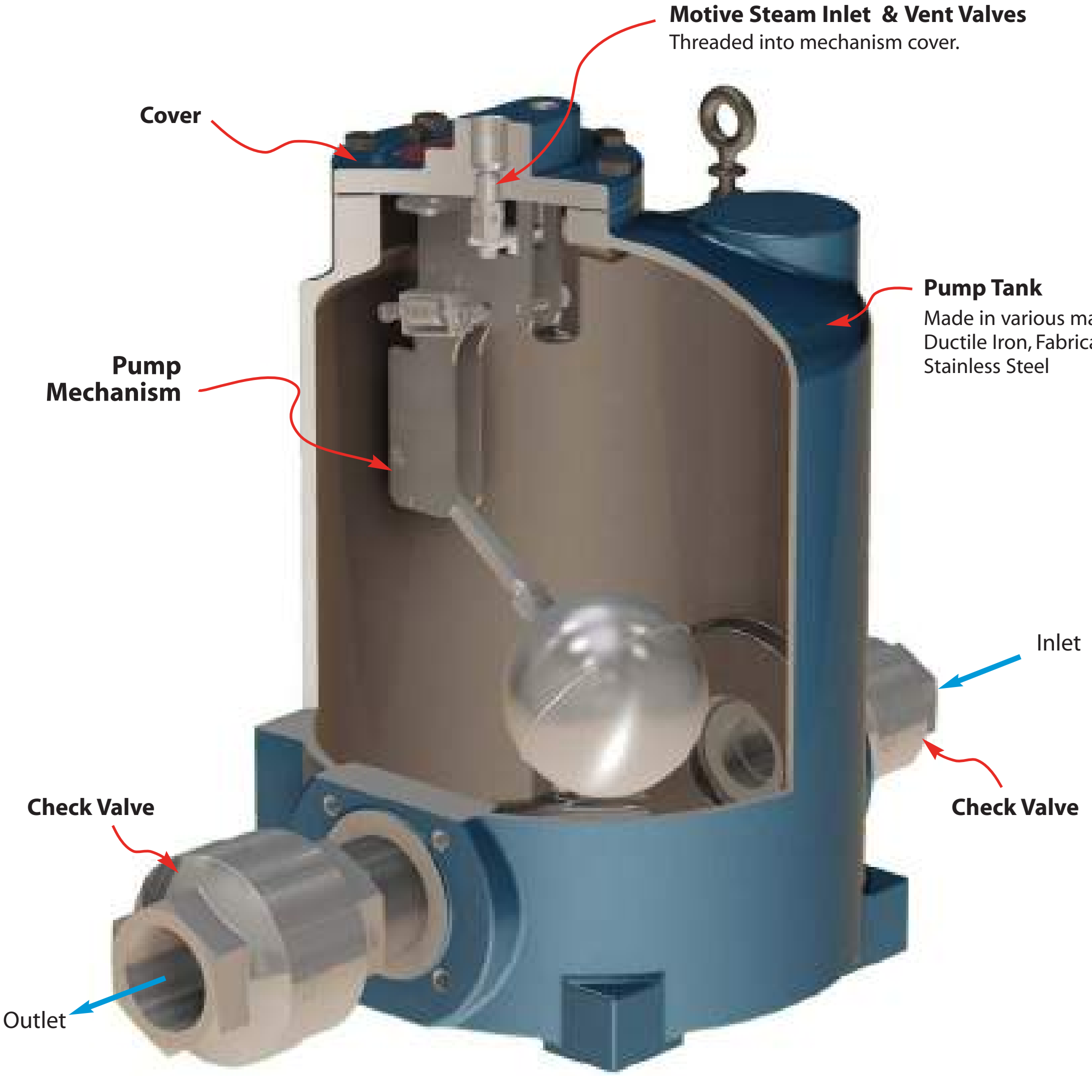
Snap-Assure
U.S. Patent No. 6572340

Internal Mechanism Features

- Equipped with Watson McDaniel's patented "Snap-Assure" feature, which extends the useful life of the pump by assuring that the internal toggle action triggers at every fill and discharge cycle
- All Stainless Steel components minimize corrosion (spring material is Inconel-X-750)
- Hard chrome-plated pivot pins and wear points substantially reduce the rate of wear on critical components
- 17-4 heat-treated stainless steel inlet and vent valve (Hardened seats have proven themselves to last years)
- Dual-compression springs, made from Inconel-X-750, eliminate the effects of stress corrosion-cracking and are designed to last indefinitely
- Precision manufactured mechanisms never require field adjustments
- Watson McDaniel "Snap-Assure" mechanisms can be purchased separately and will fit other manufacturers' pump tanks

Snap-Assure Pump Mechanism

1) Cover & mechanism bolt to top of pump tank.
2) Mechanism is field-repairable by replacing any of the functioning components such as springs and valve seats.
3) Mechanism can fit other manufacturers' pump tanks.



Check Valves
The inlet check valve on the PMP system must have a very low cracking pressure (opening pressure) so that the liquid will freely enter the pump tank. The proper check valve is very critical to the proper operation of the PMP system. Watson McDaniel recommends using spring-loaded stainless steel check valves with ¼ PSI cracking pressure.

Mechanical Condensate Return Pumps are available as:

1) PMP (Pressure Motive Pump - Stand-Alone Unit) or
2) Pump System (Pumps with Vented Receiver Tanks):

Mechanical PMP Stand-Alone Pumps

Watson McDaniel's **Pressure Motive Pump** (**PMP** stand-alone unit) consists of the pump tank, which is made from ductile iron, fabricated steel, or stainless steel, and Watson McDaniel's patented "Snap-Assure" internal operating mechanism, along with a set of inlet and outlet check valves. An additional vented receiver or flash tank is required to collect the condensate before it enters the pump.

Watson McDaniel offers a full line of PMP accessories, including custom tanks, insulation jackets, gauge glasses, cycle counters, pre-piped accessories, pump mechanisms, check valves and anything else you may need to maintain your system.

Several choices of pump body materials, types and configurations are available to meet specific customer applications:

Ductile Iron Pump Tanks
Ductile Iron is far superior to cast iron in handling higher pressures and temperatures. Ductile iron is also extremely corrosion resistant to condensate and water and can last in excess of 50 years before tank replacement is required. Our ductile iron tanks can be ASME coded on request.

Fabricated Carbon Steel Pump Tanks
Carbon steel tanks are required in certain industrial facilities such as chemical and petrochemical refineries. However, fabricated cast steel is much less corrosion-resistant to condensate than ductile iron. Our carbon steel tanks are standard ASME coded.

Fabricated Stainless Steel Pump Tanks
Stainless steel (304L) tanks are extremely corrosion-resistant, giving increased longevity and can serve as a substitute for fabricated carbon steel tanks.

Low Profile Pump Tanks
Low-profile tanks are required when vertical space for adequate filling head of the pump is limited.

Stand-Alone Units - Pressure Motive Pumps

PMPC
Cast Ductile Iron

Significantly more corrosion-resistant to condensate when compared to carbon steel.

PMPF
Fabricated Carbon Steel

Carbon Steel may be required by code in Chemical and Petro-Chemical industries (required in certain industries).

PMPSS
304L Stainless Steel (Corrosion Resistant)

Can serve as a substitute for fabricated carbon steel tanks for extended life or when Stainless Steel is required.

PMPLS
Fabricated Carbon Steel (Reduced-Profile)

Lower in height than PMPF. Required when vertical space for adequate filling head of the pump is limited.

PMPBP
Carbon Steel (High-Capacity)

For applications requiring large transfer rates of condensate or other liquids.

PMPNT
Ductile Iron or Stainless Steel (Low-Profile)

For lower capacity applications.

PMPSP Sump Drainer (non-electric sump pump)

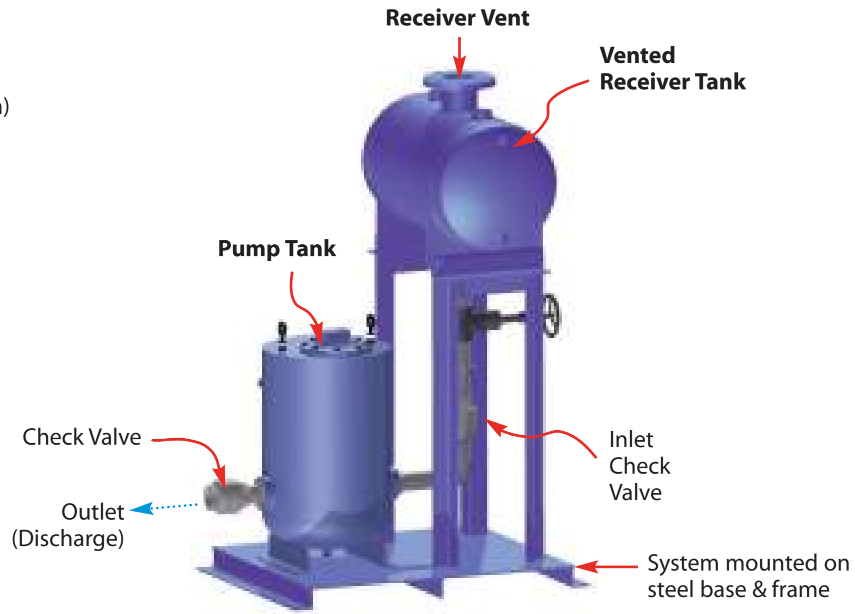
Sump drainers are used to pump water from pits or sumps using steam or air pressure. They are similar to the standard PMP models except that they discharge vertically upwards. This piping configuration allows them to be lowered into a sump or pit.

Pump Systems (Pumps with Receiver Tanks)

The **PMPC**, **PMPF** & **PMPLS** pump units are also available with a Vented Receiver mounted on a common base. The vented receiver is needed to collect the condensate which then drains by gravity into the pump tank. These standard **Simplex, Duplex** and **Triplex** packaged systems include stand-alone pump(s) and check valves with a vented receiver tank mounted on a steel base and frame. Multiple pumping units can be used for increased capacity or for system redundancy. The pump units are available in ductile iron (**PMPC**) or carbon steel (**PMPF**). Additional options include sight glasses, insulation jackets, cycle counters, motive and vent piping, pressure regulators, steam traps, strainers, ASME code stamps, etc.

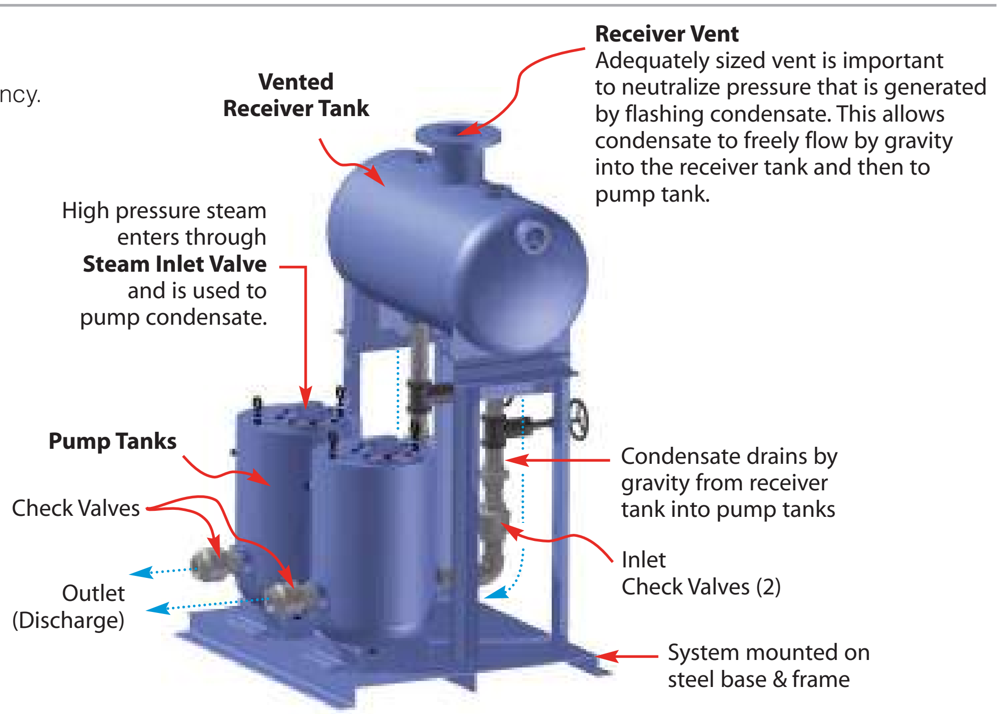
Simplex Pumping System (shown)

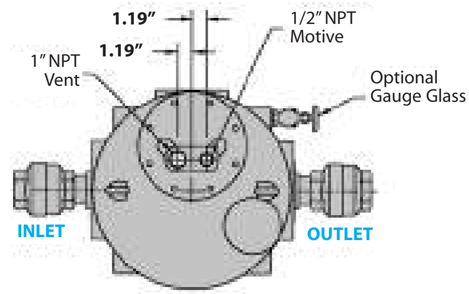
Single pump with receiver tank mounted on a common base.

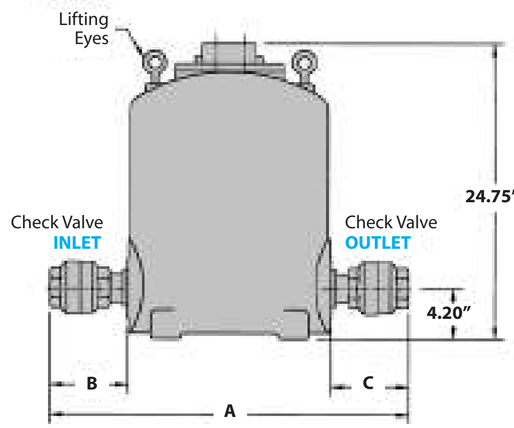


Duplex Pumping System (shown)

More than one pump can be used for increased capacity or system redundancy.







Model	**PMPC**
Body	**Ductile Iron**
Cover	**Ductile Iron**
Check Valves	**Stainless Steel**
PMO Max. Operating Pressure	**200 PSIG**
TMO Max. Operating Temperature	**388ºF**
PMA Max. Allowable Pressure	**200 PSIG @ 650˚F**
TMA Max. Allowable Temperature	**650ºF @ 200 PSIG**

Typical Applications

The **PMPC** model **Ductile Iron** non-electric pressure motive pump is typically used when liquids must be moved to higher elevation, higher pressure or extended distances. This stand-alone pump is capable of operating with a maximum motive pressure of 200 PSIG provided by steam, air or other gas supply.
ASME "UM" code stamp is available.

Features

- Equipped with our **Patented "Snap-Assure"** Mechanism which **extends the useful life of the pump**
- Mechanism incorporates **heat-treated stainless steel wear items**
- All stainless steel internals for ultimate corrosion resistance
- Dual compression springs made from Inconel-X-750 for high-temperature corrosive service
- Operates using steam, air, nitrogen or other pressurized gases as the motive force
- **Non-Electric** – can be used in remote locations or NEMA 4, 7, 9 and hazardous areas

Sample Specification

The non-electric pressure powered pump shall be capable of operating with a maximum motive pressure of 200 PSIG provided by steam, air or other gas supply. The pump body shall be cast ASTM A-395 Ductile Iron capable of an ASME "UM" code stamp if requested. The pump mechanism shall be float operated with a patented "Snap-Assure" feature constructed of all stainless steel materials with all load bearing points hardened for extended service life. The mechanism shall feature two Inconel springs used in compression with motive & vent valves hardened to 40c Rockwell.

DIMENSIONS – *inches*

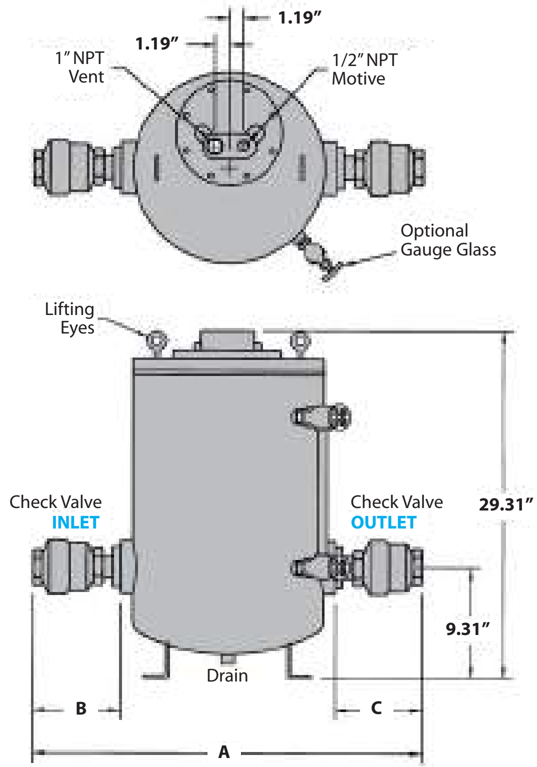
Size (Inlet x Outlet)	Model Code	A	B	C	Weight (lbs)
1" x 1"	PMPC-1X1-N-SS	29 1/2	6	6	360
1 1/2" x 1"	PMPC-1.5X1-N-SS	30 3/4	7 1/2	6	365
1 1/2" x 1 1/2"	PMPC-1.5X1.5-N-SS	31 1/4	7 1/2	7 1/2	367
2" x 1"	PMPC-2X1-N-SS	31	8	6	370
2" x 1 1/2"	PMPC-2X1.5-N-SS	32 1/2	8	7 1/2	380
2" x 2"	PMPC-2X2-N-SS	32 3/4	8	8	385
3" x 2"	PMPC-3X2-N-SS	35 1/4	9 1/4	8	390

The PMPC Stand Alone Pump consists of pump tank, internal mechanism, and inlet and outlet stainless steel check valves.

MATERIALS

Body & Cover	**Ductile Iron**
Cover Gasket	Grafoil
Cover Bolts	Steel
Inlet Valve	Hardened Stainless Steel 40 Rc
Vent Valve	Hardened Stainless Steel 40 Rc
Mechanism Yoke	304 Stainless Steel
Ball Float	304 Stainless Steel
Check Valves	Stainless Steel
Springs	Inconel-X-750
Other Internal Components	Stainless Steel

Snap-Assure U.S. Patent No. 6572340



Model	**PMPF**
Body	**Carbon Steel**
Cover	**Carbon Steel**
Check Valves	**Stainless Steel**
PMO Max. Operating Pressure	**200 PSIG**
TMO Max. Operating Temperature	**388°F**
PMA Max. Allowable Pressure	**250 PSIG @ 650°F**

Typical Applications

The **PMPF** model **Carbon Steel** non-electric pressure motive pump is typically used when liquids must be moved to higher elevation, higher pressure or extended distances. This stand-alone pump is capable of operating with a maximum motive pressure of 200 PSIG provided by steam, air or other gas supply. These tanks are fabricated with 1/8″ corrosion allowance and receive the ASME "UM" code stamp.

Features

- Equipped with our **Patented "Snap-Assure"** Mechanism which **extends the useful life of the pump**
- Mechanism incorporates **heat-treated stainless steel wear items**
- All stainless steel internals for ultimate corrosion resistance
- Dual compression springs made from Inconel-X-750 for high-temperature corrosive service
- Operates using steam, air, nitrogen or other pressurized gases as the motive force
- **Non-Electric** – can be used in remote locations or NEMA 4, 7, 9 and hazardous areas

Sample Specification

The non-electric pressure powered pump shall be capable of operating with a maximum motive pressure of 200 PSIG provided by steam, air or other gas supply. The pump body shall be fabricated carbon steel and certified with the ASME "UM" code stamp. The pump mechanism shall be float operated with a patented "Snap-Assure" feature constructed of all stainless steel materials with all load bearing points hardened for extended service life. The mechanism shall feature two Inconel springs used in compression with motive & vent valves hardened to 40c Rockwell.

DIMENSIONS – *inches*

Size (Inlet x Outlet)	Model Code	A	B	C	Weight (lbs)
1″ x 1″	**PMPF-1X1-N-SS**	30 1/2	6	6	215
1 1/2″ x 1″	**PMPF-1.5X1-N-SS**	31 3/4	7 1/2	7 1/2	220
1 1/2″ x 1 1/2″	**PMPF-1.5X1.5-N-SS**	32 1/4	7 1/2	6	223
2″ x 1″	**PMPF-2X1-N-SS**	32	8	6	225
2″ x 1 1/2″	**PMPF-2X1.5-N-SS**	33 1/2	8	7 1/2	230
2″ x 2″	**PMPF-2X2-N-SS**	33 3/4	8	8	235
3″ x 2″	**PMPF-3X2-N-SS**	35 1/4	9 1/4	8	240

The PMPF Stand Alone Pump consists of pump tank, internal mechanism, and inlet and outlet stainless steel check valves.

MATERIALS

Body & Cover	**Carbon Steel**
Cover Gasket	Grafoil
Cover Bolts	Steel
Inlet Valve	Hardened Stainless Steel 40 Rc
Vent Valve	Hardened Stainless Steel 40 Rc
Mechanism Yoke	304 Stainless Steel
Ball Float	304 Stainless Steel
Check Valves	Stainless Steel
Springs	Inconel-X-750
Other Internal Components	Stainless Steel

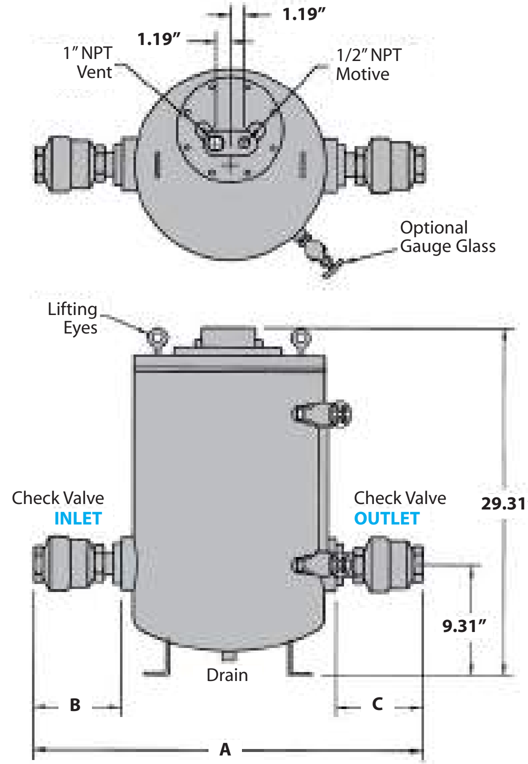
Snap-Assure U.S. Patent No. 6572340

PMPSS

Pressure Motive Pump

Model	**PMPSS**
Body	**304L Stainless Steel ***
Cover	**304L Stainless Steel ***
Check Valves	**Stainless Steel**
PMO Max. Operating Pressure	**150 PSIG**
TMO Max. Operating Temperature	**366 °F**
PMA Max. Allowable Pressure	**150 PSIG @ 650°F**

* For special 316L SS, consult factory.



Typical Applications

The **PMPSS** model **Stainless Steel** non-electric pressure motive pump can be used in harsh and corrosive environments or as a substitute for fabricated carbon steel tanks for increased longevity. This stand-alone pump is capable of operating with a maximum motive pressure of 150 PSIG provided by steam, air or other gas supply. These pumps receive the ASME "UM" code stamp.

Features

- Equipped with our **Patented "Snap-Assure"** Mechanism which **extends the useful life of the pump**
- Mechanism incorporates **heat-treated stainless steel wear items**
- All stainless steel internals for ultimate corrosion resistance
- Dual compression springs made from Inconel-X-750 for high-temperature corrosive service
- Operates using steam, air, nitrogen or other pressurized gases as the motive force
- **Non-Electric** – can be used in remote locations or NEMA 4, 7, 9 and hazardous areas

Sample Specification

The non-electric pressure powered pump shall be capable of operating with a maximum motive pressure of 150 PSIG provided by steam, air or other gas supply. The pump body shall be 304L Stainless Steel and certified with the ASME "UM" code stamp. The pump mechanism shall be float operated with a patented "Snap-Assure" feature constructed of all stainless steel materials with all load bearing points hardened for extended service life. The mechanism shall feature two Inconel springs used in compression with motive and vent valves hardened to 40c Rockwell.

DIMENSIONS – *inches*

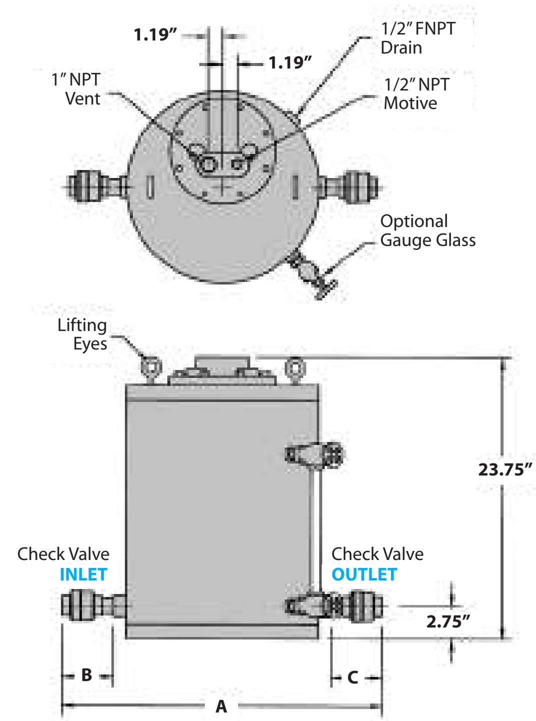
Size (Inlet x Outlet)	Model Code	A	B	C	Weight (lbs)
1" x 1"	PMPSS-1X1-N-SS	30 1/2	6	6	215
1 1/2" x 1"	PMPSS-1.5X1-N-SS	31 3/4	7 1/2	7 1/2	220
1 1/2" x 1 1/2"	PMPSS-1.5X1.5-N-SS	32 1/4	7 1/2	6	223
2" x 1"	PMPSS-2X1-N-SS	32	8	6	225
2" x 1 1/2"	PMPSS-2X1.5-N-SS	33 1/2	8	7 1/2	230
2" x 2"	PMPSS-2X2-N-SS	33 3/4	8	8	235
3" x 2"	PMPSS-3X2-N-SS	35 1/4	9 1/4	8	240

The PMPSS Stand Alone Pump consists of pump tank, internal mechanism, and inlet and outlet stainless steel check valves.

MATERIALS

Body & Cover	**304L Stainless Steel**
Cover Gasket	Grafoil
Cover Bolts	Steel
Inlet Valve	Hardened Stainless Steel 40 Rc
Vent Valve	Hardened Stainless Steel 40 Rc
Mechanism Yoke	304 Stainless Steel
Ball Float	304 Stainless Steel
Check Valves	Stainless Steel
Springs	Inconel-X-750
Other Internal Components	Stainless Steel

Snap-Assure U.S. Patent No. 6572340



Model	**PMPLS**
Body	**Carbon Steel**
Cover	**Carbon Steel**
Check Valves	**Stainless Steel**
PMO Max. Operating Pressure	**150 PSIG**
TMO Max. Operating Temperature	**366°F**
PMA Max. Allowable Pressure	**150 PSIG @ 650˚F**

Note: Optional 200 PSIG PMA/PMO. Consult Factory.

Typical Applications

The **PMPLS** model **Carbon Steel** non-electric pressure motive pump is a lower profile than the standard PMPF model. It is sometimes required when draining condensate from process equipment that is positioned close to the ground, which limits the filling head of the pump. This stand-alone pump is capable of operating with a maximum motive pressure of 150 PSIG provided by steam, air or other gas supply. These pumps receive the ASME "UM" code stamp.

Features

- Equipped with our **Patented "Snap-Assure"** Mechanism which **extends the useful life of the pump**
- Mechanism incorporates **heat-treated stainless steel wear items**
- All stainless steel internals for ultimate corrosion resistance
- Dual compression springs made from Inconel-X-750 for high-temperature corrosive service
- Operates using steam, air, nitrogen or other pressurized gases as the motive force
- **Non-Electric** – can be used in remote locations or NEMA 4, 7, 9 and hazardous areas

Sample Specification

The non-electric pressure powered pump shall be capable of operating with a maximum motive pressure of 150 PSIG provided by steam, air or other gas supply. The pump body shall be fabricated carbon steel and certified with the ASME "UM" code stamp. The pump mechanism shall be float operated with a patented "Snap-Assure" feature constructed of all stainless steel materials with all load bearing points hardened for extended service life. The mechanism shall feature two Inconel springs used in compression with motive and vent valves hardened to 40c Rockwell.

DIMENSIONS – *inches*

Size (Inlet x Outlet)	Model Code	A	B	C	Weight (lbs)
1" x 1"	PMPLS-1X1-N-SS	$29\frac{1}{2}$	$5\frac{5}{8}$	$5\frac{5}{8}$	200
$1\frac{1}{2}$" x 1"	PMPLS-1.5X1-N-SS	$30\frac{3}{4}$	7	$5\frac{5}{8}$	205
$1\frac{1}{2}$" x $1\frac{1}{2}$"	PMPLS-1.5X1.5-N-SS	$32\frac{1}{8}$	7	7	210

The PMPLS Stand Alone Pump consists of pump tank, internal mechanism, and inlet and outlet stainless steel check valves.

MATERIALS

Body & Cover	**Carbon Steel**
Cover Gasket	Grafoil
Cover Bolts	Steel
Inlet Valve	Hardened Stainless Steel 40 Rc
Vent Valve	Hardened Stainless Steel 40 Rc
Mechanism Yoke	304 Stainless Steel
Ball Float	304 Stainless Steel
Check Valves	Stainless Steel
Springs	Inconel-X-750
Other Internal Components	Stainless Steel

Snap-Assure U.S. Patent No. 6572340

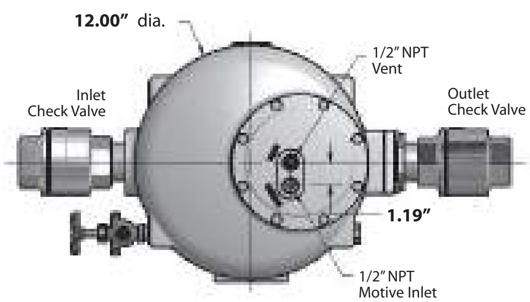
Model	PMPNT	PMPNTS
Body	Ductile Iron	Stainless Steel
Cover	Stainless Steel	Stainless Steel
Sizes	1", 1 1/2" NPT	1 1/2" FLG or NPT
Check Valves	Stainless Steel	Stainless Steel
PMO Max. Operating Pressure	125 PSIG	125 PSIG
TMO Max. Operating Temperature	366°F	366°F
PMA Max. Allowable Pressure	150 PSIG @ 450°F	150 PSIG @ 450°F

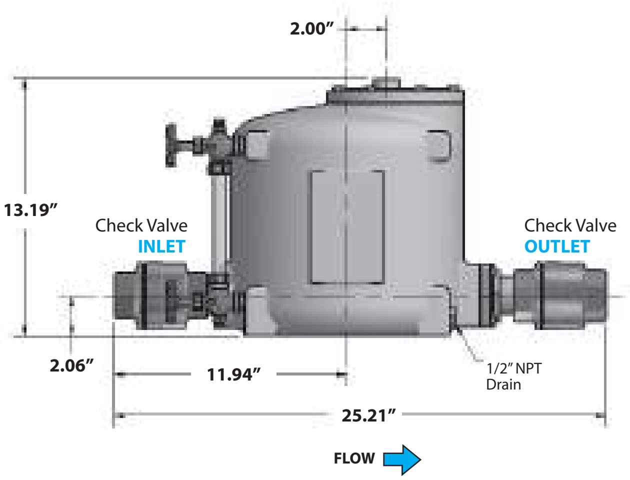
Typical Applications

The **PMPNT(S)** non-electric pressure motive pumps are light in weight and have an extremely low-profile. This stand-alone pump is capable of operating with a maximum motive pressure of 125 PSIG provided by steam, air or other gas supply. ASME Code Stamp available upon request.

Features

- Equipped with our proven, **Patented "Snap-Assure"** mechanism which **extends the useful life of the pump**
- Internal mechanism can be removed from the top of the pump while pump remains piped in line
- Mechanism incorporates **heat-treated stainless steel wear items** for ultimate corrosion resistance
- Dual compression springs made from Inconel-X-750 for high-temperature, corrosive service
- **Non-Electric** – can be used in remote locations or NEMA 4, 7, 9 and hazardous areas
- Operates using steam, air, nitrogen or other pressurized gas as the motive force





MATERIALS	
Body PMPNT	**Ductile Iron SA-395**
Body PMPNTS	**Stainless Steel CF3M**
Cover	Stainless Steel CF8
Cover Gasket	Garlock
Cover Bolts	Steel
Inlet Valve	Hardened Stainless Steel 40 Rc
Vent Valve	Hardened Stainless Steel 40 Rc
Ball Float	300 Stainless Steel
Check Valves	Stainless Steel 316SS CF3
Springs	Inconel-X-750
Other Internal Components	Stainless Steel

Size	Model Code	PMO PSI	Weight lbs
Ductile Iron Pump Body (NPT)			
1" x 1"	**PMPNT-1X1-N-SS**	125	85
1 1/2" x 1 1/2"	**PMPNT-1.5X1.5-N-SS**	125	95
Stainless Steel Pump Body (NPT or 150# FLG)			
1 1/2" x 1 1/2"	**PMPNTS-1.5X1.5-N-SS**	125	95
1 1/2" x 1 1/2"	**PMPNTS-1.5X1.5-F150-SS**	125	98

The PMPNT Stand Alone Pump consists of pump tank, internal mechanism, and inlet and outlet stainless steel check valves.

CAPACITIES – *Condensate (lbs/hr)*

Motive Pressure (PSIG)	Back Pressure (PSIG)	6" Filling Head	
		Steam Motive 1" x 1"	Steam Motive 1 1/2" x 1 1/2"
5	2	1225	2131
10	5	1204	2093
10	2	1391	2419
25	15	1171	2037
25	5	1458	2535
50	40	987	1716
50	10	1491	2593
75	60	992	1726
75	40	1262	2195
75	15	1505	2617
100	80	995	1731
100	60	1209	2102
100	15	1545	2687
125	100	997	1734
125	80	1174	2042
125	60	1316	2288
125	15	1570	2731

Note: Multiply Capacity by 1.16 for **12"** Fill Head.
Multiply Capacity by 1.28 for **18"** Fill Head.

Model	**PMPBP**
Body	**Carbon Steel**
Cover	**Carbon Steel**
Check Valves	**Stainless Steel & Steel**
PMO Max. Operating Pressure	**150 PSIG**
TMO Max. Operating Temperature	**366°F**
PMA Max. Allowable Pressure	**150 PSIG @ 470°F**

Typical Applications

The **PMPBP** model non-electric **Carbon Steel** pressure motive pump is extremely high-capacity for applications requiring large transfer of condensate or other liquids. This stand-alone pump is capable of operating with a maximum motive pressure of 150 PSIG provided by steam, air, nitrogen or other pressurized gases as the motive force. ASME "U" Code Stamp available upon request.

Features

- All stainless steel internals for ultimate corrosion resistance
- Operates using steam, air, nitrogen or other pressurized gas as the motive force
- **Non-Electric** – can be used in remote locations or NEMA 4, 7, 9 and hazardous areas

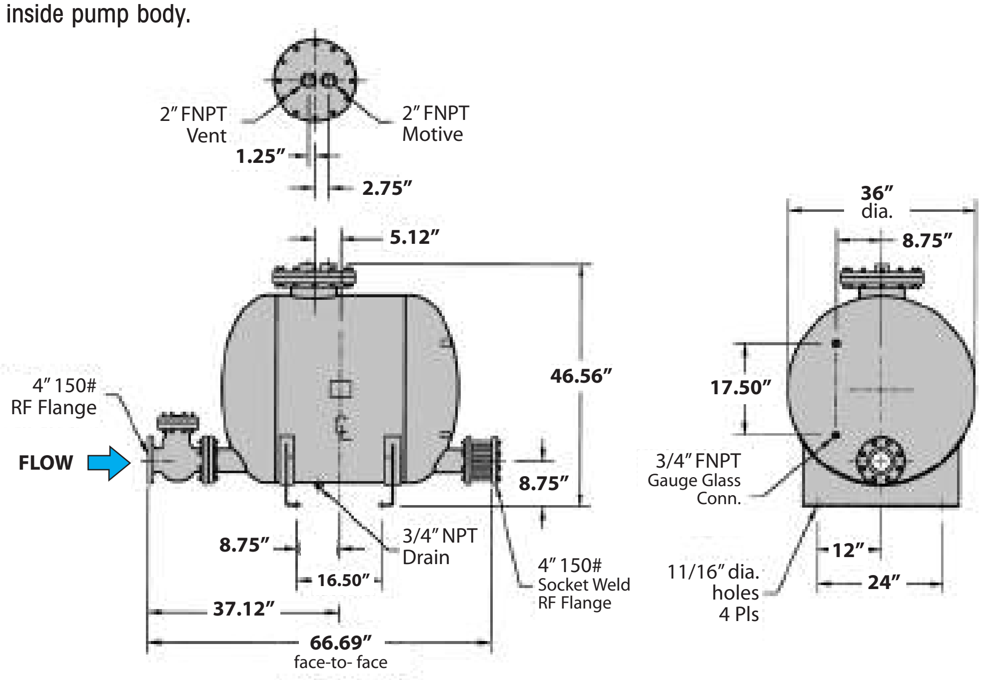
Options

- Cycle counter for measuring the amount of condensate flow through the pump.
- Insulation jackets are available to stop heat losses through the pump body.
- Sight glass for monitoring liquid level inside pump body.

MATERIALS	
Body & Cover	**Carbon Steel**
Cover Gasket	Non-Asbestos
Cover Bolts	Steel
Inlet Valve	Stainless Steel
Vent Valve	Stainless Steel
Mechanism Yoke	304 Stainless Steel
Ball Float	304 Stainless Steel
Check Valves	Stainless Steel & Steel
Springs	Stainless Steel
Other Internal Components	Stainless Steel

Size (Inlet x Outlet)	Connection	Model Code	PMO PSI	Weight (lbs)
4" x 4"	150#FLG	PMPBP-4X4-F150-SS	150	1050

The PMPBP Stand Alone Pump consists of pump tank, internal mechanism, and inlet and outlet check valves.



PMPSP

PMPSPL

Model	**PMPSP/PMPSPL**
Body	**Carbon Steel**
Cover	**Ductile Iron**
Check Valves	**Stainless Steel**
PMO Max. Operating Pressure	**150 PSIG**
TMO Max. Operating Temperature	**366°F**
PMA Max. Allowable Pressure	**150 PSIG @ 650°F**

Typical Applications

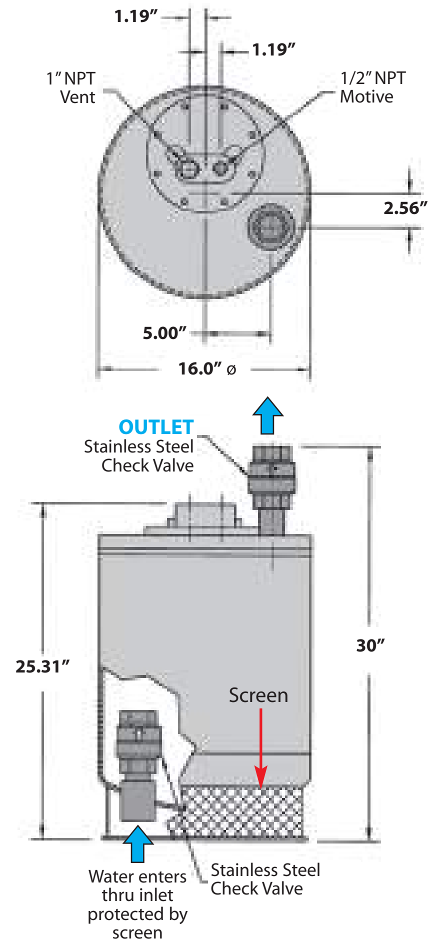
The **PMPSP** Sump Drainer uses the same internal mechanism as the standard PMP models. The piping configuration is such that the liquid is discharged vertically out the top as opposed to horizontally out the side. This allows the unit to be easily positioned inside of a sump area. Condensate or water from the sump enters the tank through a stainless steel low resistance check valve. This unit is capable of operating with a maximum motive pressure of 150 PSIG using steam, air, nitrogen or other pressurized gas as the motive force.

Features

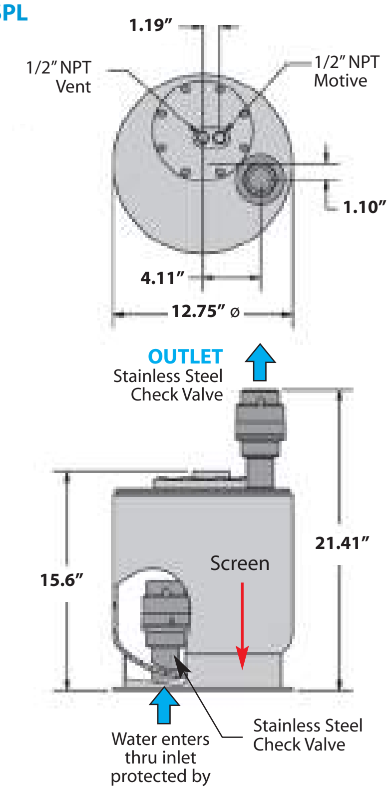
- Equipped with our **Patented "Snap-Assure"** Mechanism which **extends the useful life of the pump**
- Mechanism incorporates **heat-treated stainless steel wear items** for ultimate corrosion resistance
- Dual compression springs made from Inconel-X-750 for high-temperature corrosive service
- Operates using steam, air, nitrogen or other pressurized gas as the motive force
- **Non-Electric** – can be used in remote locations or NEMA 4, 7, 9 and hazardous areas
- Built-in Strainer screen

Snap-Assure U.S. Patent No. 6572340

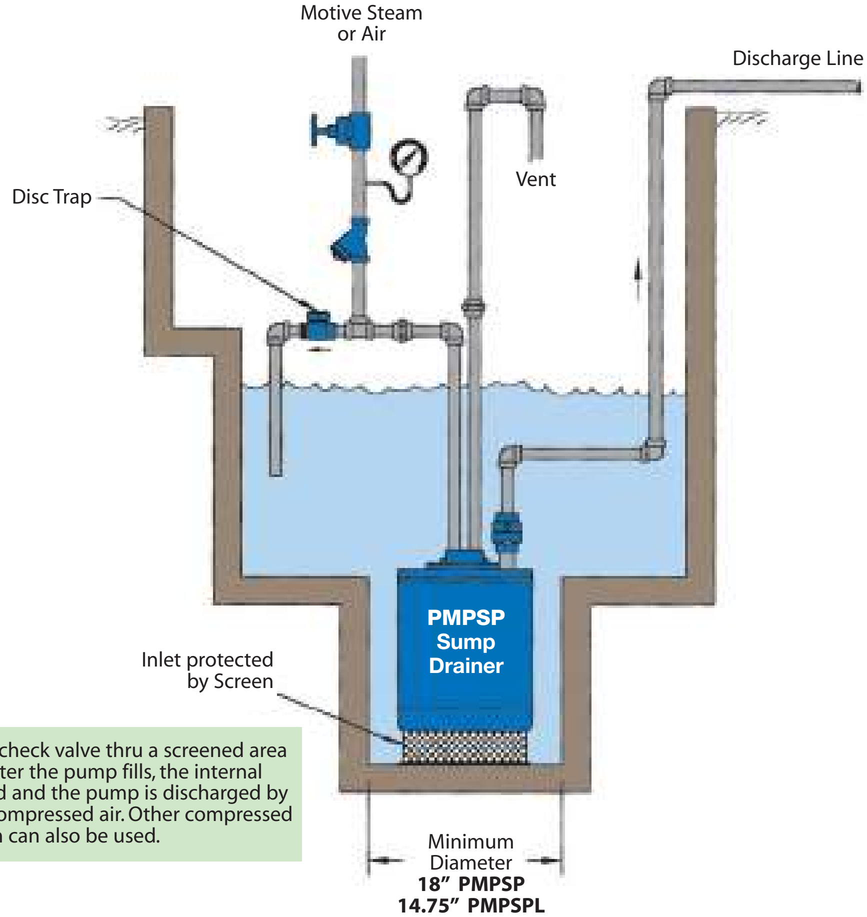
PMPSP



PMPSPL



Typical PMPSP Piping Configuration



Water enters the inlet check valve thru a screened area at bottom of pump. After the pump fills, the internal mechanism is actuated and the pump is discharged by the motive steam or compressed air. Other compressed gases such as nitrogen can also be used.

Size/Connection (Outlet) NPT	Model Code	PMO PSI	Weight lbs
$1^1/_2$"	PMPSPL	150	110
$1^1/_2$"	PMPSP-1	150	230
2"	PMPSP-2	150	270
2"	PMPSP-3	150	290

PMPSP & PMPSPL

PUMP CAPACITIES – *Water (GPM)*

Motive Pressure (PSIG)	Total Back Pressure (PSIG)	PMPSPL $1^1/_2$"	PMPSP-1 $1^1/_2$"	PMPSP-2 2"	PMPSP-3 2"
10	0	2.8	11.7	22.2	35
20	10	3.1	9.2	17.5	22
20	0	3.3	12.5	23.7	30
40	20	3.2	8.7	16.5	21
40	10	3.4	10.4	19.8	25
40	0	3.5	13.1	25	31.4
70	40	3.2	7.1	12.1	17
70	20	3.4	9.4	15	22.5
70	0	3.6	12.9	20.6	31
100	70	3.2	5.4	8.6	10.8
100	40	3.4	7.5	12	15
100	20	3.4	9.4	15	18.8
100	0	3.5	12.3	19.7	24.6
150	100	-	4.5	7.2	9
150	70	-	5.7	9.1	11.4
150	40	-	7.2	11.5	14.4
150	20	-	8.8	14	17.6
150	10	-	9.5	15.2	19
150	0	-	10.7	17.1	21.4

Standard Skid Mounted Systems

Package Model	Simplex, Duplex, Triplex	Simplex, Duplex, Triplex
Pump Model (PMP)	**PMPF**	**PMPC**
Pump Body Material	**Carbon Steel**	**Ductile Iron**
Receiver Material	**Carbon Steel**	**Carbon Steel**
Check Valves	316 Stainless Steel	316 Stainless Steel
PMO Max. Operating Pressure	200 PSIG	200 PSIG
TMO Max. Operating Temperature	388°F	388°F
PMA Max. Allowable Pressure	250 PSIG @ 650°F	200 PSIG @ 650°F
Receiver Pressure Rating	150 PSIG @ 566°F	150 PSIG @ 566°F

Typical Applications

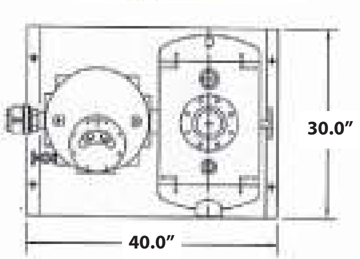
Condensate Return Pressure Motive Pump (PMPs) with a Vented Receiver. Standardized Simplex, Duplex, Triplex, and Quadraplex packaged systems include stand-alone pump(s), check valves and vented receiver, mounted on a steel base and frame. Multiple pumping units can be used for increased capacity or for system redundancy. The PMP units are available in ductile iron, carbon steel and stainless steel. Additional options include sight glasses, insulation jackets, cycle counters, motive and vent piping, pressure regulators, steam traps, strainers, ASME code stamps, etc.

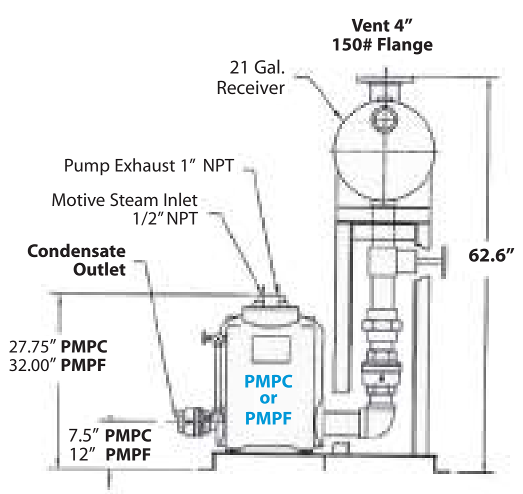
Sample Specifications

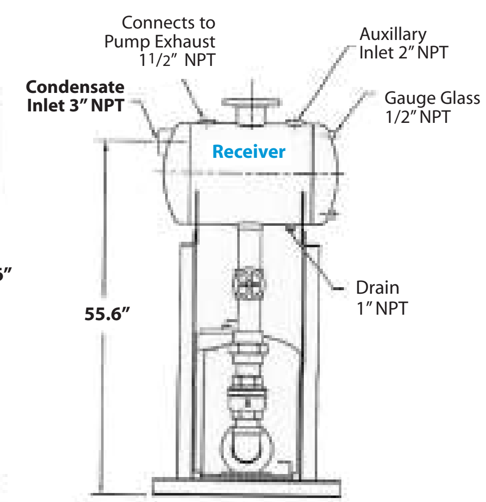
Unit shall be a Watson McDaniel, pre-packaged system to include pressure motive pump(s) with stainless steel check valves, an ASME vented receiver with "UM" code stamp, and interconnecting piping including inlet isolation valve. The carbon steel PMPF shall receive an ASME "UM" code stamp and the ductile iron PMPC shall offer it as an option. The pump mechanism shall be float operated with a patented "Snap-Assure" feature constructed of all stainless steel materials with all load bearing points hardened for extended service life, with no external seals or packing.

Connection NPT Inlet x Outlet	PMPC • Ductile Iron Mode Code	PMPF • Carbon Steel Mode Code	Receiver Size Gallons
Simplex Systems - One Pump with Receiver			
1" x 1"	**S-PMPC-1X1-SS-21**	**S-PMPF-1X1-SS-21**	21
1 1/2" x 1"	**S-PMPC-1.5X1-SS-21**	**S-PMPF-1.5X1-SS-21**	21
2" x 1"	**S-PMPC-2X1-SS-21**	**S-PMPF-2X1-SS-21**	21
2" x 1 1/2"	**S-PMPC-2X1.5-SS-21**	**S-PMPF-2X1.5-SS-21**	21
2" x 2"	**S-PMPC-2X2-SS-21**	**S-PMPF-2X2-SS-21**	21
3" x 2"	**S-PMPC-3X2-SS-21**	**S-PMPF-3X2-SS-21**	21
Duplex Systems - Two Pumps with Receiver			
3" x 2"	**D-PMPC-3X2-SS-48**	**D-PMPF-3X2-SS-48**	48
3" x 2"	**D-PMPC-3X2-SS-75**	**D-PMPF-3X2-SS-75**	75
3" x 2"	**D-PMPC-3X2-SS-116**	**D-PMPF-3X2-SS-116**	116
Triplex Systems - Three Pumps with Receiver			
3" x 2"	**T-PMPC-3X2-SS-75**	**T-PMPF-3X2-SS-75**	75
3" x 2"	**T-PMPC-3X2-SS-116**	**T-PMPF-3X2-SS-116**	116

SIMPLEX Systems







Standard Skid Mounted Systems

ASME Certified

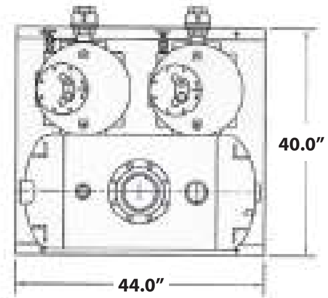
Features

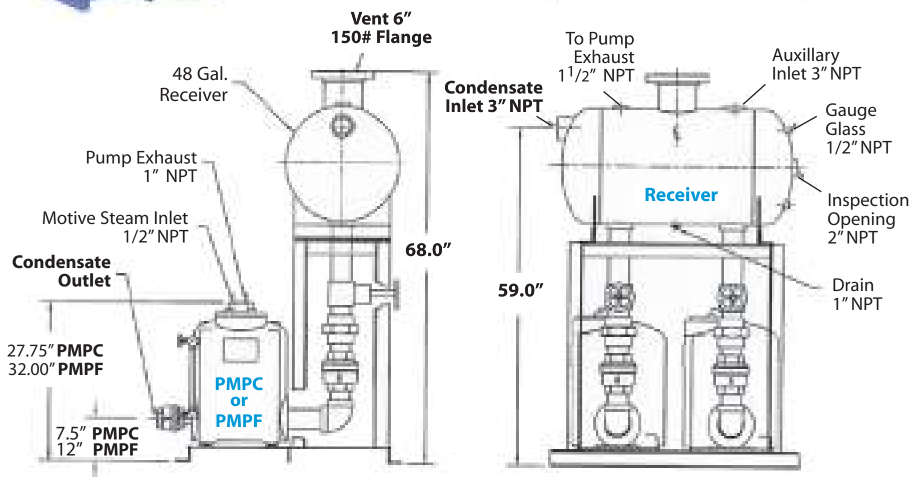
- PMP pump systems reduce installation costs. Only 4 pipe connections are required in the field
- Watson McDaniel ensures that vented receivers and other components are properly sized for optimum system performance
- Watson McDaniel's fully-qualified fabrication facility is ASME code certified. Our engineers can design and build complete custom systems to meet all your requirements

Options

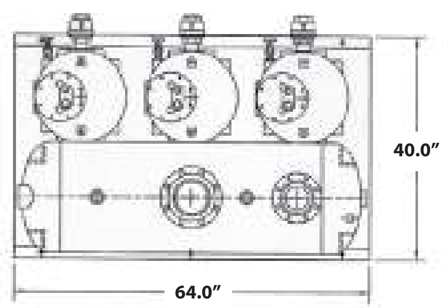
- Gauge glass assembly
- Cycle counter
- Insulation covers
- Motive steam drip trap
- Overflow pipe connection
- Pressure regulator for motive supply line

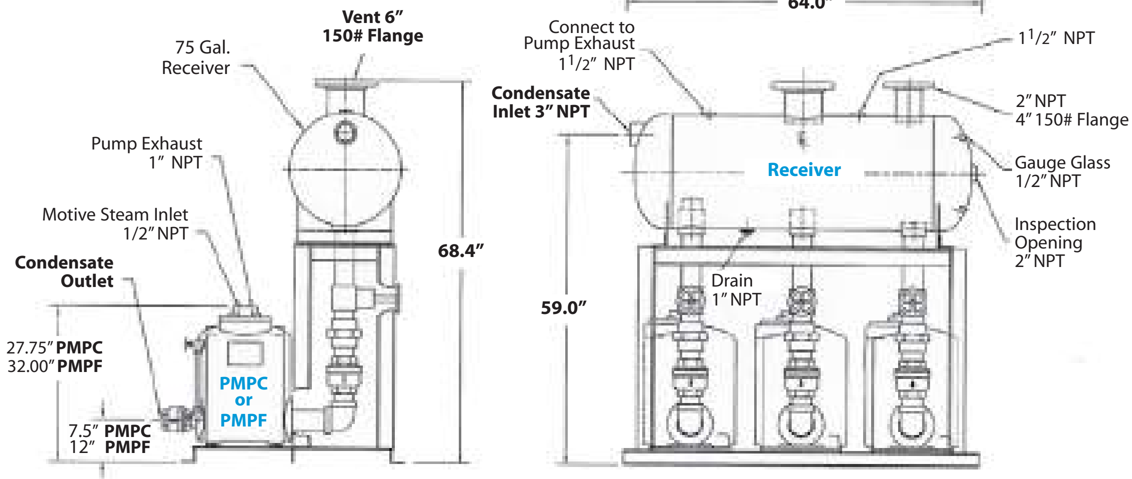
DUPLEX Systems





TRIPLEX Systems





Sizing and Selecting a PMP

The Capacity Charts cover both Stand Alone Pumps (PMPC, PMPF, PMPLS, etc.) as well as Pumps with Receiver Tanks (Simplex, Duplex, Triplex). If a stand alone pump is chosen, consideration should be given to the size of the vented receiver that collects the condensate before the PMP (see flash tank vent sizing). If the pump is replacing an existing installation, a vented receiver that is acceptable in size and configuration may already be installed. If required to meet capacity, pre-packaged systems with more than one pump, such as the Duplex or Triplex are available. These units come pre-mounted with the pump(s), a receiver tank as well as other options to optimize the system. A multiple pump unit may also be chosen for reserve capacity or pump redundancy in critical applications.

To select the proper size pressure motive pump requires you to know a few key pieces of information:

1. **Condensate load you need to pump:** Condensate Load is normally expressed in lbs/hr. To convert to GPM flow rate, note that 500 lbs/hr is equivalent to 1 GPM.

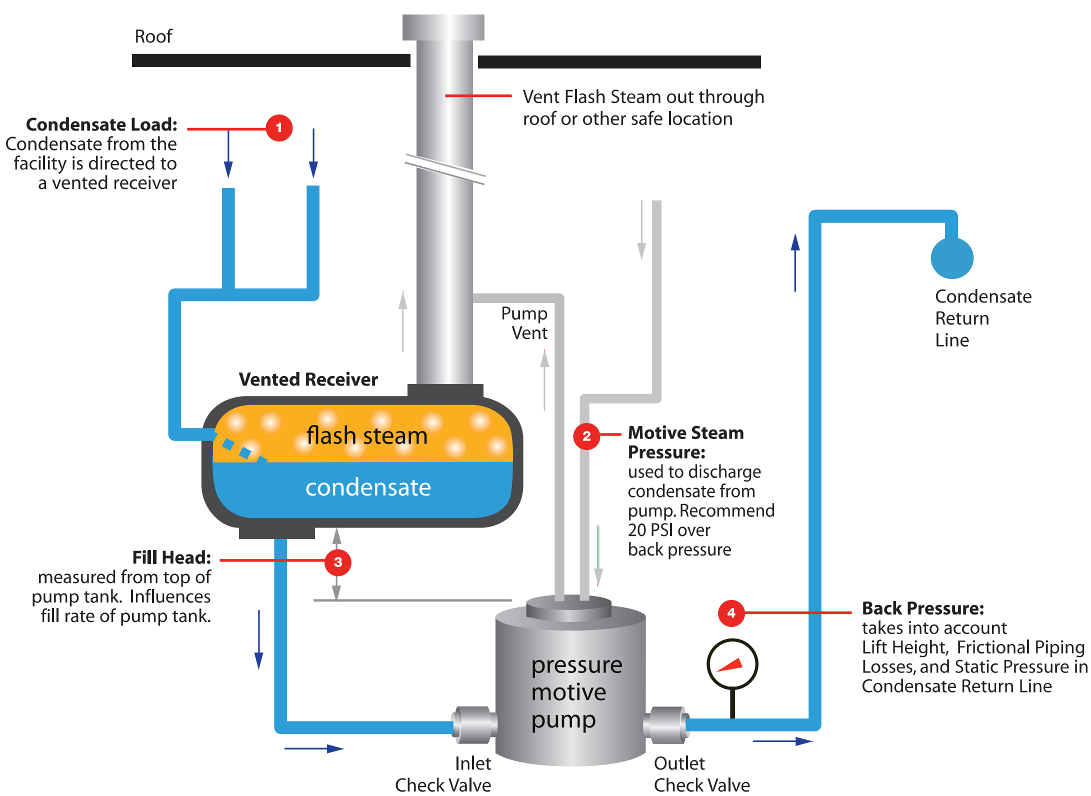
2. **Motive Pressure:** The motive pressure of the steam (or other gas) impacts pump capacity. The sizing chart indicates different flow rates based upon motive steam inlet pressure. It is recommended to regulate the steam inlet pressure to 20 psi above the total back pressure.

3. **Fill head:** Is the height (in inches) of the condensate receiver tank (or flash tank) above the pump tank. This head pressure determines how quickly the pump tank will refill with condensate after its discharge cycle. Therefore, reducing the fill time will increase the overall capacity of the pump. The capacity chart is based on 12" of fill head (PMPLS based on 6" fill head). Increasing fill head height can increase capacity by as much as 20 - 50%. (See Capacity Correction Chart.)

4. **Back Pressure:** Back Pressure is the sum total of condensate return line pressure and the physical height that the condensate needs to be elevated. (See sizing section for guidance on how to calculate back pressure.)

Inlet x Outlet Size:

In addition to body material, pumps are designated by inlet and outlet size. For example, PMPC 3 x 2 has 3" inlet and 2" outlet check valves with a ductile iron tank. Since the pump fills by gravity from the receiver tank located above it, the size of the inlet check valve significantly impacts pump capacity. The larger the check valve, the quicker the condensate will fill the pump tank, allowing it to cycle again. For example, a 3" check valve may have twice the inlet flow rate of a 2" check valve. The size of the outlet (or discharge) check valve also affects capacity but to a lesser extent.



Capacity Charts

Stand Alone Pumps & Systems

Capacity based on 12" Fill Head except as noted

CAPACITIES – *Condensate (lbs/hr)* Using steam as a motive pressure

Motive Pressure (PSIG)	Total Back Pressure (PSIG)	PMPLS 6" Fill Head 1" X 1"	PMPC, PMPF, PMPSS* (12" Fill Head) 1 1/2" X 1"	1 1/2" X 1 1/2"	2" X 1"	2" X 1 1/2"	2" X 2"	3" x 2"	Duplex 3" x 2"	Triplex 3" x 2"	Quadraplex 3" x 2"	PMPBP 4" x 4" 24" Head
5	2	1,760	1,860	1,920	2,860	3,180	3,540	5,000	10,000	15,000	20,000	16,600
10	5	1,870	2,200	2,450	4,350	4,840	5,380	7,210	14,420	21,630	28,840	19,000
10	2	2,200	3,030	3,370	6,880	7,650	8,500	11,110	22,220	33,330	44,440	22,600
25	15	1,650	3,130	3,480	4,990	5,550	6,170	8,230	16,460	24,690	32,920	33,200
25	10	1,980	3,600	3,990	6,560	7,290	8,100	10,780	21,560	32,340	43,120	40,300
25	5	2,300	4,700	5,200	7,970	8,860	9,850	13,350	26,700	40,050	53,400	46,200
50	40	1,650	2,280	2,530	3,370	3,750	4,170	5,670	11,340	17,010	22,680	33,300
50	25	1,980	4,050	4,500	6,800	7,560	8,440	11,550	23,100	34,650	46,200	40,100
50	10	2,300	4,700	5,240	7,970	8,860	9,850	13,440	26,880	40,320	53,760	47,000
75	60	1,540	2,400	2,660	3,600	4,000	4,440	6,340	12,680	19,020	25,360	32,900
75	40	1,980	3,780	4,190	5,920	6,580	7,320	9,870	19,740	29,610	39,480	39,400
75	15	2,420	5,130	5,700	8,580	9,540	10,600	14,330	28,660	42,990	57,320	47,200
100	80	1,650	2,750	3,060	4,160	4,630	5,150	6,860	13,720	20,580	27,440	27,200
100	60	1,870	3,600	4,000	5,560	6,180	6,870	9,100	18,200	27,300	36,400	35,100
100	40	2,090	4,700	5,210	6,880	7,650	8,500	11,270	22,540	33,810	45,080	42,100
100	15	2,420	5,400	6,010	8,740	9,720	10,800	14,330	28,660	42,990	57,320	48,000
125	115	1,430	2,380	2,640	3,270	3,640	4,050	4,960	9,920	14,880	19,840	19,500
125	100	1,540	2,980	3,330	4,140	4,600	5,130	6,390	12,780	19,170	25,560	25,300
125	80	1,760	3,430	4,100	5,400	6,000	6,670	8,540	17,080	25,620	34,160	32,200
125	60	1,980	4,170	4,850	6,600	7,340	8,160	10,530	21,060	31,590	42,120	38,500
125	40	2,200	5,100	5,950	7,760	8,630	9,590	12,500	25,000	37,500	50,000	44,000
125	15	2,420	5,850	6,660	9,240	10,270	11,420	15,100	30,200	45,300	60,400	49,200
150	120	1,590	2,650	2,940	3,400	3,780	4,200	5,690	11,380	17,070	22,760	21,600
150	100	1,640	3,150	3,490	4,320	4,800	5,350	7,000	14,000	21,000	28,000	29,000
150	80	1,860	3,800	4,230	5,490	6,100	6,770	9,100	18,200	27,300	36,400	34,500
150	60	2,080	4,500	5,000	6,660	7,400	8,240	11,120	22,240	33,360	44,480	40,300
150	40	2,300	5,290	5,870	7,920	8,800	9,780	13,220	26,440	39,660	52,880	44,700
150	15	2,520	6,100	6,820	9,450	10,500	11,680	15,500	31,000	46,500	62,000	49,500
175	140	-	2,600	2,900	3,800	4,200	4,650	6,200	12,400	18,600	24,800	-
175	120	-	3,100	3,400	4,400	4,850	5,400	7,200	14,400	21,600	28,800	-
175	100	-	3,600	4,000	5,100	5,700	6,300	8,400	16,800	25,200	33,600	-
175	60	-	4,850	5,400	6,900	7,700	8,550	11,400	22.800	34.200	45,600	-
175	40	-	6,200	6,900	8,900	9,850	10,950	14,600	29,200	43,800	58,400	-
175	15	-	7,500	8,350	10,600	11,900	13,200	17,600	35,200	52,800	70,400	-
200	160	-	2,400	2,700	3,500	3,800	4,300	5,700	11,400	17,100	22,800	-
200	140	-	3,100	3,400	4,400	4,900	5,400	7,200	14,400	21,600	28,800	-
200	100	-	4,200	4,650	5,950	6,600	7,350	9,800	19,600	29,400	39,200	-
200	80	-	4,700	5,250	6,750	7,500	8,300	11,100	22,200	33,300	44,400	-
200	40	-	6,800	7,550	9,700	10,800	11,950	15,950	31,900	47,850	63,800	-
200	15	-	8,400	9,350	12,000	13,300	14,800	19,700	39,400	59,100	78,800	-

** PMPSS is rated to only 150 PSIG.*

Note: For PMPNT capacity, refer to PMPNT specification page.

Capacity Correction Factors for Alternate Filling Heads

Pump Inlet Size	Filling Head 6"	12"	18"	24"	36"	48"	60"
1"	1.00	1.10	1.20	1.30	1.50		
1 1/2"	0.70	1.00	1.10	1.20	1.35		
2"	0.70	1.00	1.10	1.20	1.35		
3"	0.84	1.00	1.04	1.08	1.20		
4"			0.80	1.00	1.10	1.15	1.20

NOTE: *When the filling head differs from the standard filling height, the capacity of the pressure power pumps are either increased or decreased. For example, a pump with a 3" inlet that has a filling head of 36" as opposed to a standard filling head of 12", will have a capacity increase of 20%. Multiply the value found in the Capacity Table above by 1.2.*

Capacity Correction Factors for Gas as Motive Pressure

Pump Inlet Size	% Back Pressure relative to Motive Pressure 10%	20%	30%	40%	50%	60%	70%	80%	90%
1"	1.00	1.13	1.16	1.20	1.25	1.30	1.35	1.40	1.45
1 1/2"	1.04	1.06	1.08	1.10	1.12	1.15	1.18	1.23	1.28
2"	1.04	1.06	1.08	1.10	1.12	1.15	1.18	1.23	1.28
3"	1.04	1.06	1.08	1.10	1.12	1.15	1.18	1.23	1.28
4"	No Capacity Change								

Note: For low specific gravity applications, consult factory.

Pump Size

The models of a Pressure Motive Pump are designated by the size of the inlet and outlet check valves (for example, a 3” x 2” PMPC or PMPF has a 3” Inlet check valve and a 2” outlet check valve). The larger the check valves, the larger the pump capacity.

STAND-ALONE PUMPS include pump tank, internal pumping mechanism, and check valves.

PUMP(S) WITH RECEIVER TANKS includes stand-alone pump(s), and vented receiver tank mounted together on a frame. These are available in Simplex, Duplex, Triplex and Quadraplex systems.

When sizing and selecting a Pressure Motive Pump, Four system conditions are required:

(See Diagram on following page)

1. **Condensate Load:** If condensate from several sources of equipment is required to be pumped, sum up the maximum flow rate of condensate each could produce separately.
2. **Motive Pressure:** Normally steam is used; however, other gases can be used to pump the condensate, including Air or Nitrogen.
3. **Filling Head:** The Filling Head is measured between the bottom of the receiver tank and the top of the pump tank. It has a significant effect on pump capacity.
4. **System Back Pressure:** Pressure in condensate return line that pump will be operating against, as determined by condensate return line pressure and vertical height condensate must be lifted.

Sample System Conditions:

1 Condensate Load	8,000 lbs/hr
2 Motive Steam Pressure	100 PSIG
3 Filling Head	12"
4 System Back Pressure:	40 PSIG

(To find the pressure required to lift condensate in PSIG, multiply Vertical lift in feet by 0.433)

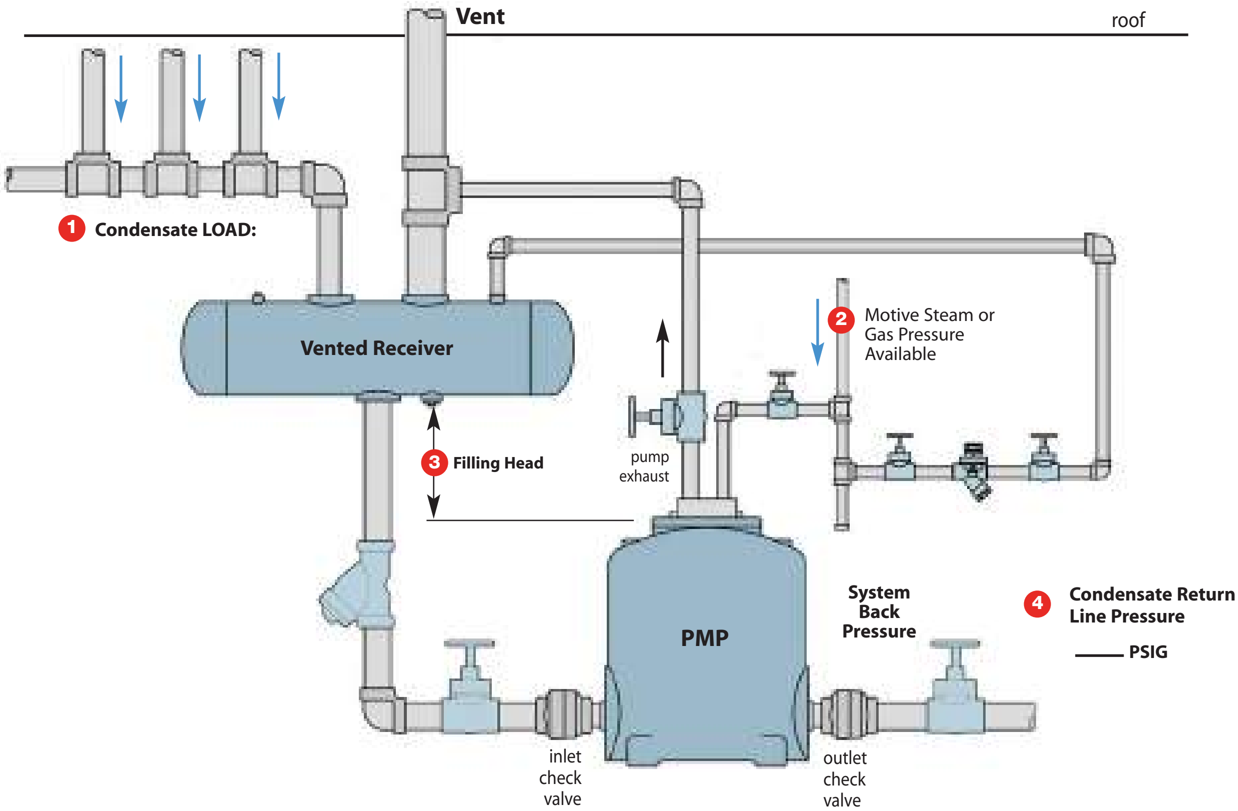
For PMP Selection: Consult PMP Sizing Capacity Chart using 100 PSIG inlet pressure and 40 PSIG back pressure. A 2" x 2" pump has a capacity of 8,500 lbs/hr and is an appropriate selection. Pump choices are models PMPC, PMPF and PMPSS.

How to specify when ordering:	Example:
1) Model	**PMPC**
2) Size of Pump(s)	**2” x 2”**
3) Stand-alone Pump or Pump with Receiver Tank *(Note: Size of Receiver Tank must be specified when ordering Pump with Receiver Tank)*	**Simplex or Duplex**
4) Options	**Gauge glass**
5) When ordering a Customized Skid System, please confirm and specify Receiver size.	

PMP-Mechanical Condensate Return Pumps

Sizing & Selection

Vented Receiver (Open-Loop System)



Receiver & Vent Sizing

The purpose of the vented receiver is to neutralize the pressure inside the condensate return line so condensate will properly drain from the processes and into the pump tank. An undersized vent will increase the velocity of flash steam in the vent pipe, potentially pulling condensate from the receiver tank out the vent. It may also increase pressure in the receiver and condensate return line upstream of the receiver, possibly causing issues with condensate drainage from the steam traps. The table below lists vent and corresponding receiver sizes based on the amount of flash steam. The amount of flash steam generated is determined by the condensate flow rate and condensate pressure entering the vented receiver.

Determine the amount of condensate in lbs/hr flowing into the vented receiver. The percentage of condensate that will flash into steam is based on the initial condensate pressure and the pressure inside the vented receiver. Since we are trying to achieve 0 psig, reference the 0 psig flash tank pressure to determine % flash steam. Multiply the % flash by the total condensate load.

Example: 10,000 lbs/hr of condensate is generated at an estimated steam pressure of 20 psig.
The percent (%) flash steam is **4.9%**. **Quantity of flash steam = .049 x 10,000 = 490 lbs/hr**.

From the table, select a Vent and Receiver size which can handle **600 lbs/hr** of flash steam.
(**4"** vent with a **10"** receiver diameter and **36"** length.)

PERCENT (%) FLASH STEAM

Produced when condensate is discharged to atmosphere or into a flash tank controlled at various pressures

Condensate Pressure (PSIG)	Flash Tank Pressure (PSIG)								
	0	5	10	20	30	40	60	80	100
5	**1.6**	0.0							
10	**2.9**	1.3	0.0						
15	**3.9**	2.4	1.1						
20	**4.9**	3.3	2.1	0.0					
30	**6.5**	5.0	3.7	1.7	0.0				
40	**7.8**	6.3	5.1	3.0	1.4	0.0			
60	**10.0**	8.5	7.3	5.3	3.7	2.3	0.0		
80	**11.8**	10.3	9.1	7.1	5.5	4.2	1.9	0.0	
100	**13.3**	11.8	10.6	8.7	7.1	5.8	3.5	1.6	0.0
125	**14.9**	13.5	12.3	10.4	8.8	7.5	5.3	3.4	1.8
150	**16.3**	14.9	13.7	11.8	10.3	9.0	6.8	4.9	3.3

VENTED RECEIVER SIZING *(inches)*

Quantity of Flash Steam (lbs/hr)	Vent Line Diameter	Receiver Diameter	Receiver Length
75	1"	4"	36"
150	2"	6"	36"
300	3"	8"	36"
600	4"	10"	36"
900	6"	12"	36"
1200	6"	16"	36"
2000	8"	20"	60"
3000	8"	24"	60"
4000	10"	26"	60"
5000	10"	28"	60"
6000	12"	30"	72"
7000	12"	32"	72"
8000	14"	36"	72"

Pump & Trap Combinations

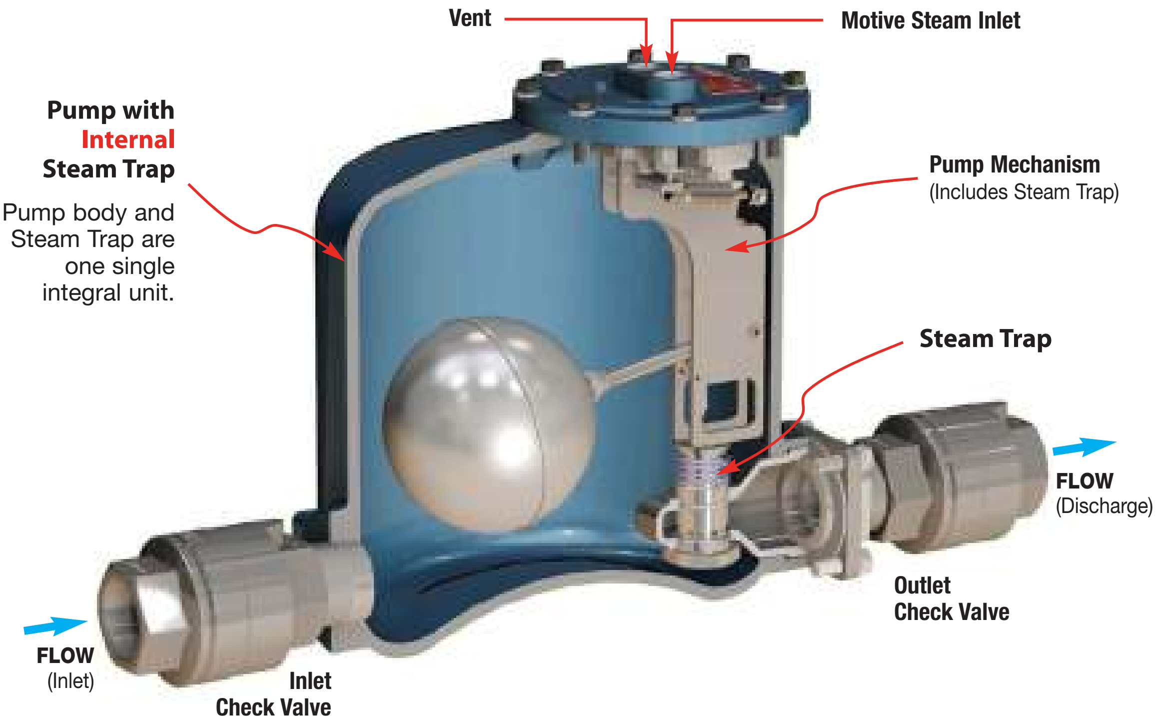
PMPT & WPT

What is a Pump-Trap?

A Pump-Trap is a float-operated steam trap that works in conjunction with a steam powered condensate return pump (Pressure Motive Pump). It is used when system conditions prevent a steam trap from effectively discharging condensate due to excessive back-pressure, or when it is desirable to operate a heat exchanger in vacuum.

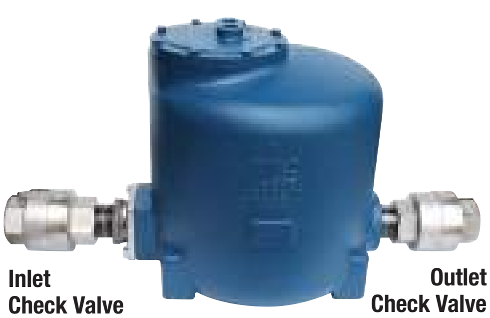
What is a Pump-Trap used for?

A **Pump-Trap** is used in place of a Steam Trap to drain condensate from a process application when the steam pressure in the process is not sufficient to push the condensate thru the steam trap and into the condensate return line. When steam pressure in a Heat Exchanger is less than the back pressure on the discharge side of the steam trap, the condensate backs up, causing inconsistent heat transfer and potential waterhammer. This frequently occurs on applications where a temperature control valve is used to supply steam to a Heat Exchanger based on product temperature and flow rate. The temperature control valve increases and decreases steam flow to the Heat Exchanger to satisfy the temperature set point. When system demand is high, the steam pressure in the Heat exchanger is most likely adequate to overcome system back pressure; however, when system demand decreases, steam pressure to the Heat Exchanger must also decrease and can fall below the back pressure. This condition is referred to as Stall, since it causes condensate to back up into the Heat Exchanger. To prevent condensate backup under stall conditions, a pump-trap must be used in place of a steam trap.



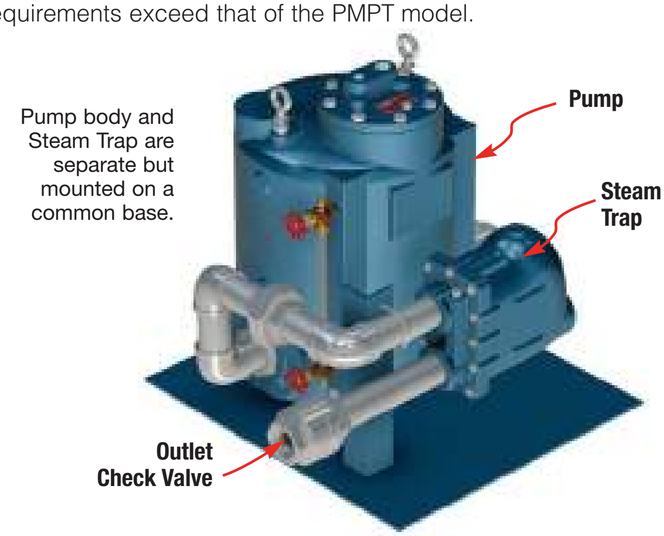
Pump with Internal Steam Trap (PMPT)

The **PMPT** pressure motive pump has an internal steam trap. The compact design makes it a suitable choice for most applications.



Pump with External Steam Trap (WPT)

The **WPT** is a stand-alone pump unit with a separate steam trap mounted on a common base. It is used when capacity requirements exceed that of the PMPT model.



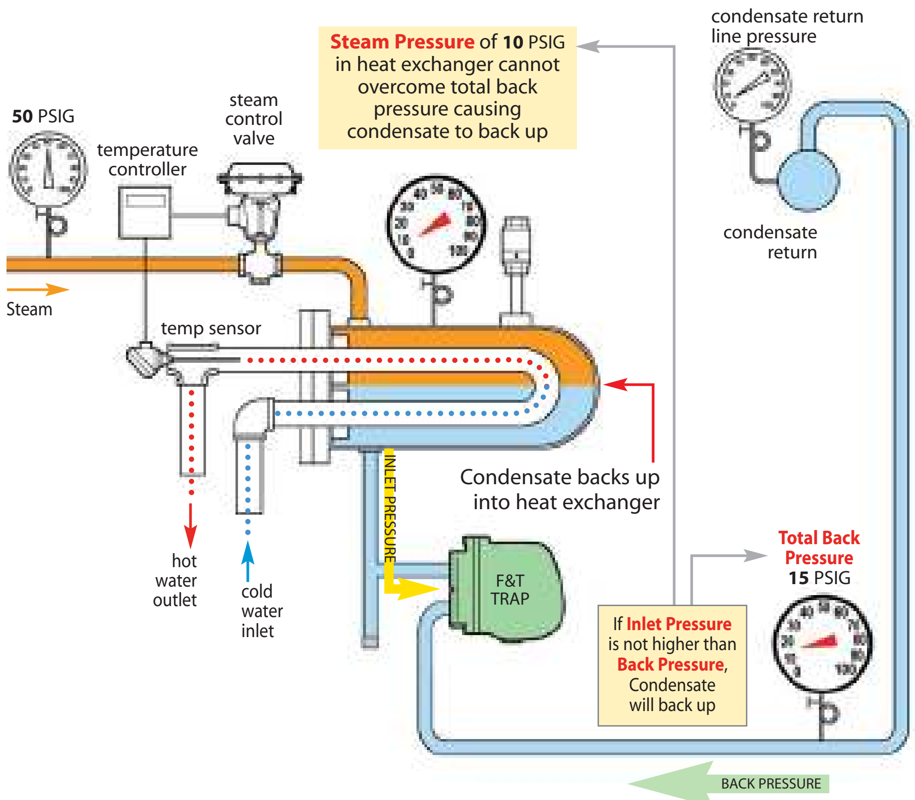
Why use a Pump-Trap?

Problem:

Condensate Backs Up Into Heat Exchanger

The diagram shows a temperature control valve delivering steam to a Heat Exchanger that is using steam to heat water. Condensate formed in the heat exchanger is being discharged through the steam trap into the condensate return line. This particular application demonstrates what happens when the return line is elevated and/or pressurized. The plant steam pressure on the inlet side of the control valve would be adequate to purge (push) the condensate through the trap and into the return line. However, the steam pressure in the heat exchanger is controlled by the valve and is dependent on the demand of the system. When the demand for HOT water is low, the steam pressure in the Heat Exchanger falls below the back pressure and the system backs up with condensate, creating unstable temperature control and waterhammer. This undesirable condition, referred to as Stall, occurs when the steam pressure in the heat exchanger falls to or below the system back pressure due to a decrease in the demand (flow rate) of hot water.

Heat Exchanger System with Steam Trap

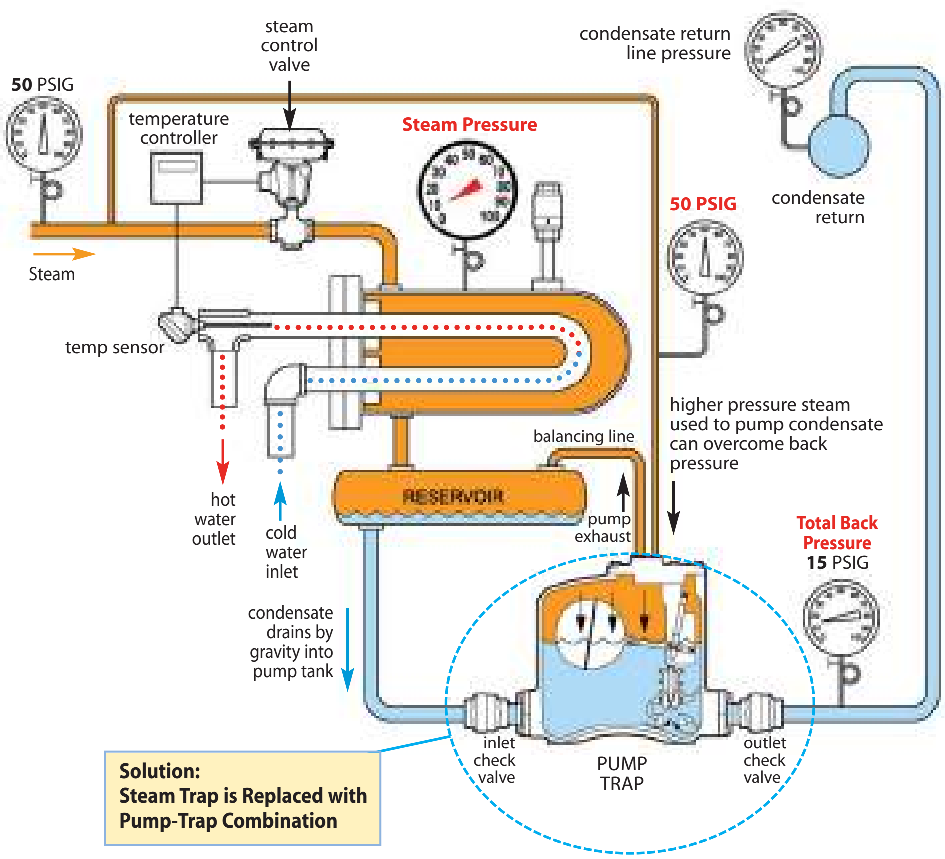


Solution:

Use a Pump-Trap to Avoid Condensate Back-up & Improve Temperature Control

To eliminate condensate backing up (STALL), the standard float trap is replaced with a PUMP-TRAP. When steam pressure in the Heat Exchanger is greater than the back pressure, the steam pressure will push the condensate through the Pump-Trap and it functions like a standard float-operated trap. When the steam pressure to the Heat Exchanger drops below the back pressure, the condensate backs up inside the PUMP-TRAP, raising the float. When the trip point of the mechanism is reached, the high-pressure steam valve will open to drive the condensate out.

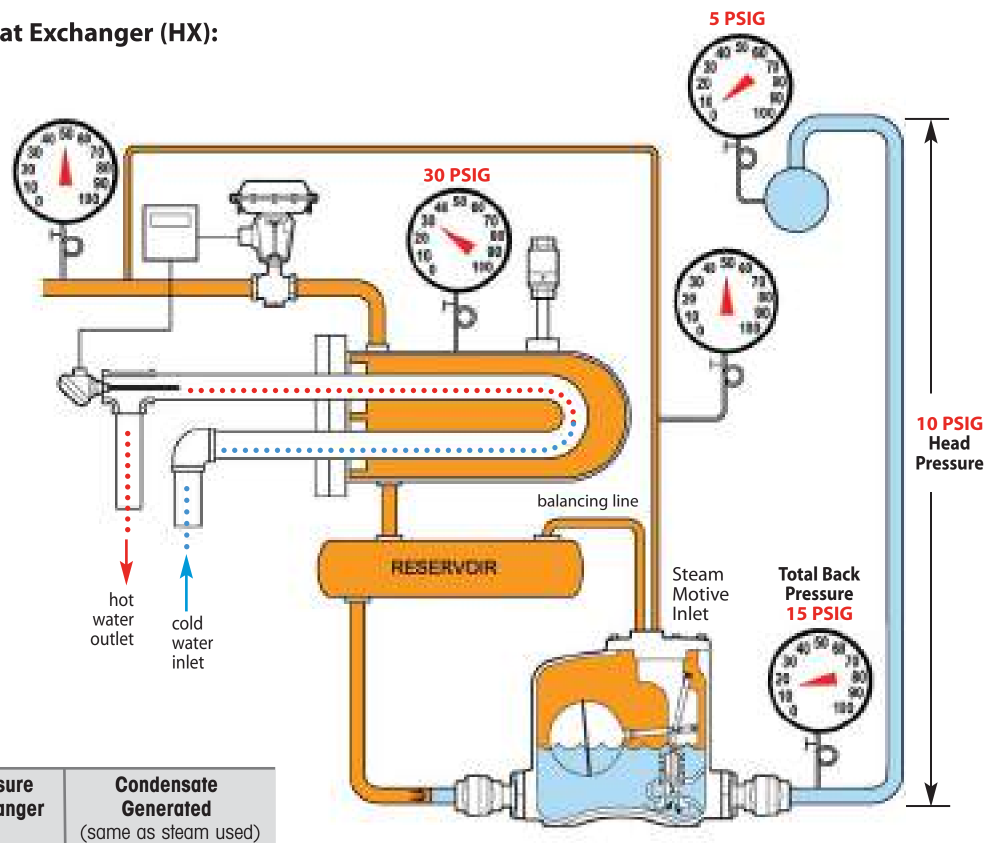
Heat Exchanger System with Pumping Trap



How a Pump-Trap Works

Operation of a PUMP-TRAP with a Heat Exchanger (HX):

The steam pressure to the HX will vary depending on the flow rate of hot water required by the system. Let's assume the HX was sized for a maximum flow rate of 40 GPM of HOT water at 140˚F using 30 PSIG steam. When maximum flow rate of water is required, the 30 PSIG steam pressure is more than adequate to push the condensate generated thru the steam trap against the 15 PSIG back pressure. Now, if the hot water requirement reduces from 40 to 20 GPM, the steam flow (lbs/hr) to the Heat Exchanger must drop by about half. Since it is the same size HX, the steam temperature (steam pressure) must also reduce (see table below).

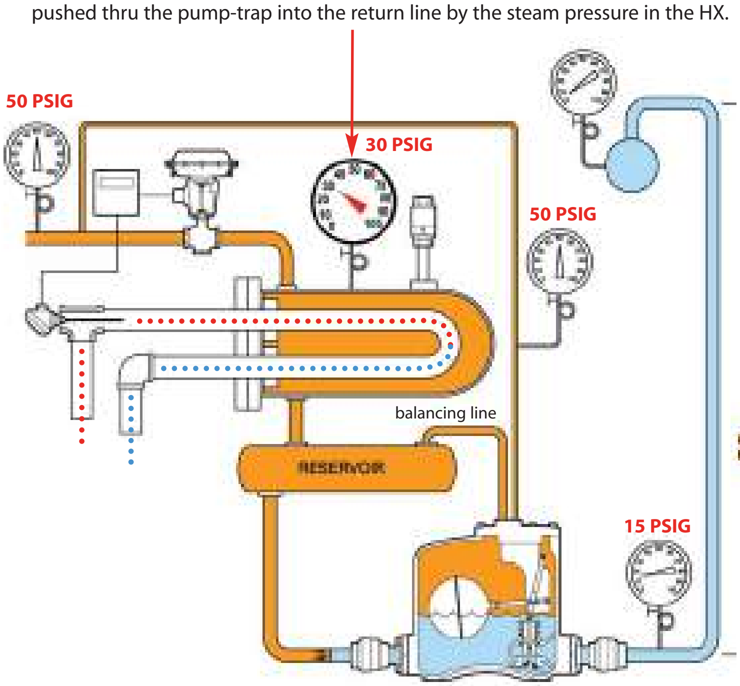


Steam Pressure vs. Hot Water Required

Flow Rate Water (gallons per minute)	Steam Usage (lbs/hr)	Steam Pressure in Heat Exchanger (PSIG)	Condensate Generated (same as steam used)	
40	1,900	30	1,900	**Trap Mode**
35	1,650	15	1,650	*Stall Point*
32	1,530	10	1,530	**Pump Mode**
20	950	-6.6 (Vacuum)	950	

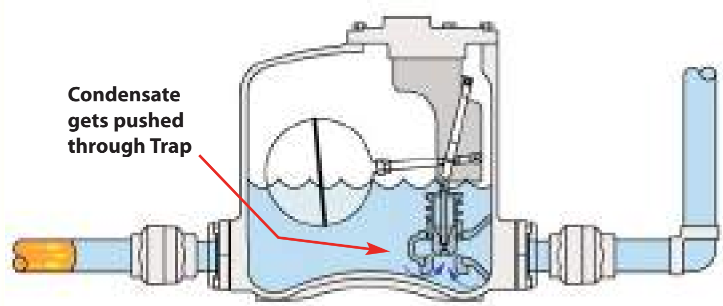
TRAP Mode

The system is operating with **30 PSIG** inlet pressure to the heat exchanger.
The Pump-Trap unit functions like a standard float-operated trap. Condensate is pushed thru the pump-trap into the return line by the steam pressure in the HX.



Vent Outlet: Open position, allowing pressure in the pump tank to equal pressure in the heat exchanger, allowing condensate to freely enter Pump-Trap by gravity, even under vacuum.

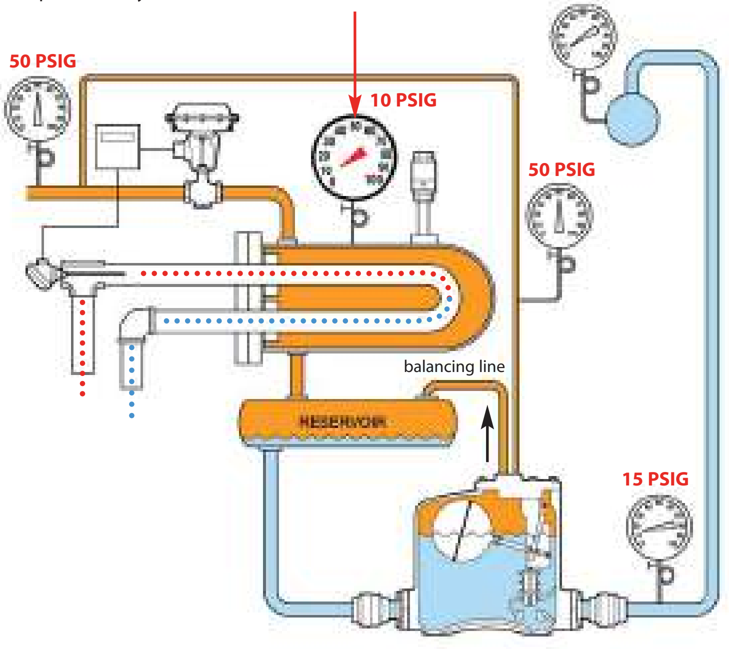
Motive Inlet: Closed position



1 TRAPPING Mode: Inlet steam pressure is higher than back pressure. Steam pushes condensate through Pump-Trap.

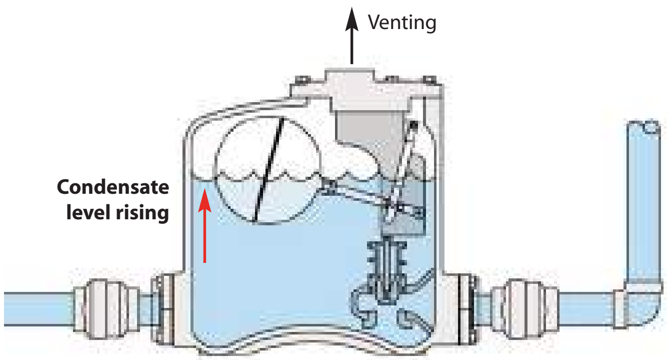
PUMP Mode

The pressure in the HX has now dropped to **10 PSIG**. This was in response to a fall off in demand of hot water. Based on this particular size HX, 10 PSIG steam will heat 32 GPM of water. Since back pressure is 15 PSIG, the system is stalled and condensate is beginning to back up into the system and the float continues to rise.



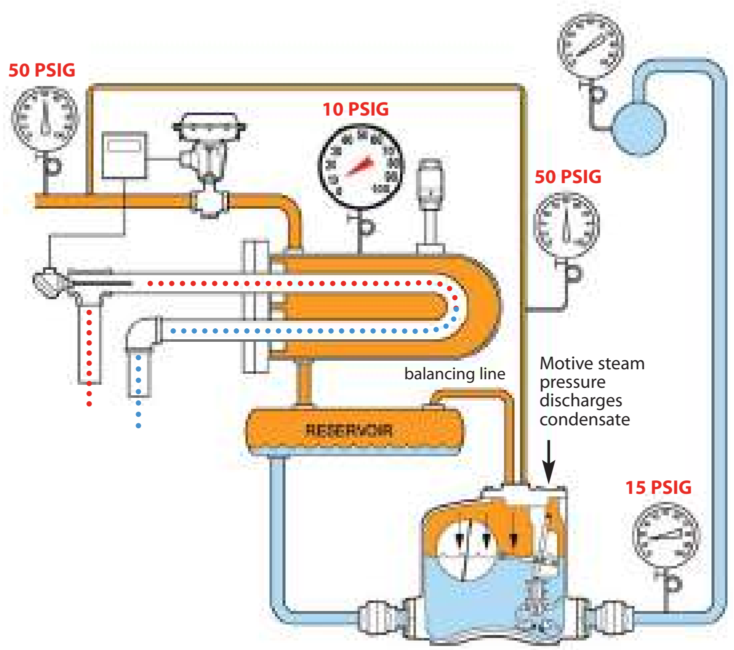
Vent Outlet: Open position, allowing pressure in the pump tank to equal pressure in the heat exchanger, allowing condensate to freely enter Pump-Trap by gravity.

Motive Inlet: Closed position



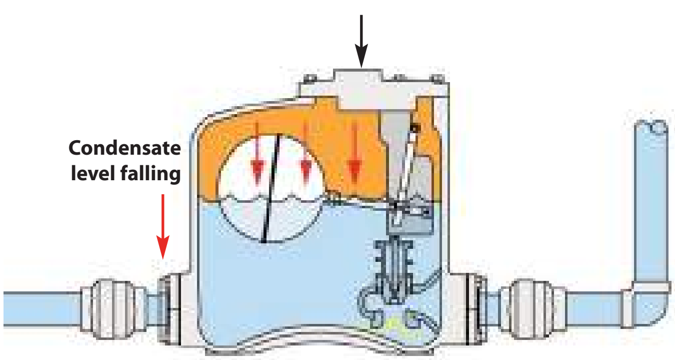
2 PUMP TANK FILLS: Inlet steam pressure falls below back pressure. Steam can no longer push the condensate through the Steam Trap.

Condensate rises to a level that the float triggers the inlet steam valve and closes the vent valve. Full line pressure steam (50 PSIG) enters thru the inlet valve on top of the pump body to discharge the condensate. Because of check valves, condensate will not flow back to HX and is discharged to the condensate return line. Unit will continue to operate and cycle in pump mode as long as pressure in the HX is below back pressure. Pump-Trap will also operate in vacuum conditions.



Vent Outlet: Closed

Motive Inlet: Open; steam pressure (50 PSI) enters tank and discharges condensate.



3 PUMP Mode: Pump is activated. When the pump tank has filled to the trip point, the mechanism triggers, opening the motive gas inlet valve and simultaneously closing the vent valve. This allows motive pressure to enter the pump body, which drives the condensate thru the outlet check valve and into the condensate return line. During the discharge cycle, the liquid level and the float inside the pump tank drop. When the lower trip point is reached, the mechanism closes the motive inlet valve and opens the vent valve so the pump-trap can fill on the next cycle.

Model	PMPT	PMPTS
Body	Ductile Iron	Stainless Steel
Cover	Stainless Steel	Stainless Steel
Sizes	1”, 1½” NPT	1½” FLG
Check Valves	Stainless Steel	Stainless Steel
PMO Max. Operating Pressure	125 PSIG	125 PSIG
TMO Max. Operating Temperature	366ºF	366ºF
PMA Max. Allowable Pressure	150 PSIG @ 450˚F	150 PSIG @ 450˚F

Typical Applications

The **PMPT** low-profile pressure motive pump & trap combination has an internal steam trap for draining heat exchangers and other equipment whose steam pressure is modulated by a temperature regulator or a temperature control valve. In these applications the steam pressure in the heat exchanger may not be sufficient to overcome the back pressure in the condensate return line. When this condition occurs, the pressure powered pump takes over and uses high pressure steam supplied to the pump to discharge the condensate. When sufficient pressure does exist, the PMPT functions like a standard steam trap. Its small compact design is perfect for applications with limited space.

Pump-Traps facilitate condensate discharge under all operating conditions, including vacuum.

Steam Trap internal to pump body will function like a normal float trap discharging condensate as its formed. If condensate backs up, the pumping mechanism will use motive steam pressure to discharge the condensate.

Features

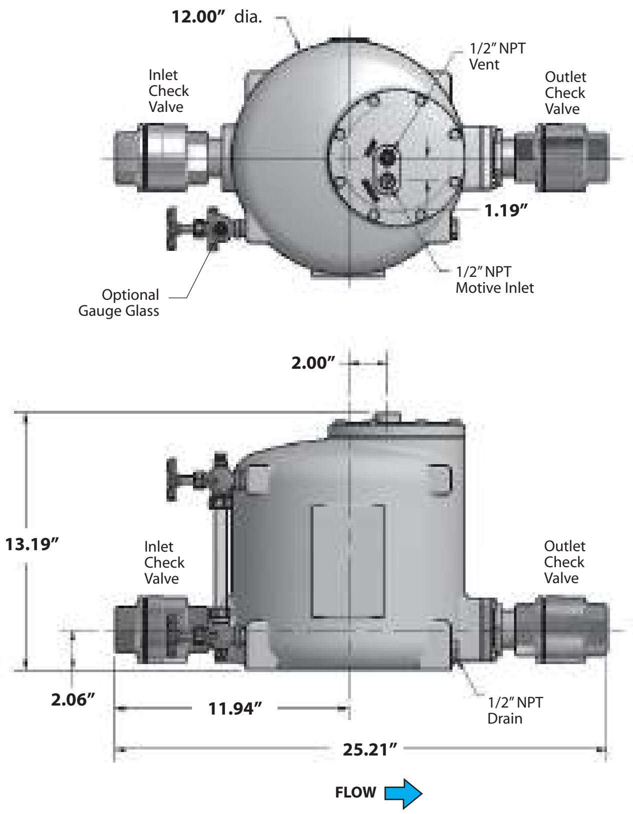
- Low-profile design allows for condensate drainage of equipment positioned close to the floor
- Equipped with our proven, **Patented “Snap-Assure”** mechanism which extends the useful life of the pump
- Internal mechanism can be removed from the top of the pump while pump remains piped in line
- Mechanism incorporates heat-treated stainless steel wear items
- Dual compression springs made from Inconel-X-750 for high-temperature, corrosive service

NOTE: Reservoir - Pump-Trap Combination may require a reservoir above the pump to collect condensate generated in the heat exchanger during the discharge cycle of the pump. Consult Reservoir Sizing Guidelines or contact factory for additional information.

PMPT with Receiver Tank

Options

- Horizontal pipe reservoir (recommended)
- Motive and vent piping
- Motive piping components such as steam trap, strainer and regulator
- Packaged systems available with reservoir, base and skid
- Gauge Glass
- Insulation Jacket
- ASME Code Stamp

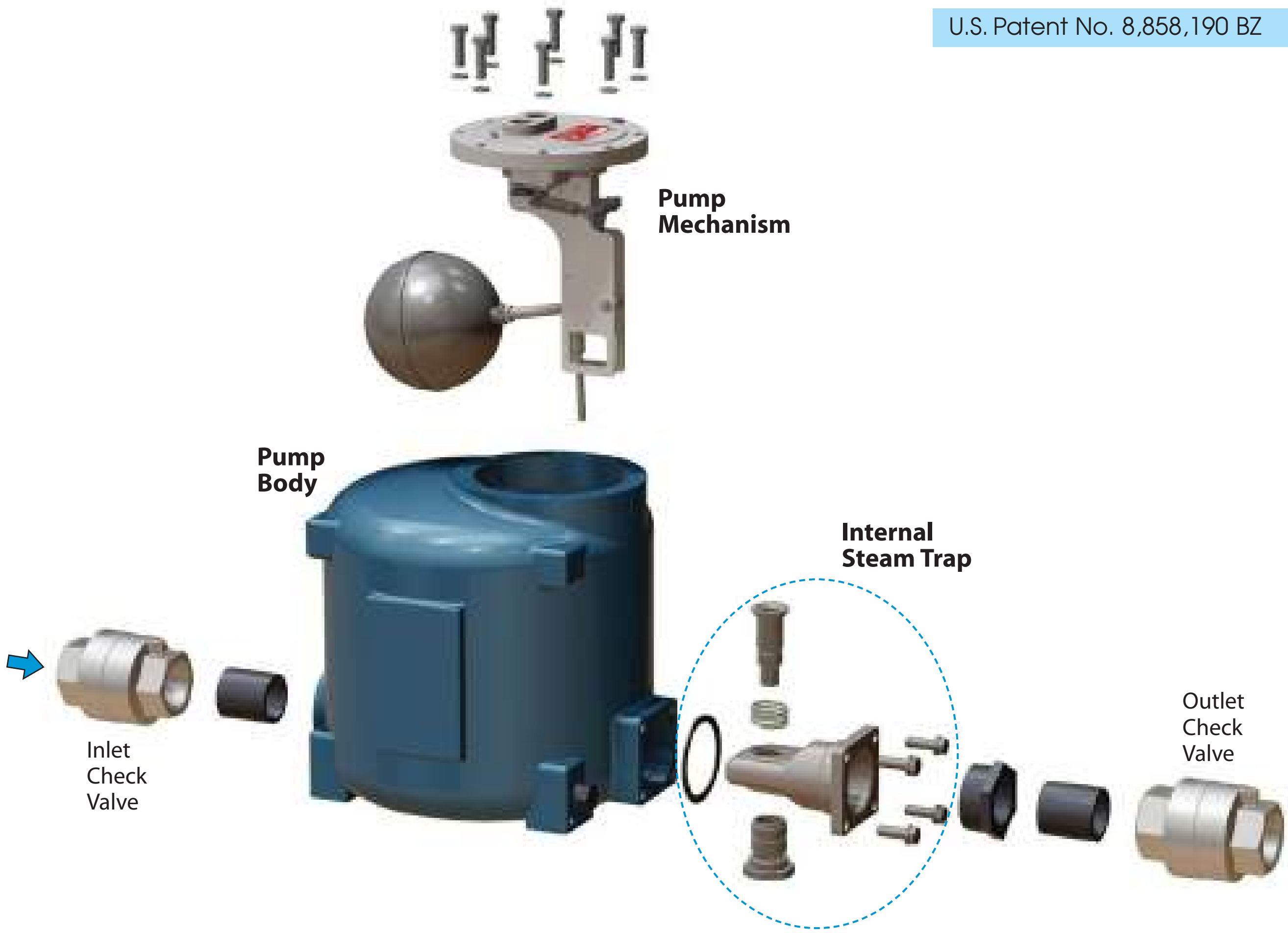


MATERIALS	
Body PMPT	**Ductile Iron SA-395**
Body PMPTS	**Stainless Steel CF3M**
Cover	Stainless Steel CF8
Cover Gasket	Garlock
Cover Bolts	Steel
Inlet Valve	Hardened Stainless Steel 40 Rc
Vent Valve	Hardened Stainless Steel 40 Rc
Ball Float	300 Stainless Steel
Check Valves	Stainless Steel 316SS CF3
Springs	Inconel-X-750
Other Internal Components	Stainless Steel

Size	Model Code	PMO PSI	Weight lbs
Ductile Iron Pump Body (NPT)			
1" x 1"	**PMPT-1X1-N-SS**	125	85
1 1/2" x 1 1/2"	**PMPT-1.5X1.5-N-SS**	125	95
Stainless Steel Pump Body (NPT or 150# FLG)			
1 1/2" x 1 1/2"	**PMPTS-1.5X1.5-N-SS**	125	95
1 1/2" x 1 1/2"	**PMPTS-1.5X1.5-F150-SS**	125	98

The PMPT Pump-Trap consists of pump tank, internal mechanism & trap, and inlet & outlet stainless steel check valves.

U.S. Patent No. 8,858,190 BZ



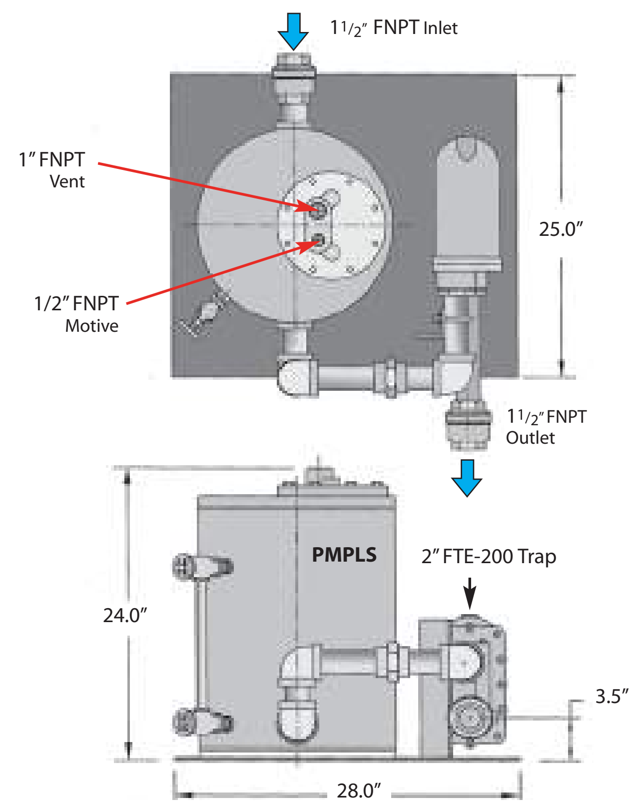
PUMPING TRAPS

WPT-Series Pump-Trap Combinations simplify Selection & Installation of Pressure Motive Pumps

- 3 size ranges available
- Up to 13,000 lbs/hr of condensate load

WPT3 • 1 1/2 x 1 1/2

(**PMPLS** with 2″ FTE-200 Steam Trap)



Typical Applications

WPT Pump-Trap Combinations are excellent for draining condensate from heat exchangers and other equipment whose steam pressure is modulated by a temperature regulator or a temperature control valve. In these applications the steam pressure in the heat exchanger may not be sufficient to overcome the back pressure in the condensate return line. When this condition occurs, the pressure powered pump takes over and uses high pressure steam supplied to the pump to discharge the condensate. When sufficient pressure does exist, the WPT functions like a standard steam trap.

Pump-Traps facilitate condensate discharge under all operating conditions, including vacuum.

Pump-Trap Features

- Pump and Steam Trap are pre-mounted together on a single base for easy installation
- Higher capacities than Pump-Trap combinations with internal steam traps (PMPT)
- Engineering and selection is simplified using a pre-mounted system

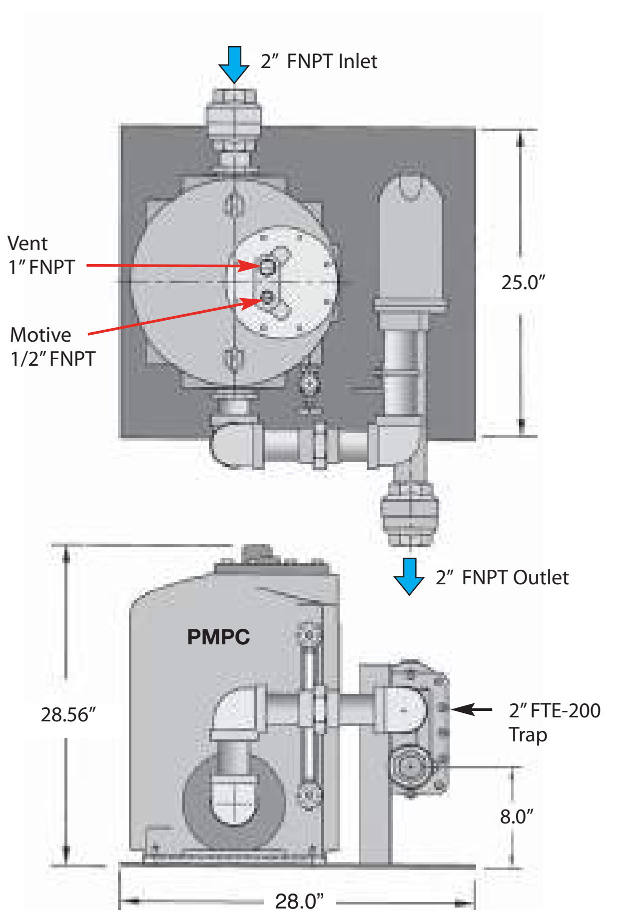
NOTE: Reservoir - Pump-Trap Combination may require a reservoir above the pump to collect condensate generated in the heat exchanger during the discharge cycle of the pump. Consult Reservoir Sizing Guidelines or contact factory for additional information.

MATERIALS	WPT3		WPT4		WPT5	
	Pump	Trap	Pump	Trap	Pump	Trap
Body	**Carbon Steel**	**Ductile Iron SA-395**	**Ductile Iron SA-395**	**Ductile Iron SA-395**	**Ductile Iron SA-395**	**Ductile Iron SA-395**
Cover	Carbon Steel	Ductile Iron SA-395	Ductile Iron SA-395	Ductile Iron SA-395	Ductile Iron SA-395	Ductile Iron SA-395
Cover Gasket	Garlock	Garlock	Garlock	Garlock	Garlock	Garlock
Cover Bolts	Steel	Steel	Steel	Steel	Steel	Steel
Inlet Valve	17-4 Ph SS 40 Rc	n/a	17-4 Ph SS 40 Rc	n/a	17-4 Ph SS 40 Rc	n/a
Vent Valve	17-4 Ph SS 40 Rc	n/a	17-4 Ph SS 40 Rc	n/a	17-4 Ph SS 40 Rc	n/a
Ball Float	304 SS	304 SS	304 SS	304 SS	304 SS	304 SS
Check Valves	316 SS	n/a	316 SS	n/a	316 SS	n/a
Springs	Inconel-X-750	n/a	Inconel-X-750	n/a	Inconel-X-750	n/a
Other Internal Components	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel

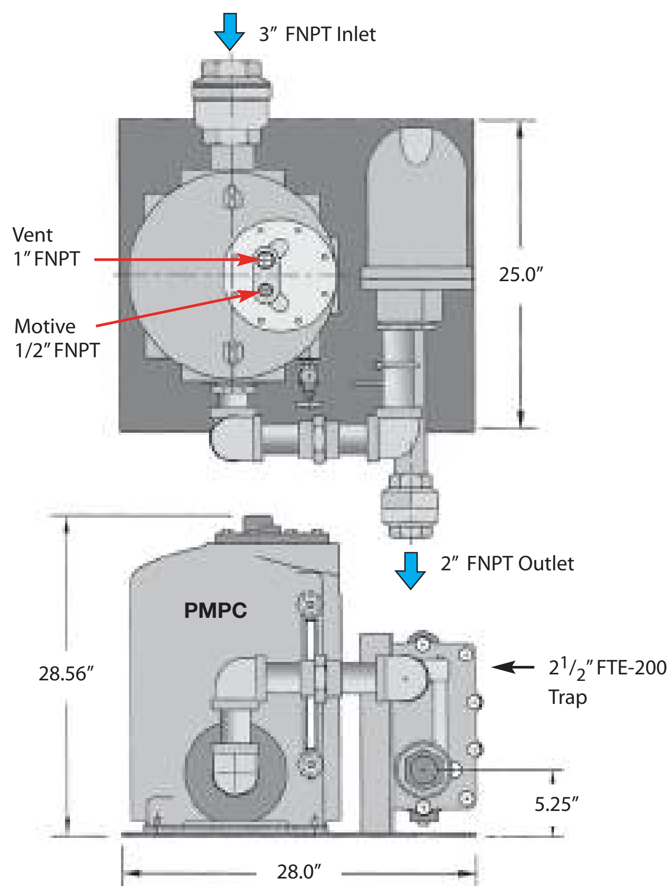
Pump & Trap Combination
External Steam Trap

WPT

WPT4 • 2″ x 2″
(**PMPC** with 2″ FTE-200 Steam Trap)



WPT5 • 3″ x 2″
(**PMPC** with $2^1/_2$″ FTE-200 Steam Trap)



PUMPING TRAPS

PMPT & WPT Pump-Trap Combinations (Operating in **Pump** Mode)

PUMP CAPACITIES – *Condensate (lbs/hr); using steam as a motive pressure*

Motive Pressure (PSIG)	Total Back Pressure (PSIG)	PMPT 1″ x 1″ 6″ Fill Head	PMPT 1 1/2″ x 1 1/2″ 6″ Fill Head	WPT3 1 1/2″ x 1 1/2″ 12″ Fill Head	WPT4 2″ x 2″ 12″ Fill Head	WPT5 3″ x 2″ 12″ Fill Head
5	2	1,064	1,850	1,310	2,320	4,270
10	5	1,049	1,824	1,760	3,740	6,230
10	2	1,200	2,087	2,350	5,640	9,450
25	15	1,026	1,784	2,700	4,690	7,230
25	10	1,151	2,002	3,020	5,970	9,370
25	5	1,257	2,186	3,780	6,850	11,400
50	40	877	1,525	2,090	3,410	5,040
50	25	1,115	1,939	3,620	6,650	10,200
50	10	1,286	2,237	4,080	7,140	11,500
75	60	882	1,533	2,250	3,730	5,660
75	40	1,102	1,916	3,470	6,010	8,770
75	15	1,298	2,257	4,390	7,920	12,400
100	80	884	1,538	2,620	4,390	6,140
100	60	1,058	1,841	3,390	5,780	8,120
100	40	1,192	2,074	4,310	6,940	10,000
100	15	1,331	2,314	4,620	8,000	12,300
125	115	737	1,281	2,280	3,490	4,440
125	100	886	1,541	2,880	4,420	5,720
125	80	1,030	1,792	3,520	5,700	7,630
125	60	1,146	1,992	4,110	6,880	9,390
125	40	1,243	2,161	4,910	7,800	11,100
125	15	1,351	2,350	5,120	8,420	12,900
150	120	-	-	2,560	3,640	5,100
150	100	-	-	3,020	4,610	6,270
150	80	-	-	3,630	5,780	8,140
150	60	-	-	4,230	6,910	9,920
150	40	-	-	4,830	7,930	11,700
150	15	-	-	5,230	8,590	13,300

PMPT & WPT Pump-Trap Combinations (Operating in **Trap** Mode)

TRAP CAPACITIES – *Condensate (lbs/hr)*

Differential Pressure (PSI)	PMPT	WPT3 & WPT4	WPT5
1/4	1,511	2,770	7,200
1/2	2,137	4,100	12,300
1	3,020	5,700	17,400
2	4,030	7,400	25,400
5	4,354	9,900	27,600
10	4,841	11,800	32,600
15	5,150	13,400	36,000
20	5,686	14,400	39,300
30	6,425	16,400	43,100
40	7,711	18,000	46,600
50	8,000	19,000	49,200
75	9,100	21,000	54,700
100	10,334	23,000	58,800
125	11,451	24,500	61,900
200	NA	29,200	74,000

Recommended Reservoir sizes for Pump-Trap Applications

RESERVOIR PIPE LENGTH in feet (ft)

Condensate Load (lbs/hr)	Reservoir Pipe Size (Diameter)				
	3″	4″	6″	8″	10″
0-500	2′				
1,000	2′				
1,500	3′	2′			
2,000	3.5′	2′	1′		
3,000		3′	2′		
4,000		4′	2′	1′	
5,000		6′	3′	2′	
6,000			3′	2′	
7,000			3′	2′	
8,000			4′	2′	
9,000			4.5′	3′	2′

Pump-Trap Sizing:

When the steam pressure in the heat exchanger is higher than the return line back pressure, the PUMP-TRAP functions like a standard float-operated TRAP, allowing the steam pressure in the heat exchanger to discharge the condensate. Under these conditions, the unit is in TRAP mode. When the steam pressure in the heat exchanger falls below the back pressure, the condensate backs up into the body of the pump-trap, raising the float and opening the motive steam inlet valve, which then pumps the condensate into the return line. Under these conditions, the unit is in PUMP mode. We therefore have two separate and distinct capacities; the **PUMP CAPACITY** (when operating in Pump Mode) and the **TRAP CAPACITY** (when operating in Trap Mode).

In the example below, the system will be analyzed to determine when the Pump-Trap is in Trap Mode and when it is in Pump Mode, and the specific capacity requirement of the pump. If the total back-pressure of the condensate return line is known, the Pump-Trap should be selected with sufficient pump capacity to handle the condensate load at the system stall point. (i.e.; when the steam pressure is equal to the total back-pressure). Alternatively, if the total back-pressure is not known, it is best to select a pump-trap with enough pump capacity to handle the maximum condensate load of the application. (i.e., at maximum steam pressure and flow). Refer to Sizing Charts.

Reservoir Sizing: (Refer to chart on previous page)
When using a Pump-Trap, a condensate holding reservoir should be installed above the pump-trap and below the heat exchanger (shown below). This will enable the condensate to collect while the pump is in the discharge cycle, thus preventing condensate backup. When back pressure against the pump outlet is less than 50% of the steam pressure to the heat exchanger, the pipe lengths given in the chart can be reduced by half.

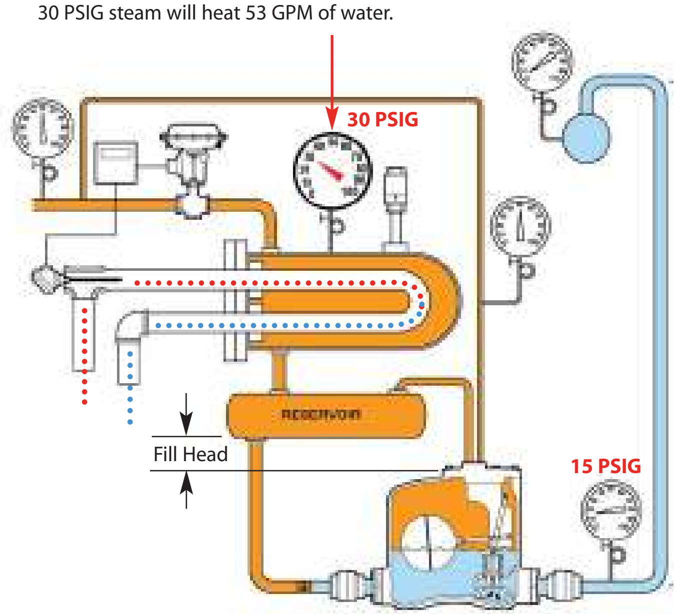
Heat Exchanger (HX) using Steam to heat Hot Water

The following example describes a Heat Exchanger (HX) using Steam to heat domestic hot water for a medium size apartment complex. Note that the hot water usage varies significantly depending on the time of day. The physical size of the heat exchanger needed (sq. ft. of surface area) is based on the following criteria: **(1)** MAXIMUM water usage (GPM), **(2)** the temperature rise of the water, and **(3)** what pressure steam will be used to heat the water during maximum demand.
Note: The selection of the steam pressure (which determines the steam temperature), to heat the water at maximum demand (flow rate), is the primary factor in heat exchanger sizing.

The application is requiring water to be heated from **45˚F** to **140˚F** in a HX using Steam. The maximum flow rate has been determined to be **60 GPM**. The Steam Trap will be discharging into a condensate return line that may have a Total Back Pressure of **15 PSIG** and the flow rate of heated water could be as low as **20 GPM**. The facility engineer has chosen to base the HX size on using **50 PSIG** of steam pressure. Therefore, the size of the heat exchanger was selected based on heating **60 GPM** of water using **50 PSIG** of steam.

TRAP Mode

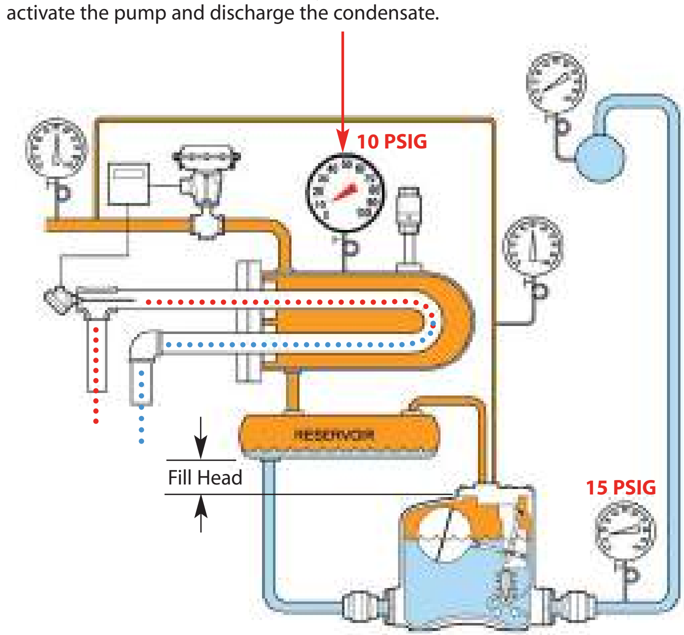
The system is operating with **30 PSIG** inlet pressure to the heat exchanger. The Pump-Trap unit functions like a standard float operated trap. Condensate is pushed thru into the return line by the steam pressure in the HX. Based on this particular size HX, 30 PSIG steam will heat 53 GPM of water.



ΔP Trap = 30 psig - 15 psig
= 15 psi

PUMP Mode

In response to a reduction in demand of hot water, the pressure in the HX has now dropped to **10 PSIG**. Based on this particular size HX, 10 PSIG steam will heat 43 GPM of water. Since back pressure is **15 PSIG**, the system is stalled and condensate backs up into the system; the float will continue to rise to activate the pump and discharge the condensate.



Summary of conditions for a Heat Exchanger (HX) using Steam to heat Water

Set of conditions used to size the Heat Exchanger:

1) Maximum Flow of Hot Water		=	**60 GPM**
2) Water temperature required	T_O	=	**140˚F**
3) Steam Pressure in Heat Exchanger		=	**50 PSIG**
4) Temperature of 50 PSIG Steam	T_S	=	**298˚F**
5) Inlet Water Temperature	T_i	=	**45˚F**
6) Temperature Rise of Water (140˚ F - 45˚F = 95˚ F)		=	**95˚F**

What is the Heat Transfer Rate (E) to heat 60 GPM of water from 45˚to 140˚F?

$$E\left[\frac{\text{Btu}}{\text{hr}}\right] = \textbf{Water Flow Rate } (\text{GPM}) \times \textbf{500} \times \textbf{Temp Rise } (^\circ\text{F})$$

$$= 60 \times 500 \times [140^\circ - 45^\circ\text{F}]$$

$$= \mathbf{2{,}850{,}000}\ \text{Btu/hr}$$

How much Steam Flow is required?

$$\mathbf{Q_s}\ (\text{steam}) = \frac{\mathbf{E}}{\mathbf{LH}}$$ (For 50 psi steam, the LH is 912 Btu/lb)

$$= \frac{2{,}850{,}000\ \text{Btu/hr}}{912\ \text{Btu/lb}}$$

$$= \mathbf{3{,}125}\ \text{lbs/hr}$$

$$\mathbf{E = U \times A \times \Delta T}$$ [Fundamental formula for heat transfer and the basic formula for HX sizing]

The formula shows that the heat transfer rate (**E**) between the hot steam and cold water is directly proportional to the Surface contact area (**A**) inside the HX and the difference in temperature between the steam and water (ΔT). The more surface area (larger HX) the more heat will get transferred or the hotter the steam temperature (higher pressure) the more heat will get transferred.

E = **Heat Transfer Rate** in Btu/hr of the energy in the steam to the water. The flow of steam (**Q_s**) required in lbs/hr is determined by dividing **E** by the Latent Heat of Steam (LH) in Btu/lb.

U = is referred to as the **Overall Heat Transfer Coefficient**. This depends on the HX type and the materials involved. Typical **U** values are 120 for Stainless Steel and 200 for Copper. We will use 120 for Stainless Steel HX.

A = The internal **Surface Area** (size) of the HX in Sq. Ft. The size of a HX is determined by the surface contact area between the Steam and Water.

ΔT = **Average Temperature Difference** between Steam & Water. Since the water temperature changes as it flows thru the HX, we need to use the average temperature difference between the steam temperature and the water temperature. See formula below:

Average Temperature Difference

$$\Delta T = \frac{(T_S - T_i) + (T_S - T_O)}{2}$$

$$= \frac{(298 - 45) + (298 - 140)}{2}$$

ΔT = **205˚F** = Avg Temp. Difference

Heat Exchanger Size

$$\mathbf{E = U \times A \times \Delta T}$$

Above formula is rearranged to solve for **A**:

$$A = \frac{E}{U \times \Delta T}$$

$$= \frac{2{,}850{,}000}{120 \times 205}$$

A = 116 (sq ft.)

The actual size of a Heat Exchanger depends on many factors; however, based on the criteria given, **116** sq. ft of surface area is required to heat 60 GPM of water from 45˚F to 140˚F, based on a steam pressure of 50 PSIG.

Stall Condition:

When the steam pressure in the HX is equal to the back pressure of **15 PSIG**, the condensate will no longer drain out of the HX. The Pump-Trap will now need to operate in Pump Mode to remove the condensate from the HX. We need to calculate how much condensate will be produced when there is **15 PSIG** in the HX.

$$\Delta T = \frac{(T_S - T_i) + (T_S - T_o)}{2}$$

$$= \frac{(250 - 45) + (250 - 140)}{2}$$

From the steam table, 15 PSIG steam has a temp of 250˚F

$$\Delta T = 157.5^\circ\ F = \text{Avg Temp. Difference}$$

To find out how much energy will be transferred to the water, we use the **ΔT** calculated above in our heat transfer equation.

$$E = U \times A \times \Delta T$$

$$= 120 \times 116 \times 157.5$$

$$= \mathbf{2{,}192{,}400}\ \text{Btu/hr}$$

To determine how much steam is required to heat the water, we use the following formula. (LH = Latent Heat.)

$$Q_s\ \text{lbs/hr} = \frac{E}{LH} = \frac{2{,}192{,}400}{946}$$

(For 15 psig steam, the LH is 946 Btu/lb)

Steam Flow = **2,318** lbs/hr

When the HX stalls, we will be using 2,318 lbs/hr of steam and will need to pump 2,318 lbs/hr of condensate. The pump-trap must be sized to handle this condensate load since it is the maximum load under stall conditions (see table below).

Table based on a HX size of 116 ft^2 and back pressure of 15 PSIG

The following table summarizes the above results and shows how the steam flow, pressure, temperature and latent heat vary as a function of the water flow rate. It can be seen that the system is operating in **Trap Mode** between water flow rates of 60 to ~46 GPM, and in **Pump Mode** between ~46 to 20 GPM (based on 15 PSIG back pressure). Also, at flow rates below 35 GPM, the steam pressure inside the HX is below atmospheric pressure (0 PSIG).

Flow Rate Water (GPM)	Steam Usage (lbs/hr)	Steam Pressure in HX (PSIG)	Steam Temp in HX (°F)	Latent Heat of Steam (Btu/lb)	Condensate Generated (lbs/hr)	Trap Differential Pressure (PSI)	System Condition	
60	**3,125**	**50**	**298**	**912**	**3,125**	**35**	Trap Mode	**(Maximum Heat Load)**
57.0	2,943	40	287	920	2,943	25		
53.2	2,720	30	274	929	2,720	15		
48.8	2,466	20	259	940	2,466	5		
46.2	**2,318**	**15**	**250**	**946**	**2,318**	**0**	(Stall Point)	**Steam Pressure = Back Pressure**
42.9	2,140	10	239	953	2,140	---	Pump Mode	
35.0	1,715	0	212	970	1,715	---		
29.2	1,409	-5	192	983	1,409	---	(Vacuum)	
20	**948**	**-10**	**161**	**1,002**	**948**	---		**(Minimum Heat Load)**

Watson McDaniel offers a full line of accessories for our Condensate Return Pumps and Pump Systems. If there is something you don't see, please call our factory and we will do our best to help you.

ASME CODE STAMP for Receiver Pump Tanks

Four standard condensate receiver sizes are available for Pressure Motive Pump Systems: 21, 48, 75 and 116 gallons. Custom receiver fabrication is available with Watson McDaniel's ASME-certified fabrication facility. ASME Code is Standard on 21, 48, 75 and 116 gallon receiver tanks and PMPF, PMPLS, PMPSS pump tanks.

ASME Code Stamp:	Model Code
for PMPC, PMPC & PMPNT Pump Tanks	Contact Factory

Cycle Counter

The Digital Cycle Counter option allows monitoring of pump cycles for the purpose of scheduling maintenance and repairs, as well as calculation of condensate flow through the pump (i.e. returned condensate). There are several options available depending on the PMP selected as well as the operating conditions. Therefore, proper selection is required to ensure proper function and operation. See below for selection, or consult factory for additional assistance.

- Pump Only (Open Loop), with pump back pressure 15 psig or above – Standard
- Pump Only (Open Loop), with pump back pressure below 15 psig – Low Pressure Option
- Pump-Trap (Closed Loop) – Special option required – consult factory.

Pump-traps (closed loop) can not use the pressure switch because the vent pressure will vary, so pressure differential can not be guaranteed.

Cycle Counter (fits all PMPs) Open Loop Systems Only	Model Code
Digital Cycle Counter	**1529100**
Digital Cycle Counter with auxiliary contacts	**1529102**
Low Pressure Cycle Counter with auxiliary contacts	**1529103**
Low Pressure Cycle Counter w/o auxiliary contacts	**1529104**
Closed Loop Cycle Counter	**2450300**

Gauge Glass

Pumps tanks are available with gauge glass to show condensate level inside the tank (bronze or stainless steel retainer).

Gauge Glass for:	Model Code
Standard Bronze Gauge Glass	
PMPC, PMPF, PMPLS (stand alone pumps)	**GAUGE GLASS-1**
PMPT (stand alone pump)	**GAUGE GLASS-PMPT**
PMPM (stand alone pump)	**GAUGE GLASS-PMPM**
21 Gallon Receiver Tank	**GAUGE GLASS-1**
48 Gallon Receiver Tank	**GAUGE GLASS-1**
75 Gallon Receiver Tank	**GAUGE GLASS-1**
116 Gallon Receiver Tank	Contact Factory
Stainless Steel Gauge Glass	
PMPSS (stand alone pump)	**GAUGE GLASS SS**
PMPT & PMPNT	Contact Factory
Options for Gauge Glass	
Auto Drain (self-drain) Stainless Steel Armored	**GAUGE GLASS-1A**
Reflex Gauge for PMPC, PMPF, PMPLS, 21 Gallon Receiver	**GAUGE GLASS-1HP**

Insulation Jacket

Insulation Jackets improve safety by protecting personnel from hot surfaces and conserve energy by reducing heat loss. Jackets have velcro closures for easy installation or removal and fit tightly around pump tanks and receivers.

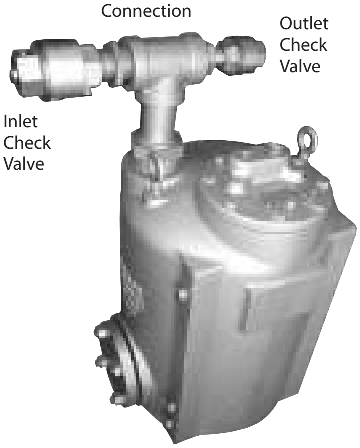
Insulation Cover

Insulation Cover for:		Model Code
PMPC	(Ductile Iron Pump)	**INSUL-CRV-PMPC**
PMPF	(Fabricated Steel Pump)	**INSUL-CRV-PMPF**
PMPLS	(Low-Profile Pump)	**INSUL-CRV-PMPLS**
PMPBP	(High Capacity Pump)	**INSUL-CRV-PMPBP**
PMPT & PMPNT	(Pump-Trap Combination or Pump)	**INSUL-CRV-PMPT**
PMPM	(Mini Pump)	**INSUL-CRV-PMPM**
21 Gallon Receiver		**INSUL-CRV-21**
48 Gallon Receiver		**INSUL-CRV-48**
75 Gallon Receiver		**INSUL-CRV-75**
116 Gallon Receiver		**INSUL-CRV-116**

"T-Bone" Connection

Outlet Check Valve

Inlet Check Valve



Vertical Discharge Pump

Vertical Discharge Pump with "T-Bone" connection allows inlet and outlet condensate hook-ups to be made above the pump. This is an advantage when space is limited around the base of the pump due to equipment or piping obstructions.

Vertical Discharge Pump	Model Code
T-Bone Connections available for Stand Alone Pump	**PMP-TBONE**

Check Valves - Stainless Steel

The **Inlet Check Valve** on PMP systems require a very low opening pressure (cracking pressure) so that the liquid will freely enter the pump tank. The proper check valve is critical to the operation of the PMP system. Watson McDaniel uses only Stainless Steel Check Valves with a maximum of ¼ PSI cracking pressure. (See Check Valves in Pipeline Accessories.)

Check Valves - NPT	Model Code
1/2"	**WSSCV-12-N-0**
3/4"	**WSSCV-13-N-0**
1"	**WSSCV-14-N-0**
11/4"	**WSSCV-15-N-0**
11/2"	**WSSCV-16-N-0**
11/2" (no closing spring)	**WSSCVQF-16-N-0**
2"	**WSSCV-17-N-0**
3"	**WSSCV-19-N-0**

Mechanism for Pump Tanks (with Patented "Snap-Assure" Feature)

The Patented "Snap-Assure" feature extends the useful life of the pump by assuring the internal mechanism toggles at every fill and discharge cycle. These mechanisms are simple and easy to replace, and are a cost-effective way to make your pump as good as new. They will also fit other manufacturers' pump tanks.

Mechanisms for:	Model Code
Complete Mechanism Assembly with Cover for:	
PMPF & PMPSP	**W-KIT-900-03**
PMPC & PMPLS	**W-KIT-910-03**
PMPBP	**W-KIT-900-01**
PMPM	**W-KIT-911-03**
PMPT	**W-KIT-912-03**
PMPNT	**W-KIT-914-03**
Rebuilt Mechanism* for:	
PMPF	**W-KIT-900-03R**
PMPC & PMPLS	**W-KIT-910-03R**
PMPT & PMPNT	**W-KIT-912-03R**

*** Note for Rebuilt Mechanisms:**
The exchange program is for mechanisms with two years of service or less. The old mechanism must be returned along with the order for the rebuilt mechanism. Orders without old mechanisms will be invoiced at the new mechanism price.

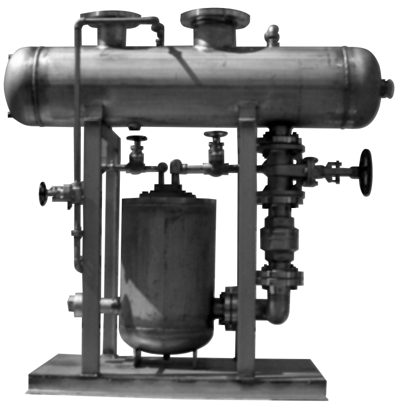
Pre-Piped PRV & Drip Leg

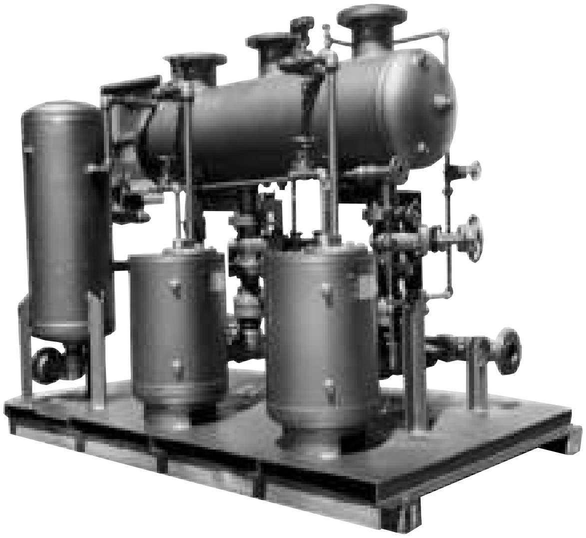
A fully-assembled Pre-piped PRV, Drip Leg, or PRV and Drip Leg Assembly guarantees proper installation of your PMP System. It assures that your skid package performs to optimum levels.

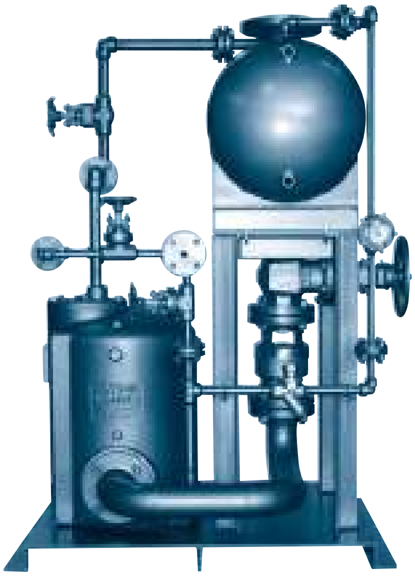
Pre-Piped Accessories	Model Code
Pre-piped Motive Line with Pressure Regulating Valve (PRV) for control of motive steam or air (drip trap not included – to be by others)	**PRV1**
Pre-piped Motive Line with Drip Leg Station and Steam Trap	**PRV2**
Pre-piped Motive Line with PRV, Drip Leg, and Steam Trap (PRV1 + PRV2)	**PRV3**
Pre-piped Exhaust Line	**PRV4**
Overflow J-pipe	Contact Factory
Pressure Gauge	Contact Factory
Drain Valve	Contact Factory

ASME Certified

Watson McDaniel's fully equipped ASME qualified fabrication facility stands ready to assist you with all of your fabrication needs. Our engineering staff specializes in the design of Pressure Motive Condensate Pumping Systems for both industrial and institutional applications. You can order either standard packages, available from stock, or specialized systems to meet your specific needs.





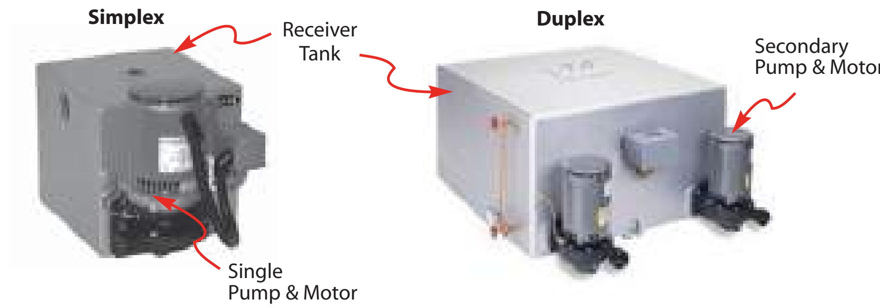


W4100, W4200 & W4300 Condensate Pumps

Watson McDaniel's **Condensate Return** and **Boiler Feed** Pumps are equipped with Cast Iron bodies and Bronze Impellers. The pump receiver tanks are available in either **Carbon Steel** (W4100), **Cast Iron** (W4200), or **Stainless Steel** (W4300) in Simplex or Duplex configurations.

Typical Condensate Pump Features

- Fabricated Steel Receivers (W4100), Cast Iron Receivers (W4200), Stainless Steel Receivers (W4300)
- Simplex and Duplex Packages
- Bronze Fitted Centrifugal Pumps
- Energy Efficient 3450 RPM motors
- Ceramic Pump Seal
- Heavy-duty Float Switch



Characteristics of Condensate Return Pumps Vs. Boiler Feed Pumps

Condensate Return Pumps

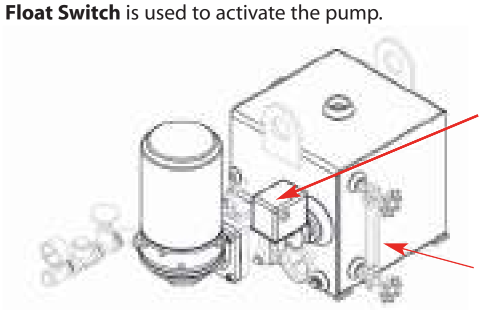
Used for returning condensate from the facility back to the boiler room. In Condensate Return applications, the operation of the pump is controlled by a **Float Switch** located on the receiver tank. The pump turns on when the receiver tank is full and shuts off when emptied. Duplex units contain a **Mechanical Alternator** float switch to alternate operation between the two pumps.

Boiler Feed Pumps

For Boiler Feed applications, the operation of the pump is controlled by the **water level control system** on the boiler. When the boiler requires water, the pump switches on pumping water from the receiver into the boiler. The receiver tank also contains an internal **make-up water valve** actuated by a stainless steel float. If the amount of condensate being returned to the receiver tank is inadequate, additional boiler feed water is automatically added to the receiver tank.

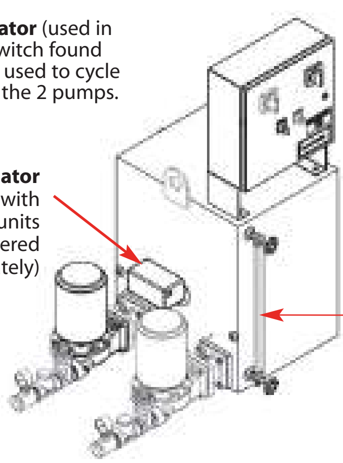
SIMPLEX

Float Switch is used to activate the pump.



DUPLEX

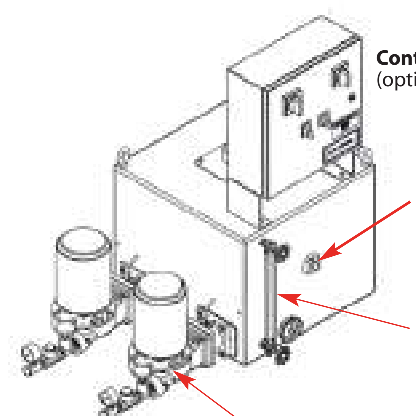
Mechanical Alternator (used in place of the Float Switch found on Simplex units) is used to cycle operation between the 2 pumps.



SIMPLEX & **DUPLEX**

Water Level Control System on boiler is used to activate the pump.

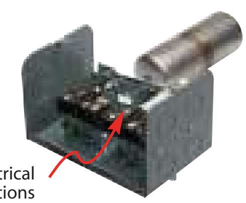
Automatic Make-up Water Valve is activated by a level float that adds additional boiler feed water to the receiver tank if required.



Simplex vs. Duplex Pump Operation:

A Simplex System contains a single pump and receiver tank. Duplex Systems contain two pumps on a common receiver tank allowing the second pump to serve as a back up in case of failure.

Mechanical Alternator/Float Switch
(must be ordered separately with Duplex units)



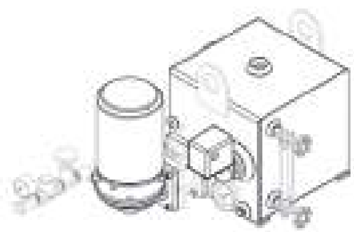
Electrical Connections

For **Duplex Condensate Return Pumps** the Float Switch is replaced with a Mechanical Alternator. The Mechanical Alternator is attached to a float and activates only one pump at a time in an alternating manner. The Mechanical Alternator switches power between the two motors so that the runtime of each pump is shared, allowing the system to continue operation in the event of a single pump failure.

Motors & Controls

Single-Phase motors

Single-phase motors supplied with these pumps have overload protection and therefore do not require ancillary motors starters. Single-phase motors can be wired directly to the Float Switch (for Simplex units) or the Mechanical Alternator (on Duplex units) and no control panel is required for installation.



3-Phase motors

3-Phase motors do not have overload protection and therefore require a separate **Motor Starter** to operate. A Motor Starter contains a set of Electrical Contactors with overload protection (OL) to protect the motor. The standard Float Switch or Mechanical Alternator/Float Switch is wired to the Motor Starter and closes the Contactors to start the pump. The OL device incorporated into the Motor Starter protects the motor from damage. A separate circuit breaker or fuse box is still required to protect the circuitry.

Typical Motor Starter

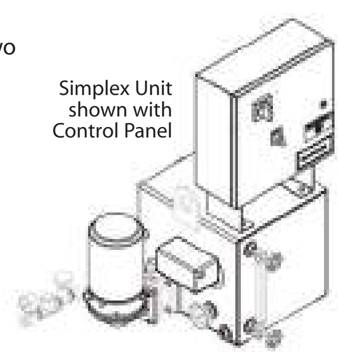
NEMA-12 Control Panel

For **Simplex** units, the control panel would include a single motor starter with a single **HOA** (Hand-Off-Automatic) selector switch to turn the pump on manually to verify functionality; or, to set in automatic mode along with a single Motor Circuit Protector switch to shut power off to the pump in case of overload. The purpose of the Motor Circuit Protector is to protect the wiring to the pump eliminating the need for a separate circuit breaker or fuse box.

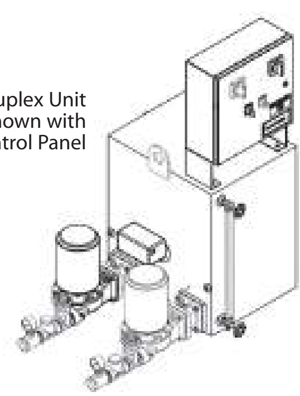
For **Duplex** systems, the control panel would include two motor starters, two HOA Switches and two Motor Circuit Protector switches.

NEMA-12 Control Panel

Simplex Unit shown with Control Panel



Duplex Unit shown with Control Panel

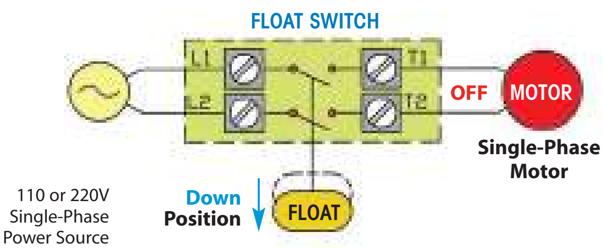


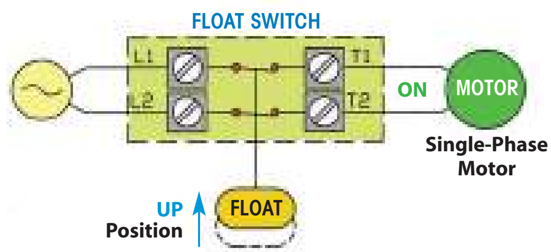
Float Switch for Simplex Condensate Return Units: Wiring Diagrams

The diagrams below show typical Single-phase & 3-phase wiring diagrams for the float switch used on Simplex Condensate Return Units. The Float Switch can be used to turn on a Single-phase motor directly or to activate a **Motor Starter**. A Motor Starter is required to operate 3-phase motors.

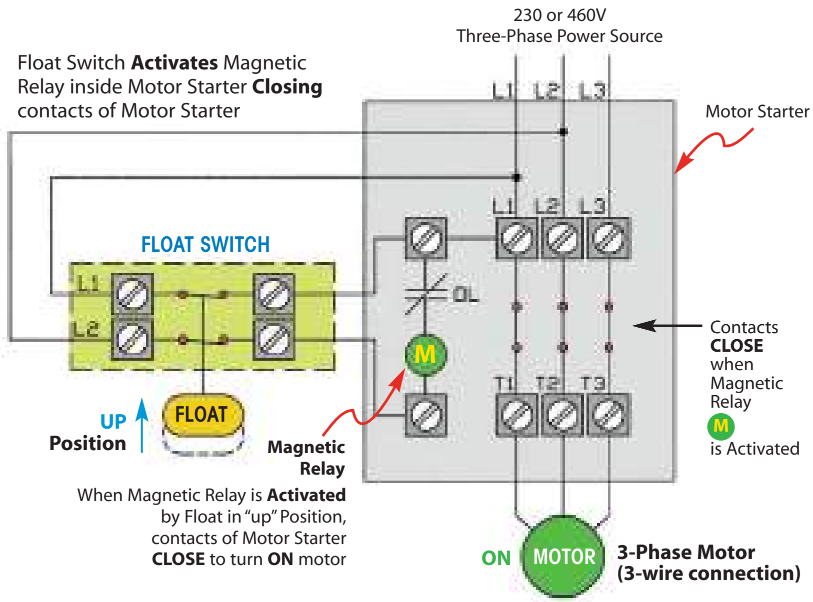
Float Switch for Simplex Pumps

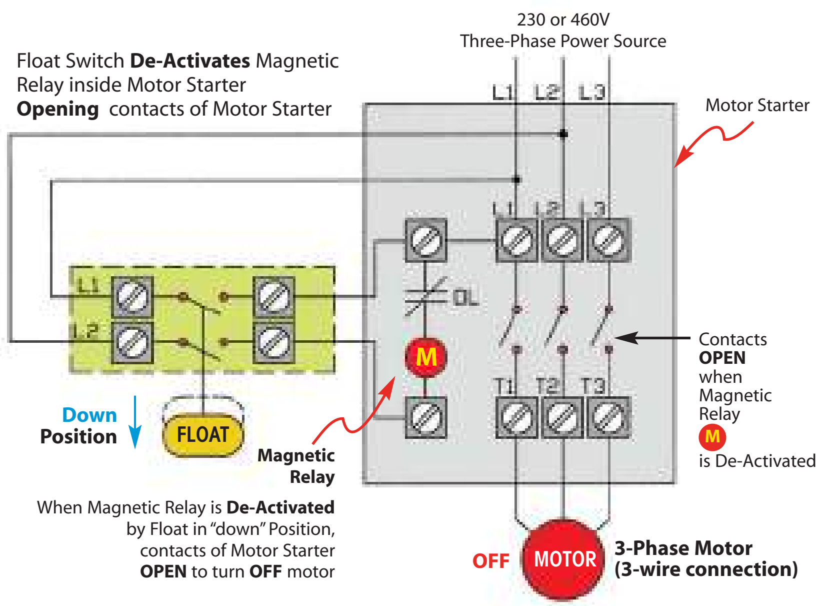
Float Switch Wired Directly to a Single-Phase Motor

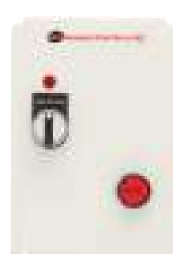


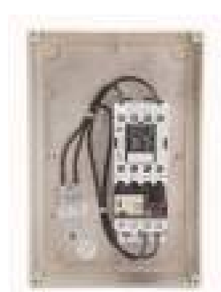


Float Switch Turning on a 3-Phase Motor Using a Motor Starter







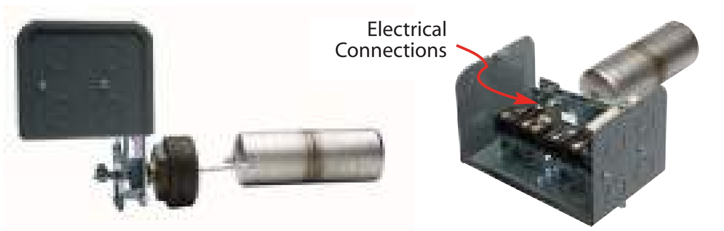


NEMA 1 Control Panel Motor Starter for Simplex Pumps

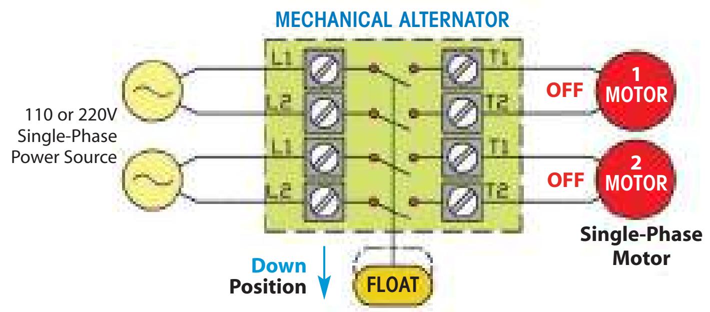
Introduction

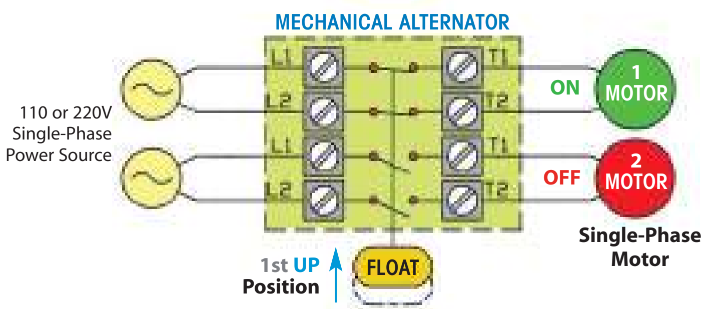
Mechanical Alternator for Duplex units: Wiring Diagrams

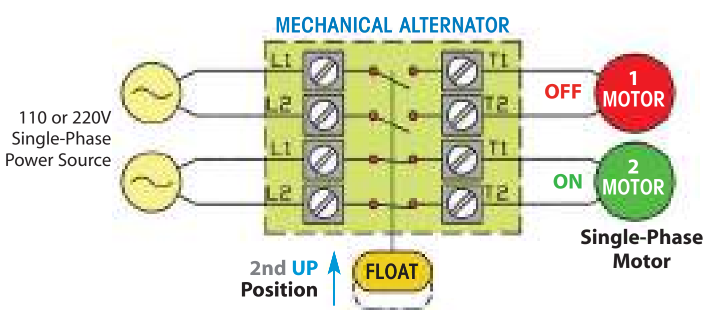
The diagrams below show a Mechanical Alternator operating two separate Single-Phase Motors required to operate a Duplex Pump System. The Mechanical Alternator can also be used to operate two separate Motor Starters which in turn would be used to operate two separate 3-phase motors.

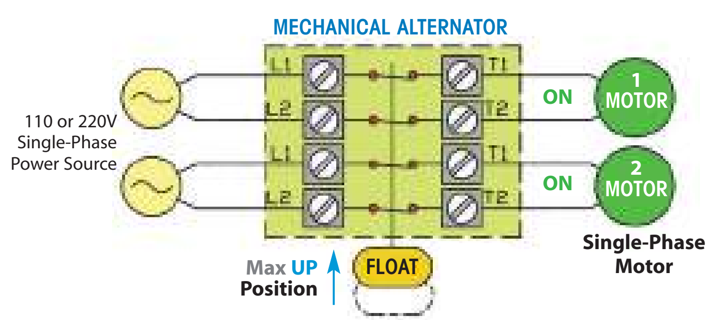


Mechanical Alternator Operating Two Single-Phase Motors



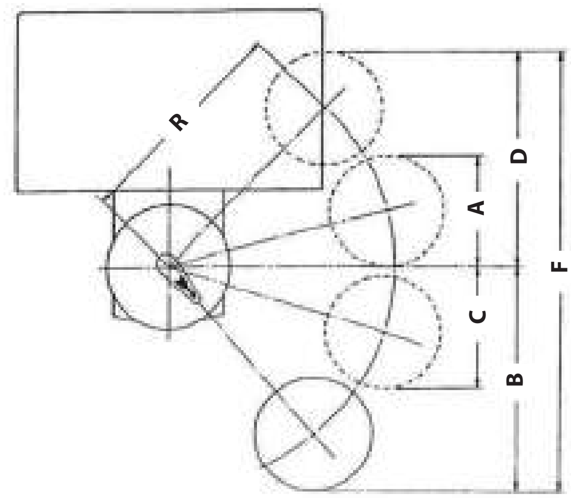






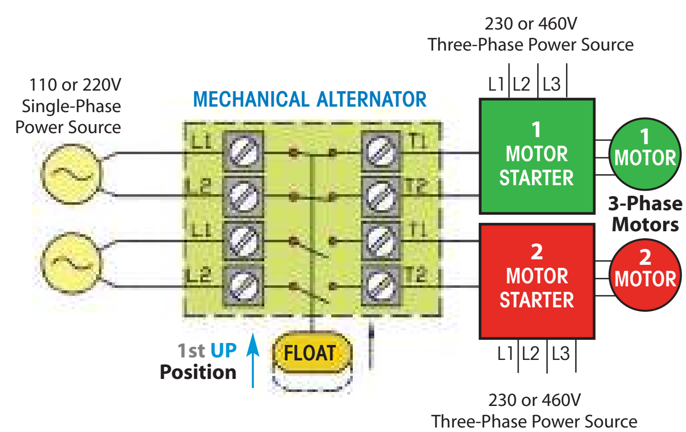
Explanation of Float Travel Position On Mechanical Alternator

Normal Operation: Switches will cut in and cut out at the high point of distance A + B given in the Figure below. Under normal conditions, as long as one pump alone is able to handle the incoming water, the pumps will alternate at this distance. With the water level continuing to rise, the second switch will cut in and start the second pump, when the float reaches the top of distance D. Both pumps will continue to run until the float returns to the lower point of distance D + C, where one pump will cut out. The other pump will continue until the float reaches the low point of distance B.



Mechanical Alternator Operating Two 3-Phase Motors

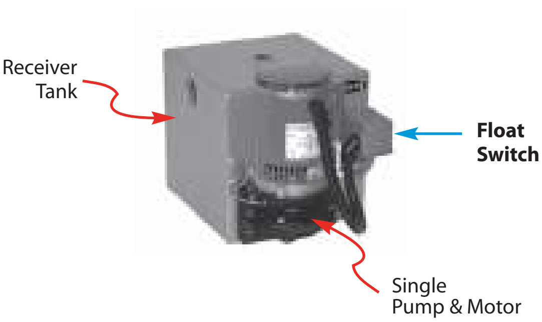
The Mechanical Alternator can also be used to operate two separate Motor Starters which in turn would be used to operate two separate 3-phase motors. Schematic shows **Motor Starter 1** activated which will turn on the 1st motor.



Operation of CONDENSATE RETURN Pumps

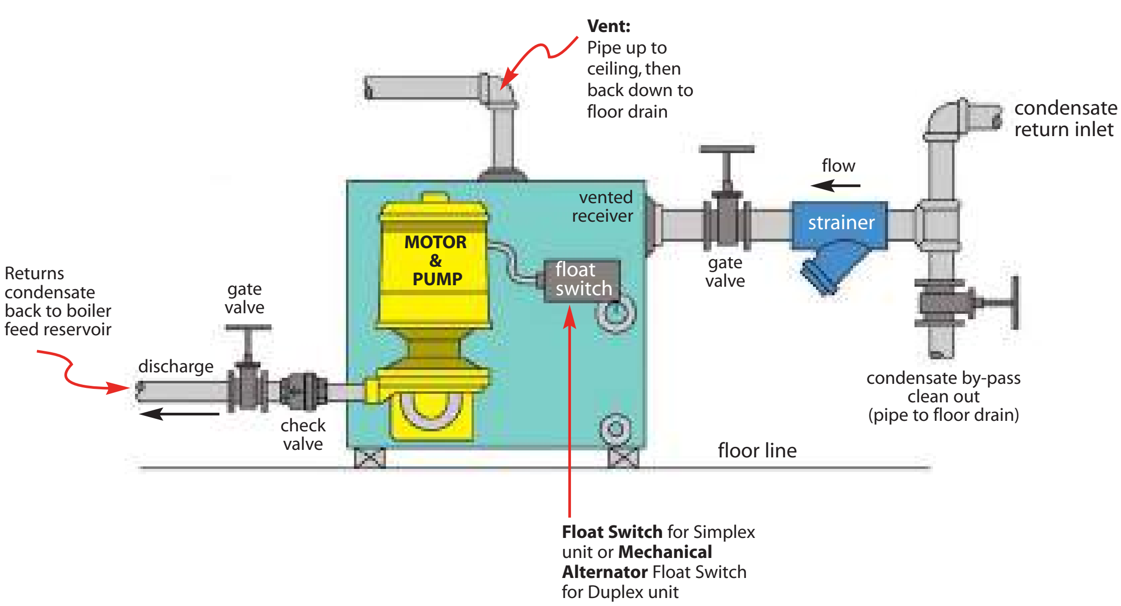
Condensate Return Pumps are designed to operate intermittently, discharging condensate only when the receiver tank is full. This is accomplished with a float switch that energizes the pump when the float rises above a set point. Once started, the pump will continue to operate until the water level drops below the bottom set position of the float switch. On Duplex condensate return pumps, a Mechanical Alternator float switch is mounted to the receiver so that both pumps are used in an alternating manner.

Simplex Unit



Duplex Unit

Condensate Return Pump Piping Diagram



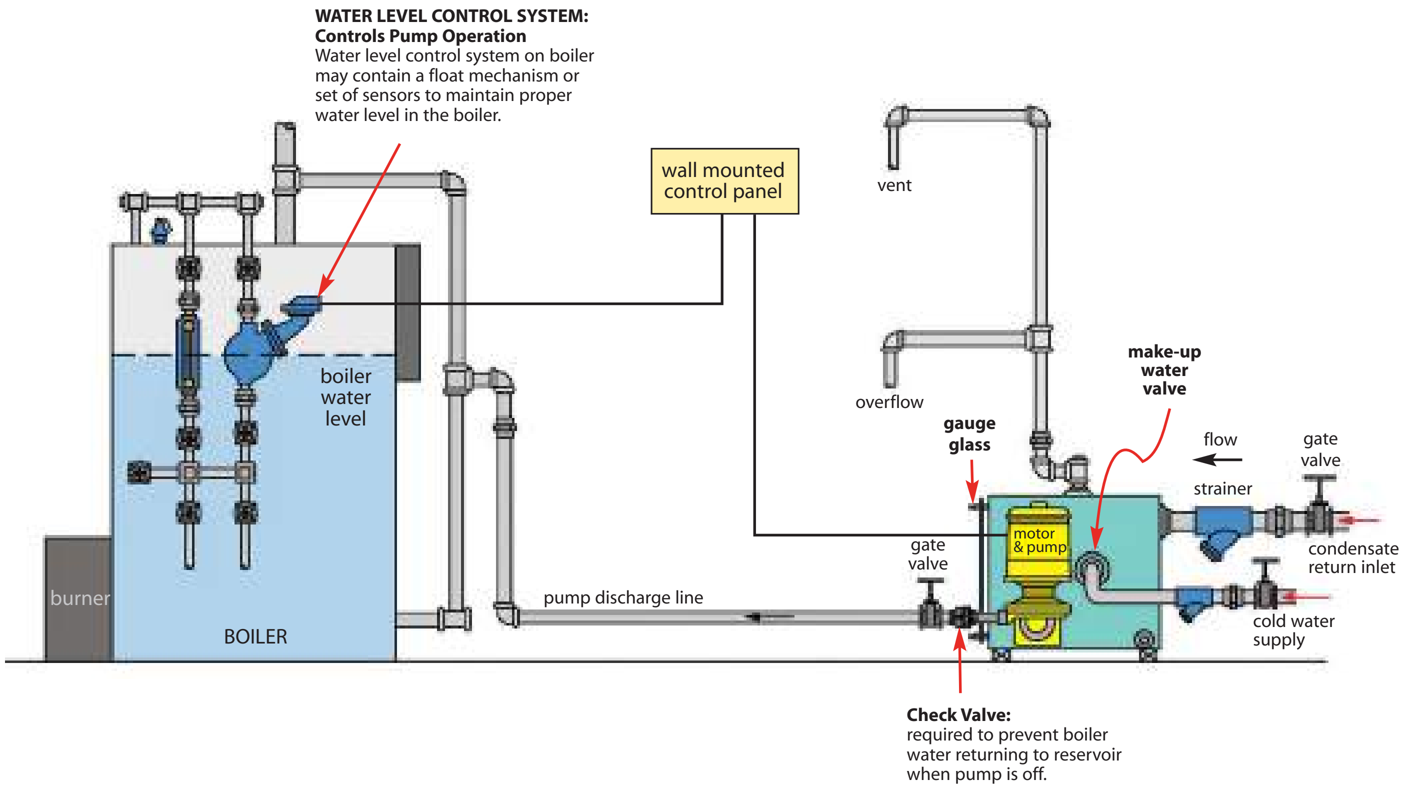
Operation of BOILER FEED Pumps

For Boiler Feed applications, the operation of the pump is controlled by the **water level control system** on the boiler. When the boiler requires water, the pump switches on pumping water from the receiver into the boiler. The receiver tank also contains an internal **make-up water valve** actuated by a stainless steel float. If the amount of condensate being returned to the receiver tank is inadequate to supply the boiler, additional make-up water is added to the receiver tank. This condition may occur when more steam is being produced than condensate being returned; common at system start-up.

An overflow pipe is used to dump excess condensate to drain during times when less boiler feed water is required than the amount of condensate being returned. Larger boiler feed tanks may be advantageous to keep systems in balance.

Duplex Boiler Feed Unit

Boiler Feed Pump Piping Diagram



What is required to choose and install an Electric Pump?

Selecting a Condensate Return Pump:

- A **Condensate Return Pump** contains an automatic float switch in the receiver tank to activate the pump when the tank is filled and deactivate when empty.
- On Duplex units, the standard float switch is replaced with a Mechanical Alternator float switch to alternate operation between the two pumps. Must be ordered separately. An Electric Alternator is also an option.
- The capacity of the condensate return pump in Gallons Per Minute (GPM) is based on the amount of Effective Direct Radiation (EDR) in sq ft. of heating surface in the facility that the pump is expected to handle.

  For Example: an EDR of 2000 sq. ft. can condense up to 500 lbs/hr of steam which translates to 1.0 GPM of condensate flow. Using a 3:1 safety factor would require a 3.0 GPM Condensate Return pump. The properly sized receiver tank that is adequate for that pump capacity is shown in the model selection chart for **Condensate Return** units. Larger receiver sizes are always desireable in order to cool condensate.
- Select a discharge pressure for the pump to overcome all system back pressures including frictional piping losses. Pump discharge pressures of 20-50 PSI are available. Selecting a pump with a significantly higher discharge pressure than required can cause pump to cavitate.

Selecting a Boiler Feed Pump:

- For a **Boiler Feed Pump**, the operation of the pump is controlled by the **water level control system** on the boiler. When the boiler requires water, the pump switches on pumping water from the receiver into the boiler. The receiver tank also contains an internal **make-up water valve** actuated by a stainless steel float. This is used if the amount of condensate being returned to the receiver tank is inadequate.
- On Duplex boiler feed pumps, an Electric Alternator is required to cycle operation between the two pumps.
- The capacity of the boiler feed pump in Gallons Per Minute (GPM) is based on the Boiler horsepower (hp).

  For Example: A 15 horsepower boiler will produce up to 500 lbs/hr of steam when running at maximum load which translates to requiring 1.0 GPM of water make-up to the boiler. Using a 3:1 safety factor would require a 3.0 GPM Boiler Feed pump. The recommended receiver sizes based on boiler horsepower are shown in selection chart.
- Select a discharge pressure for the pump to overcome boiler pressure and all system back pressure including frictional piping losses. Pump discharge pressures of 20-50 PSI are available.

General Information:
Applies to both Condensate Return & Boiler Feed Pumps

1) **Select the model** with the appropriate sized receiver and pump discharge pressure. 4100-Series Carbon Steel tank, 4200-Series – Cast Iron tank or 4300-Series – Stainless Steel tank.

   Safety factors and proper operating conditions: Pumps have a 3:1 safety factor. The 3:1 safety factor for Condensate Return pumps is based on the maximum condensate that can be produced by the EDR (Effective Direct Radiation) in square feet. For Boiler Feed pumps, the 3:1 safety factor is based on the maximum amount of water that would be required by the boiler (based on Boiler hp). Therefore, when the system is operating at maximum capacity, the pump will operate only one third of the time. Please note: these pumps as configured are not recommended for pumping condensate above 190° F.

2) **Motor hp** required for any given pump model is listed in the selection chart. For motor sizes below 1 hp, it is most common to choose single phase motors; (1Ph either 110 or 220 Volts). Single-phase motors (available up to 2 hp) have inherent overload protection (OL) and can therefore be wired directly to the float switch or Mechanical Alternator. This is the simplest method of control and does not require any additional electrical hardware. Since 3-Phase motors do not have inherent OL protection, they require a separate Motor Starter. Motor starters can be purchased separately from an electrical supply house or ordered separately with pump unit. Reference our NEMA 1 or NEMA 12 Control Panels with Motor Starter.

3) **Duplex pump units** require the addition of a mechanical or electrical **Alternator** which activates one pump at a time in alternating fashion. Condensate Return pumps most commonly use a Mechanical Alternator in place of the standard float switch and must be ordered separately. Refer to Model **MECH-ALT-N1**. For duplex Boiler Feed pumps, the **Electric Alternator** option on the NEMA-12 Control Panel (suffix code E) must be chosen. An Electric Alternator can also be used with Condensate Return pumps; however, an additional 2-level float switch is required (2-level float switch is Not required on boiler feed units).

W4100, W4200 & W4300

Electric Pump

Model	W4100	W4200	W4300
Connections	NPT	NPT	NPT
Tank Material	Carbon Steel	Cast Iron	Stainless Steel
Max Disch. Press.	50 PSIG	50 PSIG	50 PSIG
TMO/TMA	190˚F	190˚F	190˚F
Options	Mechanical & electrical alternators; gauge glass; thermometer; discharge pressure gauges; isolation valves; magnetic starters; 1750 RPM motors; control panels; oversized or stainless steel receivers; high temperature components		

Typical Applications

Used for general condensate return or for boiler feed applications. Available in Simplex or Duplex configurations with several different receiver sizes available.

How It Works

For Condensate Return Applications:

The float, which is connected to the switch assembly, rises when condensate enters the receiver tank. When the float rises above its set point, it energizes the motor on the pump. Once started, the pump will continue to run until the water level drops below the bottom position of the float switch.There it will de-energize the motor to shut off the pump. This cycle repeats as condensate begins to fill the receiver tank. On duplex systems the float switch is replaced with a Mechanical Alternator-Switch connected to a float. The Mechanical Alternator cycles use between the two pumps, allowing only one pump to run at a time under normal conditions. If the condensate reaches a high water level, both pumps will be activated.

For Boiler Feed Applications:

For Boiler Feed units, the operation of the pump is controlled by the water level control device which is part of the boiler control package. When the boiler requires water, the pump switches on pumping water from the receiver into the boiler. On Duplex boiler feed units, an Electrical Alternator is used to activate one pump at a time in alternating fashion. The receiver tank also contains an internal make-up water valve actuated by a stainless steel float. This is used if the amount of condensate being returned to the receiver tank is inadequate.

Sample Specifications

Pump(s) shall be of the centrifugal type with 2-piece closed bronze impeller, cast iron housing and stainless steel motor shaft. A flat perforated brass strainer shall be provided in the inlet of the pump.

Installation

Place on an elevated, level and substantial foundation in a clean, dry and accessible area. Locate receiver tank inlet below lowest point of the condensate return lines.

Features

- Fabricated steel receivers (W4100), Cast Iron (W4200), Stainless Steel (W4300)
- Simplex and duplex packages
- Bronze-fitted centrifugal pumps
- Energy-efficient 3450 RPM motors
- Automatic venting of mechanical seal
- Ceramic pump seal with carbon face
- Heavy-duty float switch
- All steel and iron receivers over 24 gallons include a threaded NPT overflow port

Options

- Mechanical and Electrical Alternators
- Gauge Glass
- Thermometers
- Discharge Pressure Gauges
- Isolation valves
- Magnetic Starters with HOA Selector Switch
- 1750 RPM Motors
- Larger pumping capacities & higher discharge pressures
- Wide variety of control panels
- Oversized Receivers (45, 60 & 95 gallons)
- Stainless Steel Receivers
- High Temperature (250˚F) Components

How to Order an Electric Condensate Return or Boiler Feed Pump

Ordering Guidelines:

1) Decide on appropriate Receiver tank material for the application; W4100-Series with Steel Receiver tanks, W4200-Series with Cast Iron Receiver tanks or W4300 with Stainless Steel Receiver tanks.

2) Based on the particular application the **model selection charts** are separated on adjoining pages into either Boiler Feed or Condensate Return units. The proper pump model/size in GPM (gallons per minute) to suit the application and recommended receiver size for a Boiler Feed application is based on boiler size measured in Boiler Horsepower. The proper pump model size in GPM and recommended receiver size for a Condensate Return application is based on the Effective Direct Radiation (EDR) in square feet of the heating surfaces throughout the facility that the pump is expected to handle.

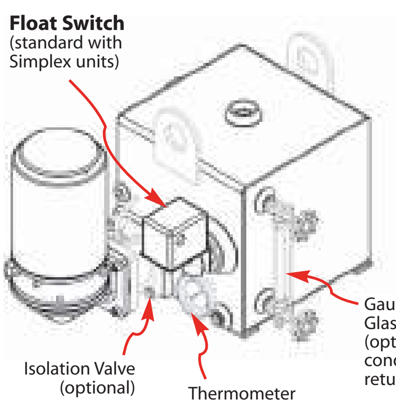
3) Select a pump discharge pressure that will exceed system back pressure, friction loss in piping and pressure in the boiler (in the case of a boiler feed pump). Selecting a pump with a significantly higher discharge pressure than required can cause pump to cavitate.

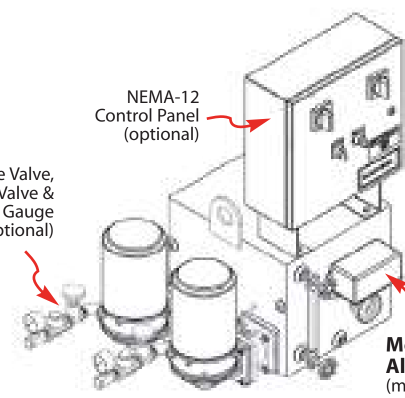
4) Decide if a Simplex (Single pump) unit is adequate or a Duplex (two pump) unit would be more appropriate in terms of system reliability and redundancy in the event of a pump failure.

5) Select Motor Phase and Voltage (reference chart). For smaller units under $1^{1}/_{2}$ hp Single phase motors may be desirable because of ease of installation. For units in excess of $1^{1}/_{2}$ hp, the more efficient and robust 3-phase motors are recommended.

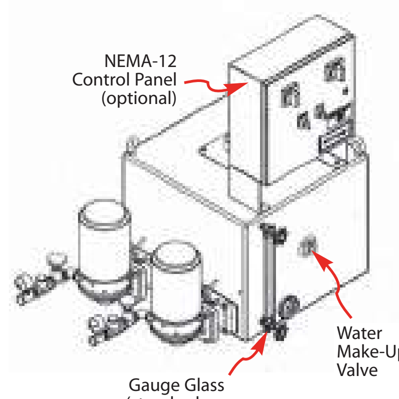
Example Model Code: **W4142JD-3P230** (Pump Unit)	Duplex Condensate Return Pump, 3 GPM flow rate & 40 PSI discharge pressure & 15 gallon receiver, 1hp, 230 VAC, 60Hz, 3-Phase motor.
Example Model Code: **MECH-ALT-N1** (Mechanical Alternator)	Note: Since a Duplex pump was chosen, a Mechanical Alternator must be purchased separately to replace the standard Float Switch.

Condensate Return





Boiler Feed



Phase & Voltage Codes for Standard 60/50 Hz Motors

Motor Phase & Voltage		60 Hz Motor Code	50 Hz Motor Code
Single Phase	115 VAC	**1P115**	**1P115E**
	208 VAC	**1P208**	**1P208E**
	230 VAC	**1P230**	**1P230E**
Three Phase	208 VAC	**3P208**	**3P208E**
	230 VAC	**3P230**	**3P230E**
	460 VAC	**3P460**	**3P460E**
	575 VAC	**3P575**	**3P575E**

Codes for Specialty Motors (add as a Suffix)

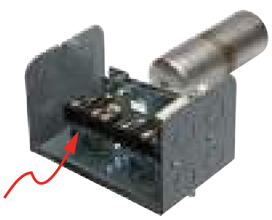
Option	Suffix Code
Totally Enclosed Fan Cooled (1/2 to 3 hp)	**TEFC**
Explosion Proof – 1/2, 3/4, 1 hp	**EP1**
Explosion Proof – $1^{1}/_{2}$ & 2 hp	**EP2**
Explosion Proof – 3 hp	**EP3**

How to Order an Electric Condensate Return or Boiler Feed Pump

Condensate Return			Boiler Feed
			
Simplex Cast Iron Tank	**Duplex** Cast Iron Tank	**Duplex** Stainless Steel Tank	**Duplex** Cast Iron Tank

Mechanical Alternator For Duplex Condensate Return Pump Only

Replaces the standard float switch on Duplex Condensate Return Units. Must be ordered separately.



Electrical Connections

On Duplex units, the standard float switch is replaced with a Mechanical Alternator float switch to alternate operation between the two pumps. Must be ordered separately. An Electric Alternator is also an option.

For Duplex Pumps must choose either:
A Mechanical Alternator or 2-Level Float Switch with the Electric Alternator Option on NEMA-12 Control Panel

Mechanical Alternator & Float Switches	Model Code
Mechanical Alternator - NEMA 1 (replaces Float Switch on Duplex pumps)	**MECH-ALT-N1**
Mechanical Alternator - NEMA 4 (replaces Float Switch on Duplex)	**MECH-ALT-N4**
Mechanical Alternator - Explosion Proof (replaces Float Switch on Duplex)	**MECH-ALT-EP**
2-Level Float Switch – (required when using an Electrical Alternator - Reference NEMA-12 Control Panel)*	**FLOAT-SWITCH-2L**
(Option) High-Level Auxiliary Contacts for Mechanical Alternator	**CONTACTS-HLA**

* 2-level float switch not required with Duplex Boiler Feed Units

Accessory Items

Condensate Return Pumps (ordered separately)

For **SIMPLEX** and **DUPLEX** pumps	Model Code
Gauge Glass for Steel Tank	**GAUGE-GLASS-ST**
Gauge Glass for Cast Iron Tank	**GAUGE-GLASS-CI**
Isolation Valve	**ISO-VALVE**
Dial Thermometer	**DIAL-THERM**
Discharge Pressure Gauge	**PRESS-GAUGE-D**
Discharge Check Valve	**CHECK VALVE-D**
Float Switch - NEMA 4 (for Simplex Unit)	**FLOAT-SWITCH-N4**
Float Switch - Explosion Proof (for Simplex Unit)	**FLOAT-SWITCH-EP**

Boiler Feel Pumps (ordered separately)

For **SIMPLEX** and **DUPLEX** pumps	Model Code
Isolation Valve	**ISO-VALVE**
Dial Thermometer	**DIAL-THERM**
Discharge Pressure Gauge	**PRESS-GAUGE-D**
Discharge Check Valve	**CHECK VALVE-D**

Gauge glass is standard on boiler feed pumps.

Isolation Valve
Allows pump and motor to be removed without draining condensate.

Motor Control Panel

NEMA 12 - Control Panel (for **Duplex** & **Simplex** Pumps)

Purchasing the optional motor control panel is a convenient and simple method of hooking up your pump.

For **Simplex** units, the control panel would include a single motor starter with a single HOA (HAND-OFF-AUTOMATIC) selector switch to turn the pump on manually to verify functionality; or, to set in automatic mode along with a single Motor Circuit Protector switch to shut power off to the pump.

For **Duplex** systems, the control panel would include two motor starters with two HOA (HAND-OFF-AUTOMATIC) selector switches to turn either of the two pumps on manually to verify functionality, or to set in automatic mode along with two separate Motor Circuit Protector switches to shut power off to either of the two pumps.

An Electric Alternator option can be used to replace the standard Mechanical Alternator; this option uses electronic logic as opposed to a mechanical device to cycle operation between the two pumps. If an Electrical Alternator is chosen, the Mechanical Alternator is replaced with a 2-level float switch (suffix code E).

Other Options, such as Pilot Light indicating when the pump is running or High Level Alarm Horn & Light indicating a flood system condition, can be added.

Control Panel Model Codes

Standard CONTROL PANEL	Simplex Model Code	Duplex Model Code
1/3 thru 5 Horsepower	**CPN12-P1-S**	**CPN12-P1-D**
Over 5 Horsepower	**CPN12-P2-S**	**CPN12-P2-D**

Standard Control Panel Includes:

- Motor Circuit Protector(s)
- HOA Selector Switch(s)
- External Reset(s)

Control Panel Options

Options	Suffix Code
UL Certification	**UL**
Pilot Light (Power On) (1 required per pump)	**P**
Test Push Button (1 required per pump)	**T**
Electric Alternator (for Duplex)* (2-Level Float Switch is required with Electric Alternator)	**E**
High-Level Alarm Horn & Light with Silencing Switch	**HA**
All of the Above Options	**AO**

Note: Standard Voltages are: 1-phase/60 Hz/115, 208, 230 VAC and 3-phase/60Hz/208, 230, 460, 575 VAC.

For non-standard voltages; consult factory.

* 2-Level Float Switch is required with Electric Alternator for Condensate Pumps Only; Not required for Boiler Feed Units.

Pilot Light
Indicates when a pump is running;
Simplex - One light; Duplex - Two Lights.

Test Push Button
Used to test if pilot light is functional. Press to test.

Electric Alternator
Uses electronic logic to alternate operation between two pumps. This option is required for Duplex Boiler Feed systems.

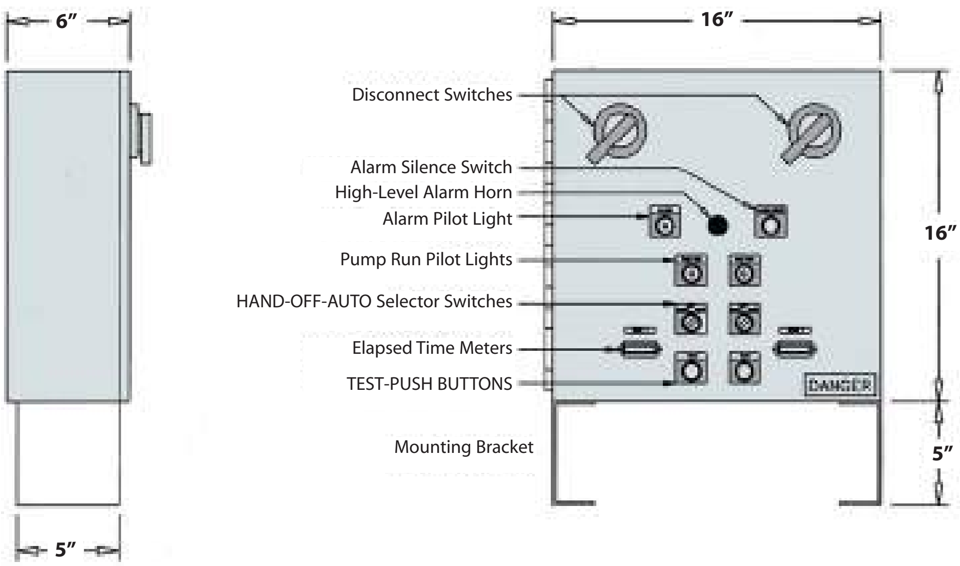
For Condensate Return Systems: if an Electric Alternator is chosen instead of the Mechanical Alternator, a 2-Level Float Switch is required. (See Accessories - Electric Alternator Option. Model: **FLOAT-SWITCH-2L**)

High-Level Alarm
Alarm to indicate if maximum water level is exceeded.

Example Model Codes:
1) **CPN12-P1-S** (Control Panel, NEMA 12, 1/3 thru 5 hp, Simplex, no options)
2) **CPN12-P1-S-UL** (Control Panel, NEMA 12, 1/3 thru 5 hp, Simplex with UL Certification)
3) **CPN12-P2-D-E** (Control Panel, NEMA 12, over 5 Hp, Duplex, with Electric Alternator)

Motor Control Panel

NEMA 12 - Control Panel (for **Duplex** & **Simplex** Pumps)



NEMA 1 - Control Panel (for **Simplex** Pumps Only)

For Simplex units, the NEMA 1 Control Panel will include a single motor starter with a **HOA** (HAND-OFF-AUTOMATIC) selector switch to turn the pump on manually, or to set in automatic mode. A single Motor Circuit Protector switch shuts the power off to the pump when an overload (OL) condition is detected.

- Magnetic across-the-line motor starter *
- Thermal overload and Hand-Off-Automatic (HOA) selector switch
- Optional Pilot Light

* Allows for remote start-up with full line voltage across the motor terminals.

Phase	Power	Voltage	Model Code
Single Phase	Up to 1 HP	115 VAC	**MSN1-1P-1-115**
	Up to 2 HP	230 VAC	**MSN1-1P-2-230**
	Up to 2 HP	115 VAC	**MSN1-1P-2-115**
	Up to 3 HP	230 VAC	**MSN1-1P-3-230**
Three Phase	Up to 3 HP	230 VAC	**MSN1-3P-3-230**
	Up to 2 HP	460 VAC	**MSN1-3P-2-460**
	Up to 7.5 HP	230 VAC	**MSN1-3P-7-230**
	Up to 5 HP	460 VAC	**MSN1-3P-5-460**
Option	Pilot Light		(Suffix Code) **P**

Example Model Codes:
1) **MSN1-1P-1-115** (Motor Starter, NEMA 1, single-phase, 1 HP, 115 VAC)
2) **MSN1-3P-3-230-P** (Motor Starter, NEMA 1, three-phase, 3 HP, 230 VAC with Pilot light)

Boiler Feed Pumps Steel Receivers (G & J Series Pumps)

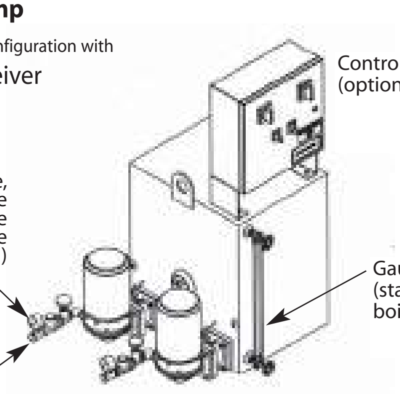
G (**20 PSI** Max Discharge Pressure) / **J** (up to **50 PSI** Max Discharge Pressure)

CAPACITIES

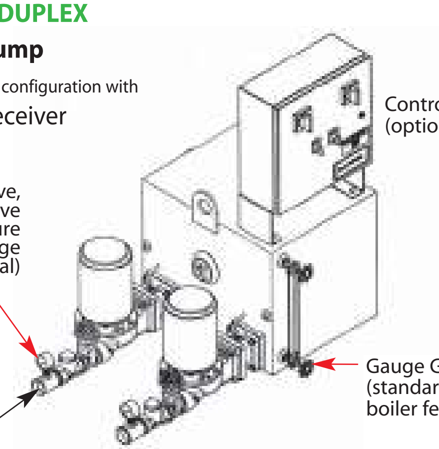
Boiler Horsepower	Discharge Pressure (PSIG)	Flow Rate (GPM)	Motor Horsepower	Receiver Capacity (gallons)	Simplex Model #	Pump Series	Weight (lbs)	Duplex Model #	Weight (lbs)
15	20	3	1/3	30	**W4122GF**	G	200	**W4122GDF**	240
	30		1/2		**W4132JF**	J	260	**W4132JDF**	300
	40		1		**W4142JF**	J	265	**W4142DF**	310
	50		2		**W4152JF**	J	275	**W4152JDF**	330
30	20	6	1/3	30	**W4124GF**	G	200	**W4124GDF**	240
	30		1/2		**W4134JF**	J	260	**W4134JDF**	300
	40		1		**W4144JF**	J	265	**W4144DF**	310
	50		2		**W4154JF**	J	275	**W4154JDF**	330
45	20	9	1/3	45	**W4126GF**	G	240	**W4126GDF**	280
	30		1/2		**W4136JF**	J	300	**W4136JDF**	340
	40		1		**W4146JF**	J	305	**W4146DF**	350
	50		2		**W4156JF**	J	315	**W4156JDF**	370
60	20	12	1/3	60	**W4128GF**	G	275	**W4128GDF**	335
	30		1/2		**W4138JF**	J	335	**W4138JDF**	395
	40		1		**W4148JF**	J	340	**W4148DF**	405
	50		2		**W4158JF**	J	350	**W4158JDF**	425

Typical 4100-Series BOILER FEED Pumps (available in Simplex & Duplex with 30, 45 & 60 Gallon Receivers)

SIMPLEX & DUPLEX
G Series Pump
Shown in Duplex configuration with
45 Gallon Receiver

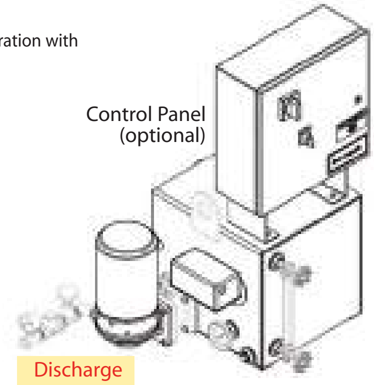


SIMPLEX & DUPLEX
J Series Pump
Shown in Duplex configuration with
30 Gallon Receiver

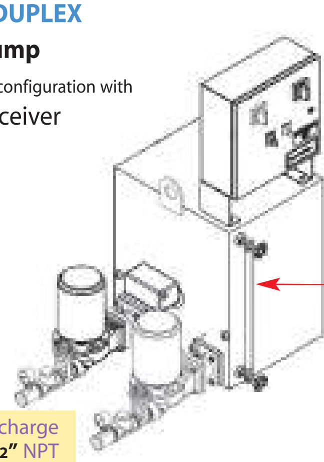


Typical 4100-Series CONDENSATE RETURN Pumps

SIMPLEX & DUPLEX
G Series Pump
Shown in Simplex configuration with
15 Gallon Receiver



SIMPLEX & DUPLEX
J Series Pump
Shown in Duplex configuration with
45 Gallon Receiver



ELECTRIC PUMPS

Condensate Return Pumps Steel Receivers (G & J Series Pumps)

G (**20 PSI** Max Discharge Pressure) / **J** (up to **50 PSI** Max Discharge Pressure)

CAPACITIES

EDR	Discharge Pressure (PSIG)	Flow Rate (GPM)	Motor HP	Receiver Capacity (gallons)	Simplex Model #	Weight (lbs)	Duplex Model #	Weight (lbs)
2000	20	3	1/3	15	W4122G	125	W4122GD	185
4000	20	6	1/3	15	W4124G	125	W4124GD	185
6000	20	9	1/3	15	W4126G	125	W4126GD	185
8000	20	12	1/3	15	W4128G	125	W4128GD	185
10000	20	15	1/2	30	W41210G	190	W41210GD	240
15000	20	22.5	1/2	30	W41215G	190	W41215GD	240
20000	20	30	3/4	30	W41220G	200	W41220GD	250
25000	20	37.5	3/4	45	W41225J	285	W41225JD	350
30000	20	45	1	45	W41230J	285	W41230JD	350
40000	20	60	1 1/2	60	W41240J	335	W41240JD	405
50000	20	75	2	95	W41250J	385	W41250JD	460
2000	30	3	1/2	15	W4132J	180	W4132JD	250
4000	30	6	1/2	15	W4134J	180	W4134JD	250
6000	30	9	1/2	15	W4136J	180	W4136JD	250
8000	30	12	1/2	15	W4138J	180	W4138JD	250
10000	30	15	3/4	15	W41310J	185	W41310JD	250
15000	30	22.5	1	30	W41315J	230	W41315JD	300
20000	30	30	1	30	W41320J	230	W41320JD	300
25000	30	37.5	1	45	W41325J	285	W41325JD	350
30000	30	45	1 1/2	45	W41330J	290	W41330JD	355
40000	30	60	2	60	W41340J	340	W41340JD	410
50000	30	75	3	95	W41350J	395	W41350JD	470
2000	40	3	1	15	W4142J	190	W4142JD	270
4000	40	6	1	15	W4144J	190	W4144JD	270
6000	40	9	1	15	W4146J	190	W4146JD	270
8000	40	12	1	15	W4148J	190	W4148JD	270
10000	40	15	1	15	W41410J	190	W41410JD	270
15000	40	22.5	1 1/2	30	W41415J	240	W41415JD	310
20000	40	30	1 1/2	30	W41420J	240	W41420JD	310
25000	40	37.5	1 1/2	45	W41425J	290	W41425JD	355
30000	40	45	2	45	W41430J	295	W41430JD	360
40000	40	60	2	60	W41440J	240	W41440JD	410
50000	40	75	3	95	W41450J	395	W41450JD	470
2000	50	3	2	15	W4152J	195	W4152JD	275
4000	50	6	2	15	W4154J	195	W4154JD	275
6000	50	9	2	15	W4156J	195	W4156JD	275
8000	50	12	2	15	W4158J	195	W4158JD	275
10000	50	15	2	15	W41510J	195	W41510JD	275
15000	50	22.5	2	30	W41515J	245	W41515JD	320
20000	50	30	3	30	W41520J	255	W41520JD	330
25000	50	37.5	3	45	W41525J	305	W41525JD	385
30000	50	45	3	45	W41530J	305	W41530JD	385
40000	50	60	5	60	W41540J	370	W41540JD	500
50000	50	75	5	95	W41550J	430	W41550JD	500

Notes: 1) EDR = Square Feet of Equivalent Direct Radiation
2) Capacity of Steam (lbs/hr) = EDR x 0.25
3) 2,000 EDR will produce 500 lbs/hr of condensate
3) 500 lbs/hr = 1 GPM

ELECTRIC PUMPS

Boiler Feed Pumps Cast Iron Receivers (G & J Series Pumps)

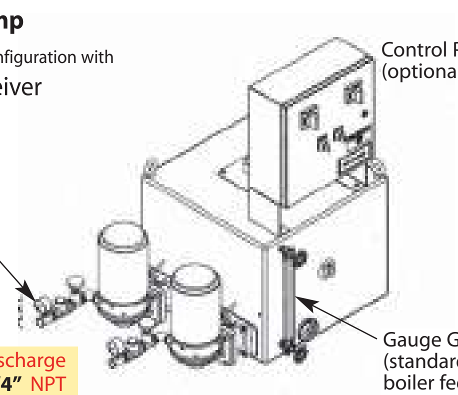
G (**20 PSI** Max Discharge Pressure) / **J** (up to **50 PSI** Max Discharge Pressure)

CAPACITIES

Boiler Horsepower	Discharge Pressure (PSIG)	Flow Rate (GPM)	Motor Horsepower	Receiver Capacity (gallons)	Simplex Model #	Weight (lbs)	Duplex Model #	Weight (lbs)
15	20	3	1/3	36	W4222GF	465	W4222GDF	500
	30		1/2		W4232JF	505	W4232JDF	580
	40		1		W4242JF	510	W4242DF	590
	50		2		W4252JF	520	W4252JDF	600
30	20	6	1/3	36	W4224GF	465	W4224GDF	500
	30		1/2		W4234JF	505	W4234JDF	580
	40		1		W4244JF	510	W4244DF	590
	50		2		W4254JF	520	W4254JDF	600
45	20	9	1/3	50	W4226GF	575	W4226GDF	610
	30		1/2		W4236JF	615	W4236JDF	690
	40		1		W4246JF	620	W4246DF	700
	50		2		W4256JF	625	W4256JDF	710
60	20	12	1/3	50	W4228GF	575	W4228GDF	610
	30		1/2		W4238JF	615	W4238JDF	690
	40		1		W4248JF	620	W4248DF	700
	50		2		W4258JF	625	W4258JDF	710

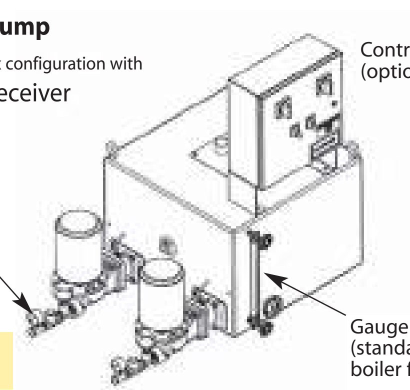
Typical 4200-Series BOILER FEED Pumps

SIMPLEX & DUPLEX
G Series Pump
Shown in Duplex configuration with
36 Gallon Receiver



Discharge **3/4"** NPT

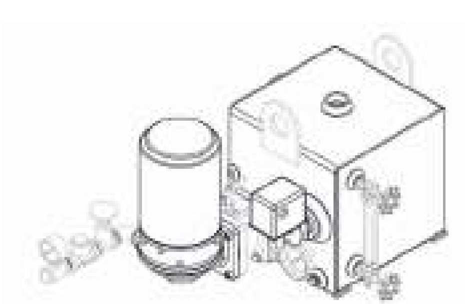
SIMPLEX & DUPLEX
J Series Pump
Shown in Duplex configuration with
50 Gallon Receiver



Discharge **1 1/2"** NPT

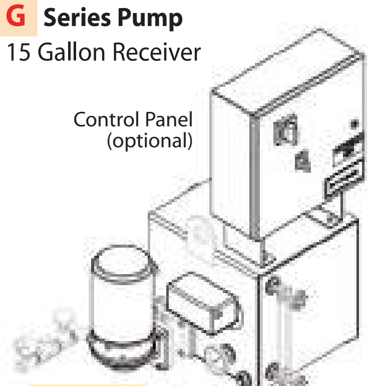
Typical 4200-Series CONDENSATE RETURN Pumps

SIMPLEX
G Series Pump
6 Gallon Receiver



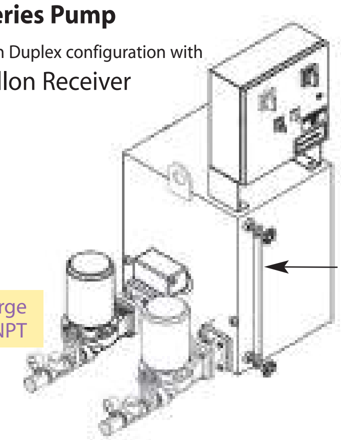
Discharge **3/4"** NPT

SIMPLEX & DUPLEX
G Series Pump
15 Gallon Receiver



Discharge **3/4"** NPT

SIMPLEX & DUPLEX
J Series Pump
Shown in Duplex configuration with
45 Gallon Receiver



Discharge **1 1/2"** NPT

Watson McDaniel

Model Selection • Condensate Return Pumps

ELECTRIC PUMPS

Condensate Return Pumps **Cast Iron** Receivers (G & J Series Pumps)

G (**20 PSI** Max Discharge Pressure) / **J** (up to **50 PSI** Max Discharge Pressure)

CAPACITIES

EDR	Discharge Pressure (PSIG)	Flow Rate (GPM)	Motor HP	Receiver Capacity (gallons)	Simplex Model #	Weight (lbs)	Duplex Model #	Weight (lbs)
2000	20	3	1/3	6	**W4222G**	150	**N/A**	N/A
4000	20	6	1/3	6	**W4224G**	150	**N/A**	N/A
6000	20	9	1/3	15	**W4226G**	260	**W4226GD**	295
8000	20	12	1/3	15	**W4228G**	260	**W4228GD**	295
10000	20	15	1/2	15	**W42210G**	260	**W42210GD**	295
15000	20	22.5	1/2	24	**W42215G**	300	**W42215GD**	335
20000	20	30	3/4	36	**W42220G**	410	**W42220GD**	445
25000	20	37.5	3/4	36	**W42225J**	350	**W42225JD**	420
30000	20	45	1	36	**W42230J**	355	**W42230JD**	430
40000	20	60	1 1/2	50	**W42240J**	420	**W42240JD**	500
50000	20	75	2	50	**W42250J**	425	**W42250JD**	510
2000	30	3	1/2	6	**W4232J**	165	**N/A**	N/A
4000	30	6	1/2	6	**W4234J**	165	**N/A**	N/A
6000	30	9	1/2	15	**W4236J**	295	**W4236JD**	360
8000	30	12	1/2	15	**W4238J**	295	**W4238JD**	360
10000	30	15	3/4	15	**W42310J**	300	**W42310JD**	365
15000	30	22.5	1	24	**W42315J**	305	**W42315JD**	380
20000	30	30	1	36	**W42320J**	355	**W42320JD**	430
25000	30	37.5	1	36	**W42325J**	355	**W42325JD**	430
30000	30	45	1 1/2	36	**W42330J**	360	**W42330JD**	440
40000	30	60	2	50	**W42340J**	425	**W42340JD**	510
50000	30	75	3	50	**W42350J**	435	**W42350JD**	525
2000	40	3	1	6	**W4242J**	170	**N/A**	N/A
4000	40	6	1	6	**W4244J**	170	**N/A**	N/A
6000	40	9	1	15	**W4246J**	295	**W4246JD**	360
8000	40	12	1	15	**W4248J**	295	**W4248JD**	360
10000	40	15	1	15	**W42410J**	295	**W42410JD**	360
15000	40	22.5	1 1/2	24	**W42415J**	310	**W42415JD**	390
20000	40	30	1 1/2	36	**W42420J**	360	**W42420JD**	440
25000	40	37.5	1 1/2	36	**W42425J**	360	**W42425JD**	440
30000	40	45	2	36	**W42430J**	365	**W42430JD**	450
40000	40	60	2	50	**W42440J**	425	**W42440JD**	510
50000	40	75	3	50	**W42450J**	435	**W42450JD**	525
2000	50	3	2	6	**W4252J**	175	**N/A**	N/A
4000	50	6	2	6	**W4254J**	175	**N/A**	N/A
6000	50	9	2	15	**W4256J**	315	**W4256JD**	395
8000	50	12	2	15	**W4258J**	315	**W4258JD**	395
10000	50	15	2	15	**W42510J**	315	**W42510JD**	395
15000	50	22.5	2	24	**W42515J**	330	**W42515JD**	415
20000	50	30	3	36	**W42520J**	370	**W42520JD**	460
25000	50	37.5	3	36	**W42525J**	370	**W42525JD**	460
30000	50	45	3	36	**W42530J**	370	**W42530JD**	460
40000	50	60	5	50	**W42540J**	445	**W42540JD**	535
50000	50	75	5	50	**W42550J**	445	**W42550JD**	535

Notes: 1) EDR = Square Feet of Equivalent Direct Radiation
2) Capacity of Steam (lbs/hr) = EDR x 0.25
3) 2,000 EDR will produce 500 lbs/hr of condensate
3) 500 lbs/hr = 1 GPM

Boiler Feed Pumps Stainless Steel Receivers (G & J Series Pumps)

G (**20 PSI** Max Discharge Pressure) / **J** (up to **50 PSI** Max Discharge Pressure)

CAPACITIES

Boiler Horsepower	Discharge Pressure (PSIG)	Flow Rate (GPM)	Motor Horsepower	Receiver Capacity (gallons)	Simplex Model #	Weight (lbs)	Duplex Model #	Weight (lbs)
15	20	3	1/3	30	W4322GF	200	W4322GDF	240
	30		1/2		W4332JF	260	W4332JDF	300
	40		1		W4342JF	265	W4342DF	310
	50		2		W4352JF	275	W4352JDF	330
30	20	6	1/3	30	W4324GF	200	W4324GDF	240
	30		1/2		W4334JF	260	W4334JDF	300
	40		1		W4344JF	265	W4344DF	310
	50		2		W4354JF	275	W4354JDF	330
45	20	9	1/3	45	W4326GF	240	W4326GDF	280
	30		1/2		W4336JF	300	W4336JDF	340
	40		1		W4346JF	305	W4346DF	350
	50		2		W4356JF	315	W4356JDF	370
60	20	12	1/3	60	W4328GF	275	W4328GDF	335
	30		1/2		W4338JF	335	W4338JDF	395
	40		1		W4348JF	340	W4348DF	405
	50		2		W4358JF	350	W4358JDF	425

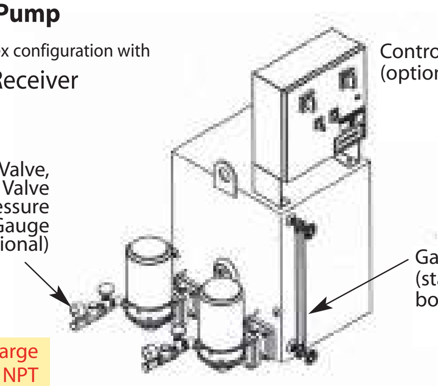
Typical 4300-Series BOILER FEED Pumps

SIMPLEX & DUPLEX

G Series Pump

Shown in Duplex configuration with

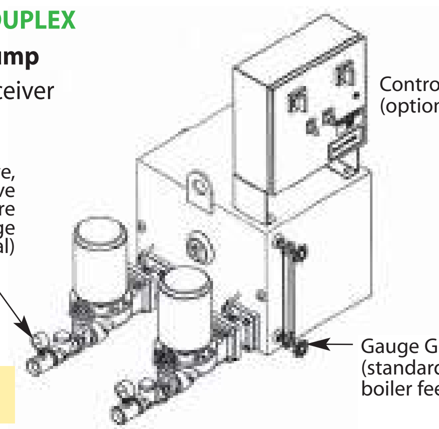
45 Gallon Receiver



SIMPLEX & DUPLEX

J Series Pump

30 Gallon Receiver

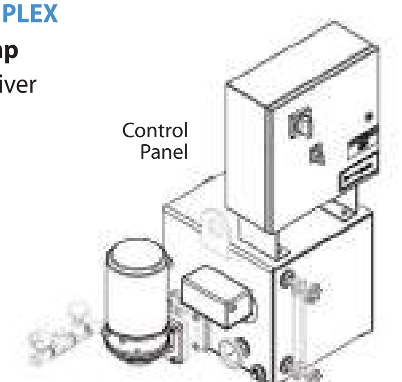


Typical 4300-Series CONDENSATE RETURN Pumps

SIMPLEX & DUPLEX

G Series Pump

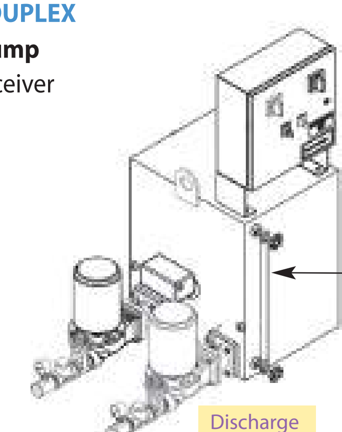
15 Gallon Receiver



SIMPLEX & DUPLEX

J Series Pump

45 Gallon Receiver



ELECTRIC PUMPS

Condensate Return Pumps Stainless Steel Receivers (G & J Series Pumps)

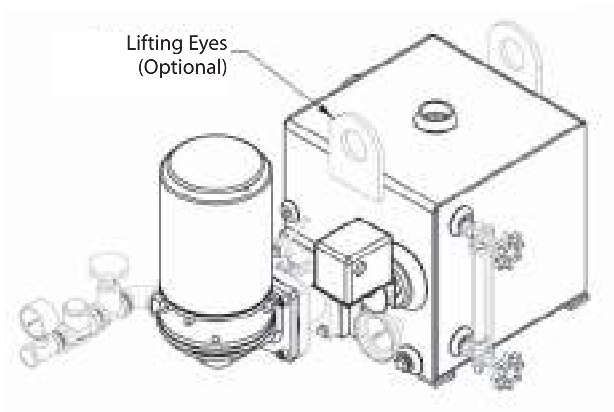
G (20 PSI Max Discharge Pressure) / J (up to 50 PSI Max Discharge Pressure)

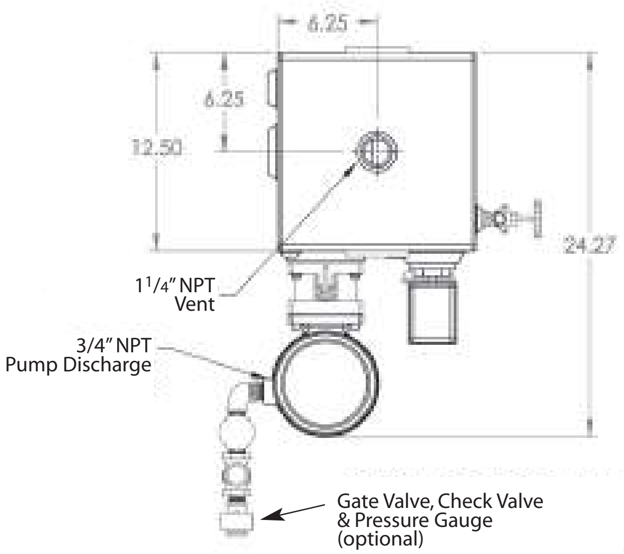
CAPACITIES

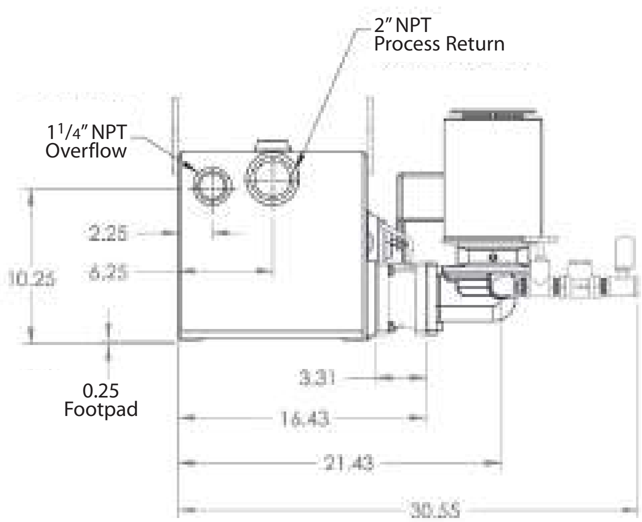
EDR	Discharge Pressure (PSIG)	Flow Rate (GPM)	Motor HP	Receiver Capacity (gallons)	Simplex Model #	Weight (lbs)	Duplex Model #	Weight (lbs)
2000	20	3	1/3	15	W4322G	125	W4322GD	185
4000	20	6	1/3	15	W4324G	125	W4324GD	185
6000	20	9	1/3	15	W4326G	125	W4326GD	185
8000	20	12	1/3	15	W4328G	125	W4328GD	185
10000	20	15	1/2	30	W43210G	190	W43210GD	240
15000	20	22.5	1/2	30	W43215G	190	W43215GD	240
20000	20	30	3/4	30	W43220G	200	W43220GD	250
25000	20	37.5	3/4	45	W43225J	285	W43225JD	350
30000	20	45	1	45	W43230J	285	W43230JD	350
40000	20	60	1 1/2	60	W43240J	335	W43240JD	405
50000	20	75	2	95	W43250J	385	W43250JD	460
2000	30	3	1/2	15	W4332J	180	W4332JD	250
4000	30	6	1/2	15	W4334J	180	W4334JD	250
6000	30	9	1/2	15	W4336J	180	W4336JD	250
8000	30	12	1/2	15	W4338J	180	W4338JD	250
10000	30	15	3/4	15	W43310J	185	W4310JD	250
15000	30	22.5	1	30	W43315J	230	W43315JD	300
20000	30	30	1	30	W43320J	230	W43320JD	300
25000	30	37.5	1	45	W43325J	285	W43325JD	350
30000	30	45	1 1/2	45	W43330J	290	W43330JD	355
40000	30	60	2	60	W43340J	340	W43340JD	410
50000	30	75	3	95	W43350J	395	W43350JD	470
2000	40	3	1	15	W4342J	190	W4342JD	270
4000	40	6	1	15	W4344J	190	W4344JD	270
6000	40	9	1	15	W4346J	190	W4346JD	270
8000	40	12	1	15	W4348J	190	W4348JD	270
10000	40	15	1	15	W43410J	190	W43410JD	270
15000	40	22.5	1 1/2	30	W43415J	240	W43415JD	310
20000	40	30	1 1/2	30	W43420J	240	W43420JD	310
25000	40	37.5	1 1/2	45	W43425J	290	W43425JD	355
30000	40	45	2	45	W43430J	295	W43430JD	360
40000	40	60	2	60	W43440J	240	W43440JD	410
50000	40	75	3	95	W43450J	395	W43450JD	470
2000	50	3	2	15	W4352J	195	W4352JD	275
4000	50	6	2	15	W4354J	195	W4354JD	275
6000	50	9	2	15	W4356J	195	W4356JD	275
8000	50	12	2	15	W4358J	195	W4358JD	275
10000	50	15	2	15	W43510J	195	W43510JD	275
15000	50	22.5	2	30	W43515J	245	W43515JD	320
20000	50	30	3	30	W43520J	255	W43520JD	330
25000	50	37.5	3	45	W43525J	305	W43525JD	385
30000	50	45	3	45	W43530J	305	W43530JD	385
40000	50	60	5	60	W43540J	370	W43540JD	500
50000	50	75	5	95	W43550J	430	W43550JD	500

Notes: 1) EDR = Square Feet of Equivalent Direct Radiation
2) Capacity of Steam (lbs/hr) = EDR x 0.25
3) 2,000 EDR will produce 500 lbs/hr of condensate
3) 500 lbs/hr = 1 GPM

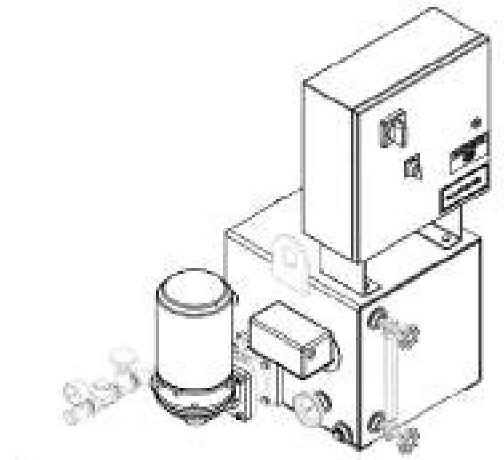
G **SIMPLEX** • 8 Gallon Receiver
4100 • Steel Receiver
4300 • Stainless Steel Receiver

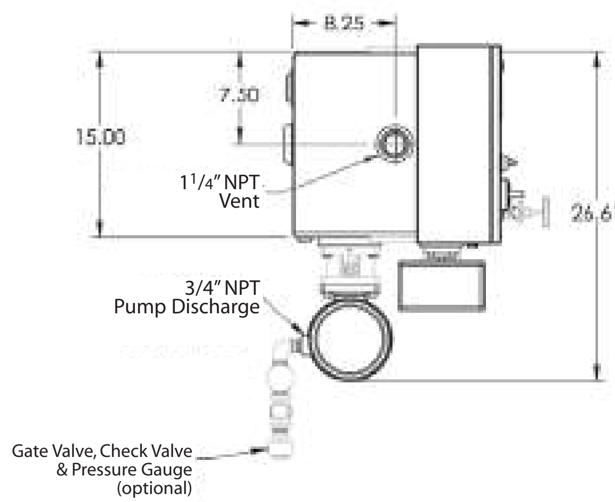


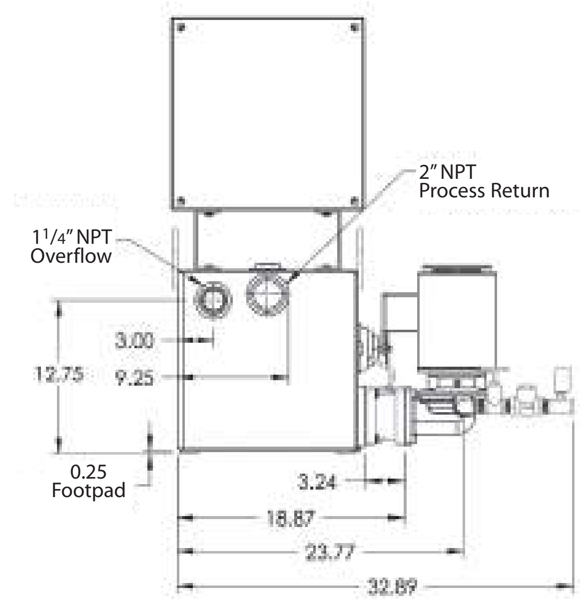




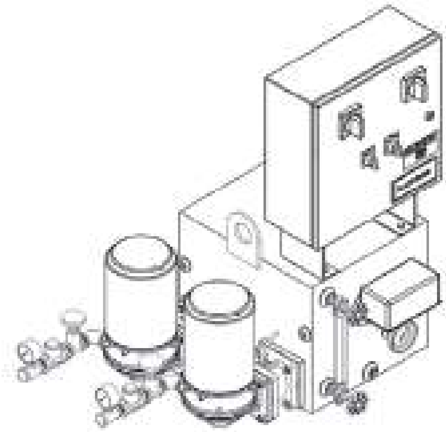
G **SIMPLEX** • 15 Gallon Receiver
4100 • Steel Receiver
4300 • Stainless Steel Receiver

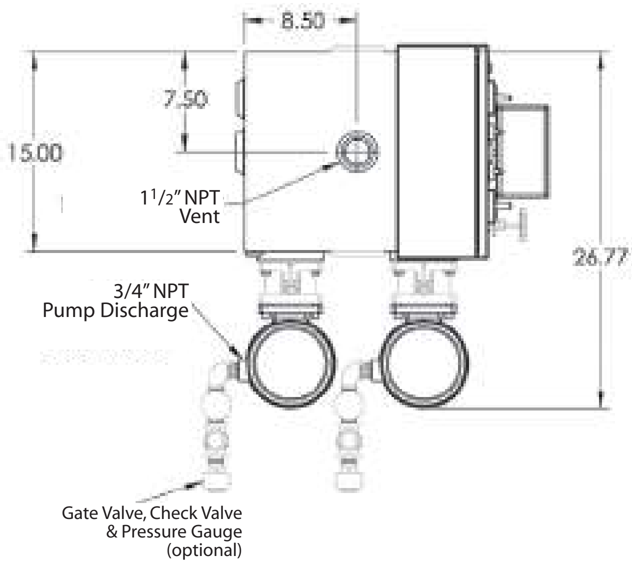


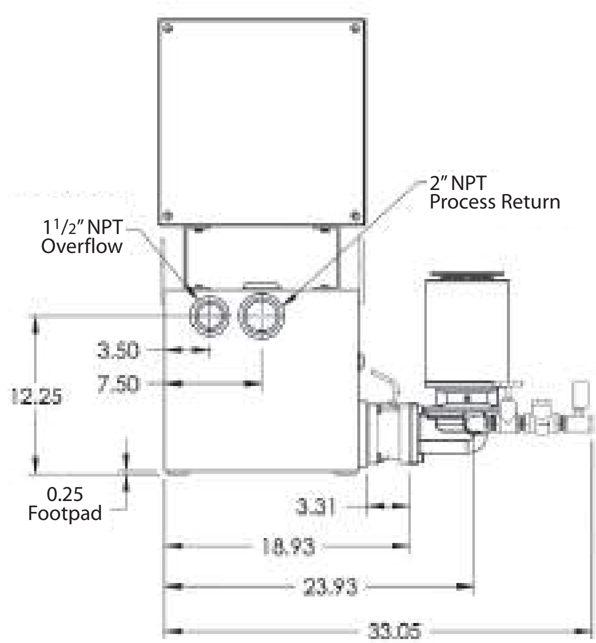




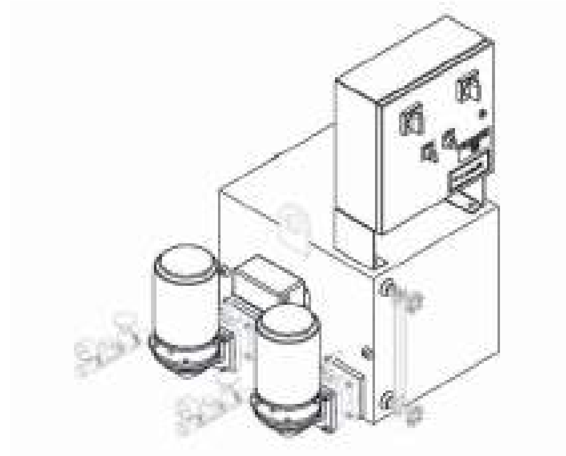
G **DUPLEX** • 15 Gallon Receiver
4100 • **Steel Receiver**
4300 • **Stainless Steel Receiver**

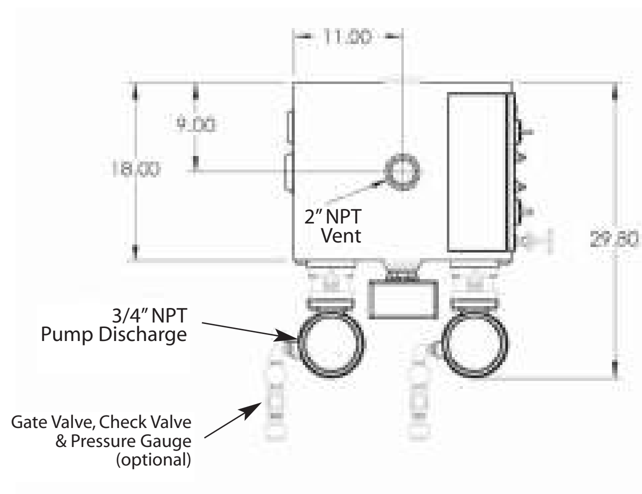


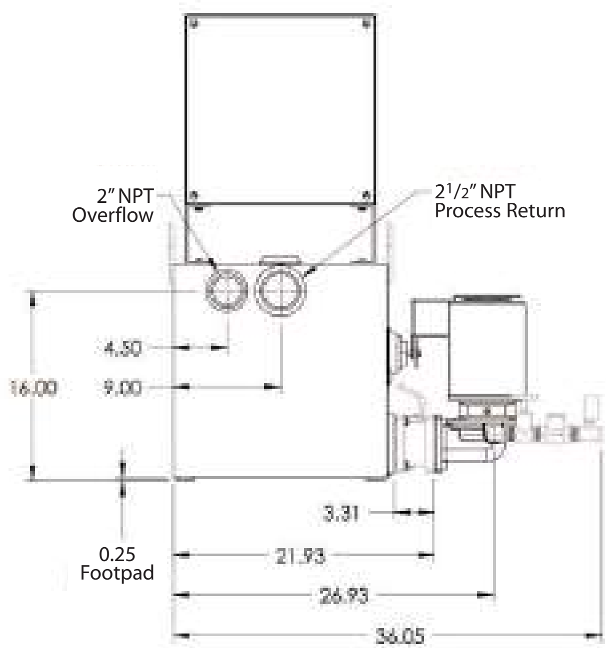




G **DUPLEX** • 30 Gallon Receiver
4100 • **Steel Receiver**
4300 • **Stainless Steel Receiver**



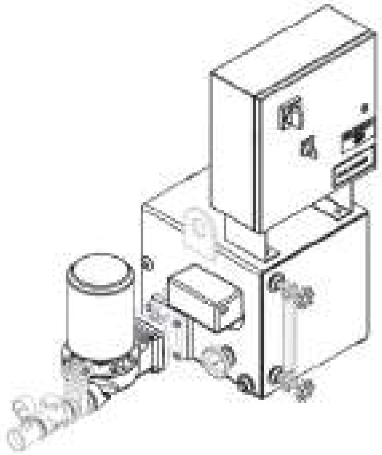


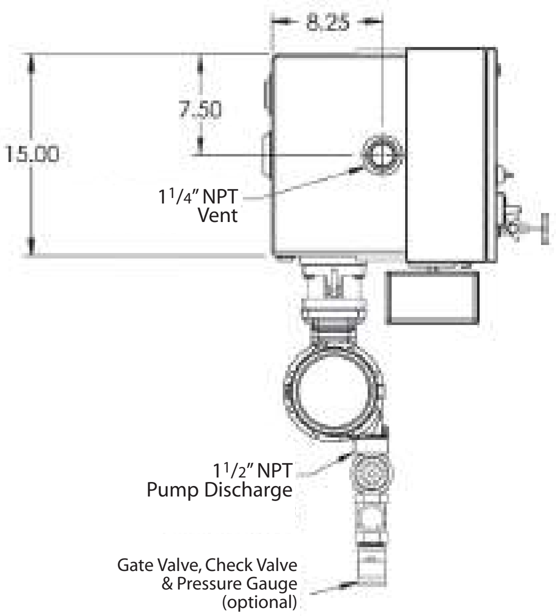


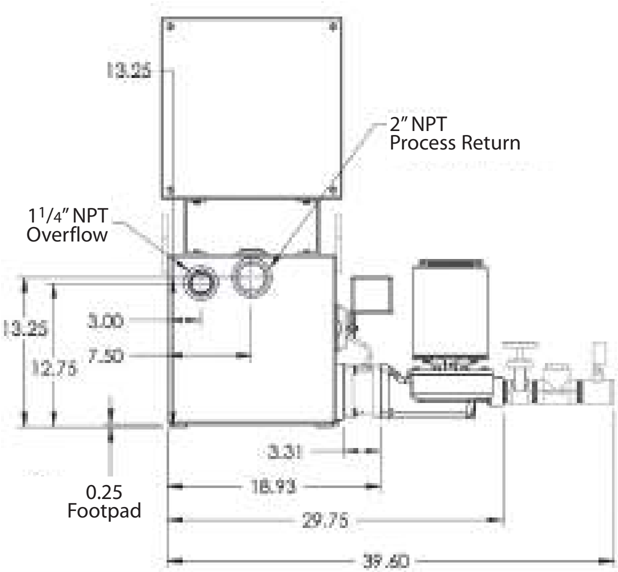
ELECTRIC PUMPS

J SIMPLEX • 15 Gallon Receiver

4100 • **Steel Receiver**
4300 • **Stainless Steel Receiver**

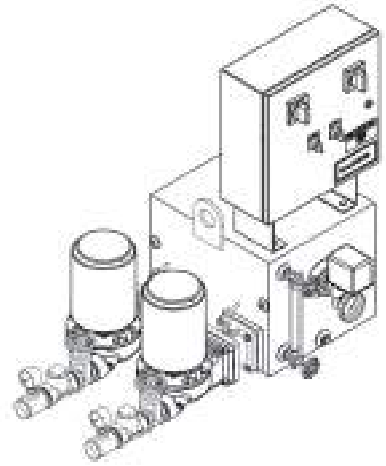


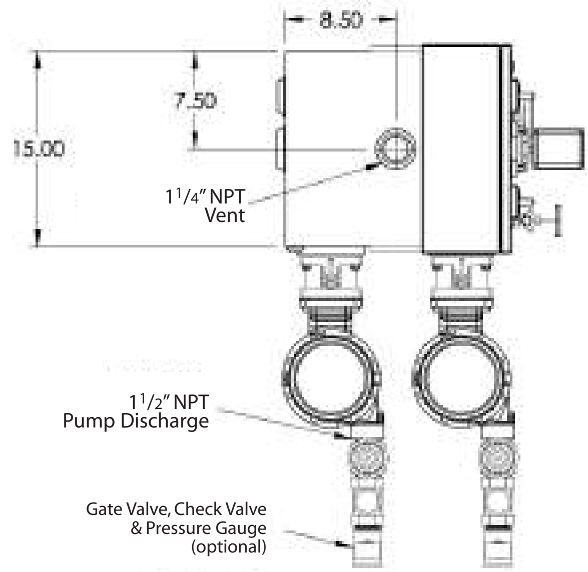


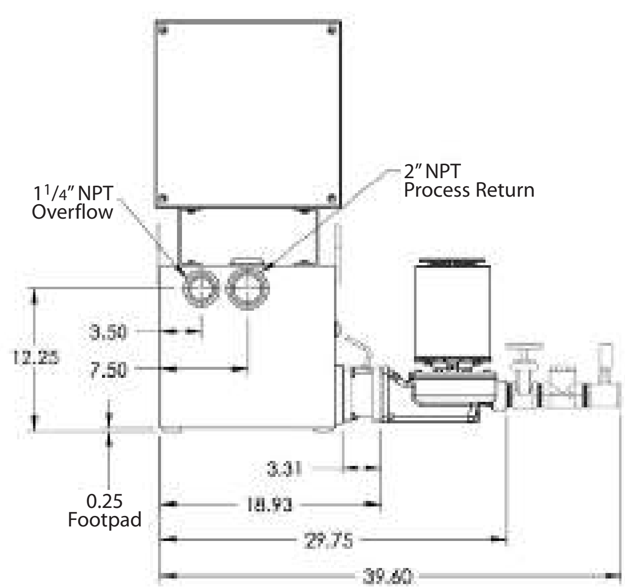


J DUPLEX • 15 Gallon Receiver

4100 • **Steel Receiver**
4300 • **Stainless Steel Receiver**

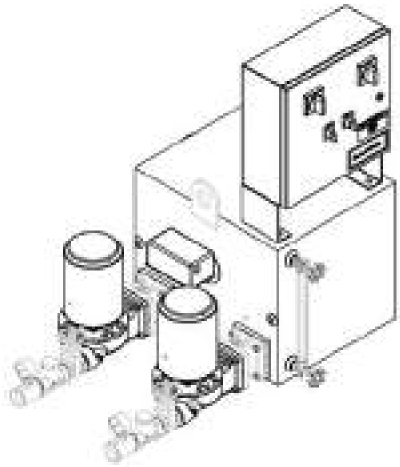


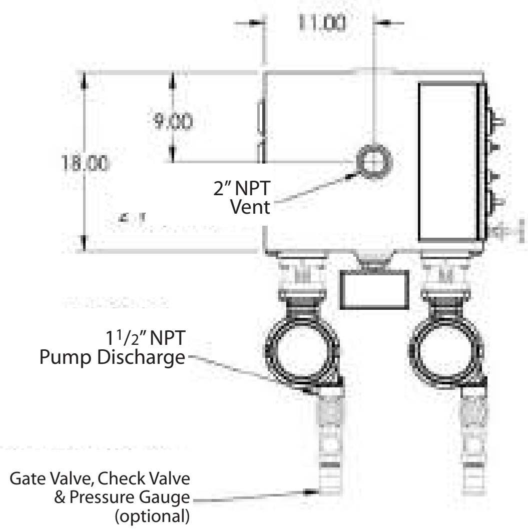


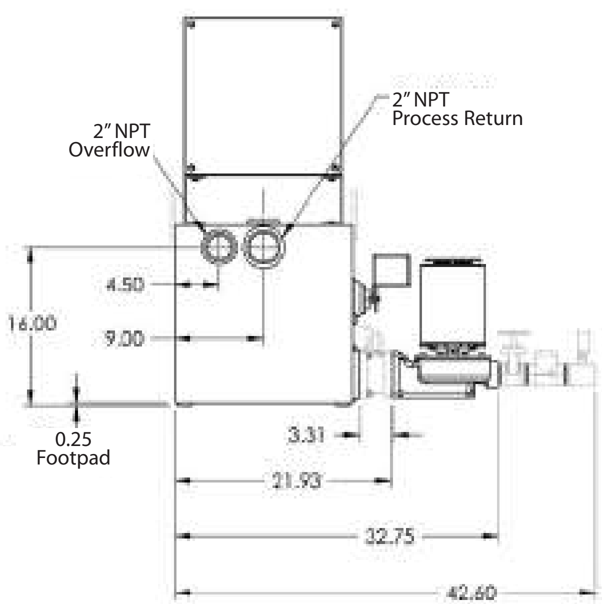


J

SIMPLEX & DUPLEX • 30 Gallon Receiver
4100 • Steel Receiver
4300 • Stainless Steel Receiver

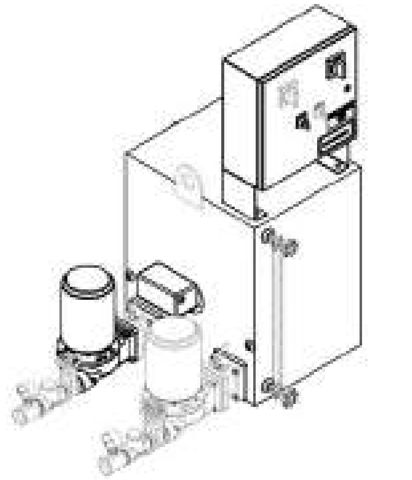


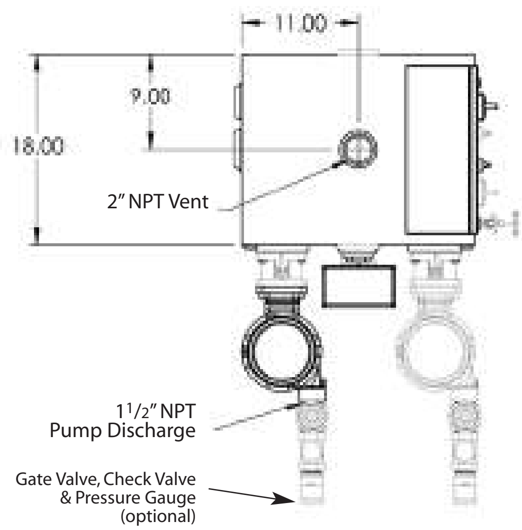


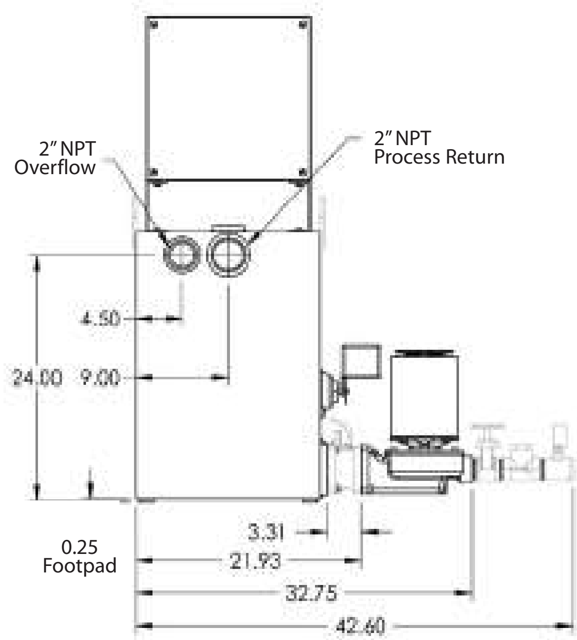


J

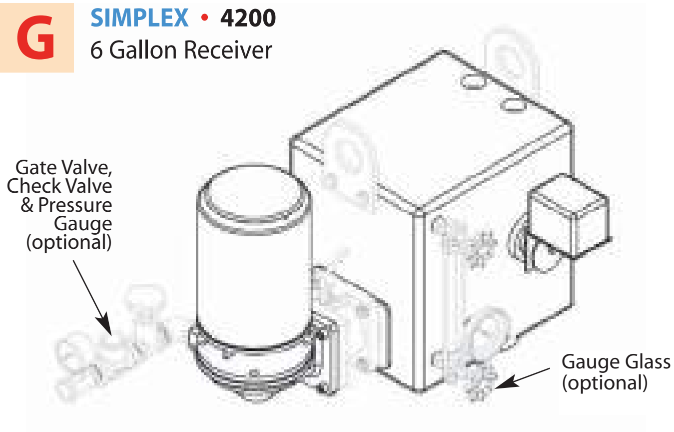
SIMPLEX & DUPLEX • 45 Gallon Receiver
4100 • Steel Receiver
4300 • Stainless Steel Receiver

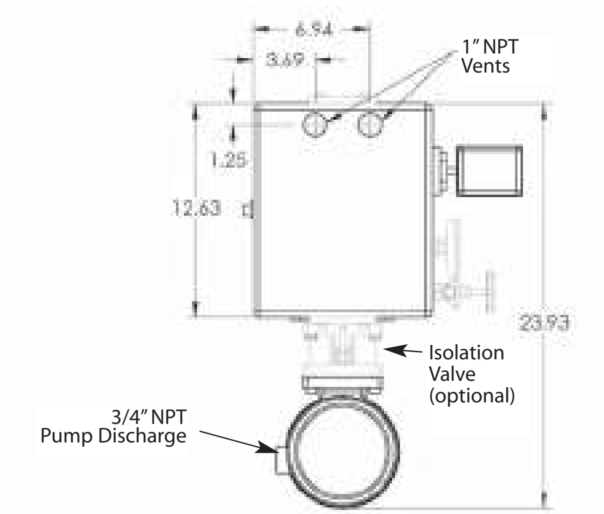


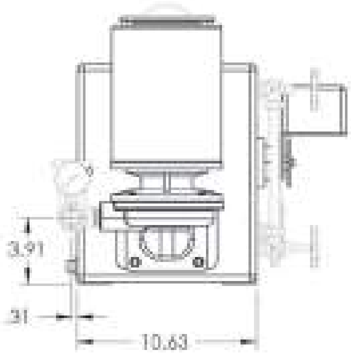


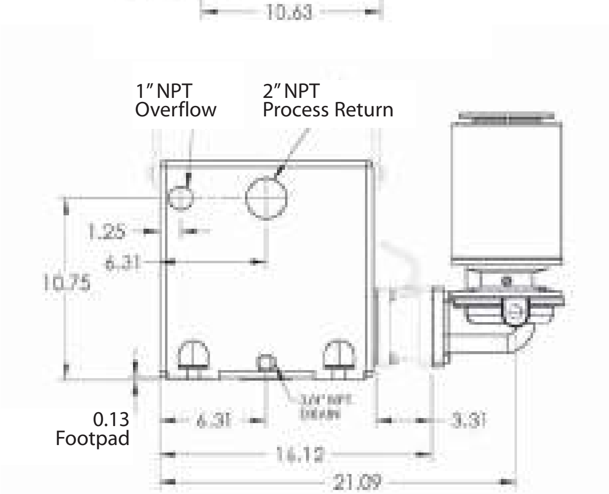


G SIMPLEX • 4200
6 Gallon Receiver

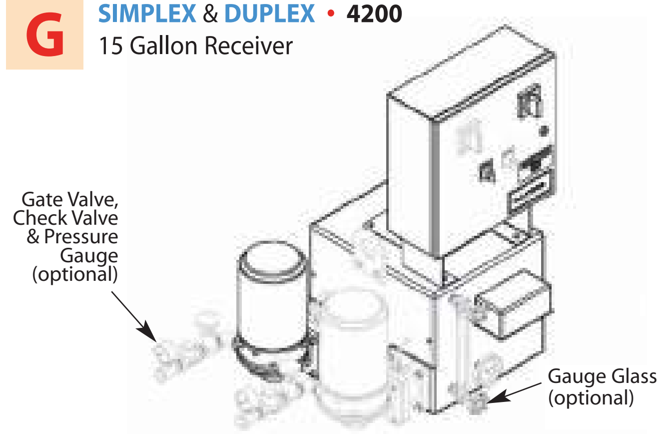


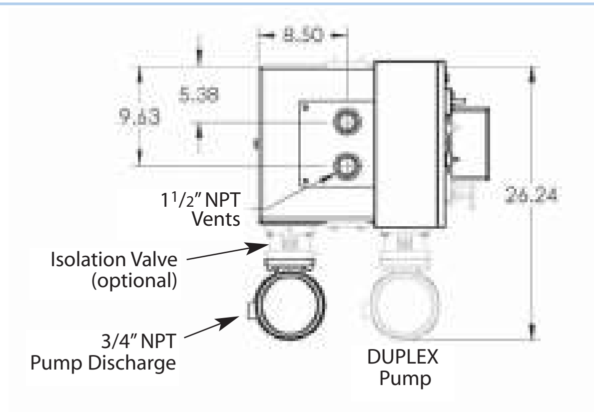


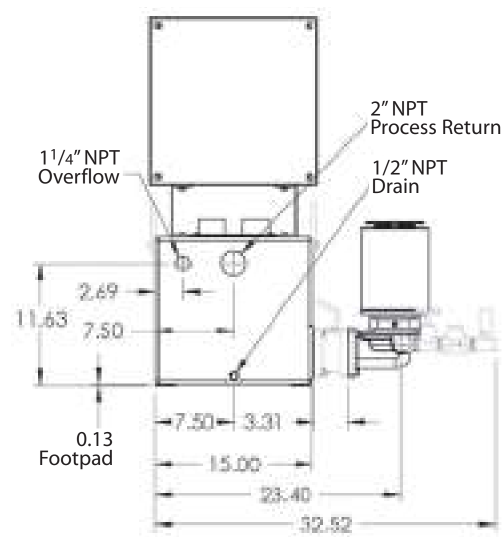




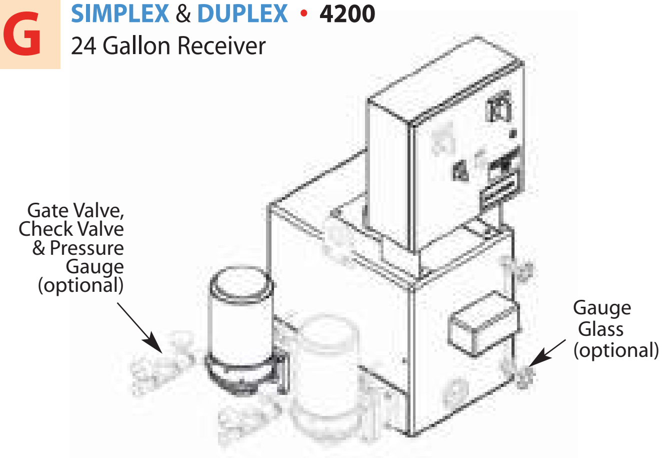
G SIMPLEX & DUPLEX • 4200
15 Gallon Receiver

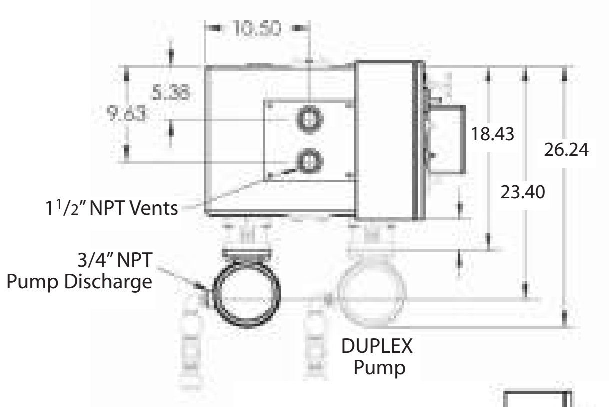


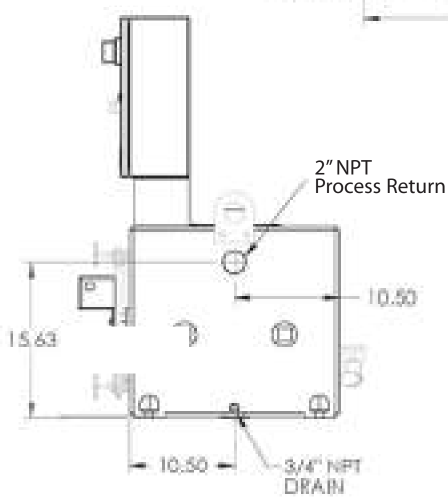




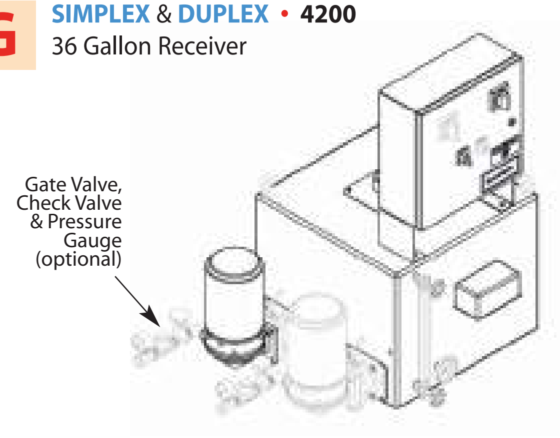
G **SIMPLEX** & **DUPLEX** • **4200**
24 Gallon Receiver

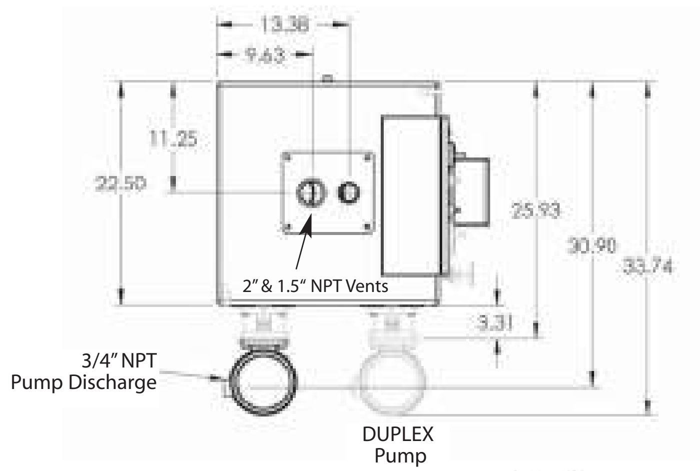


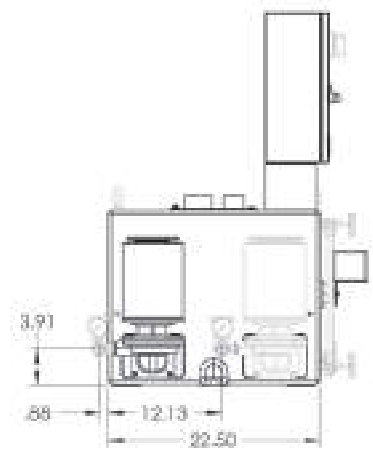


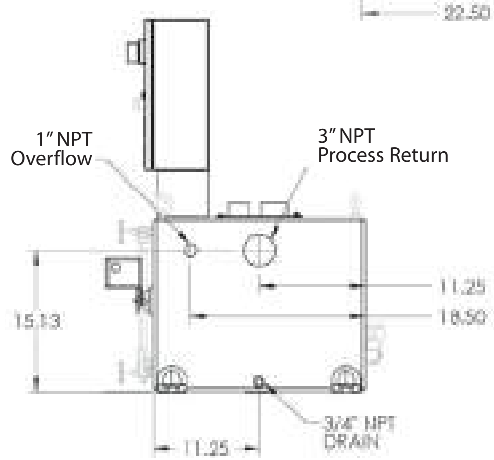


G **SIMPLEX** & **DUPLEX** • **4200**
36 Gallon Receiver





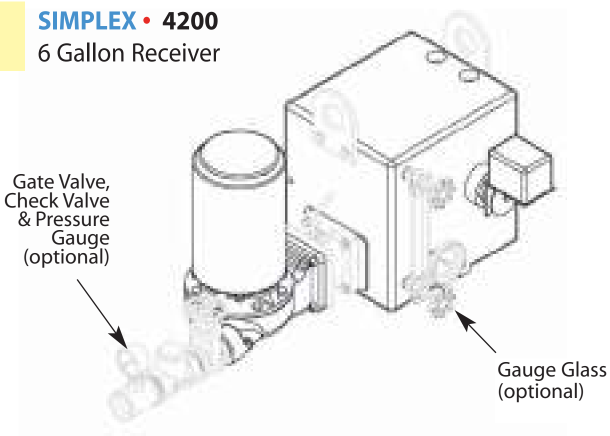


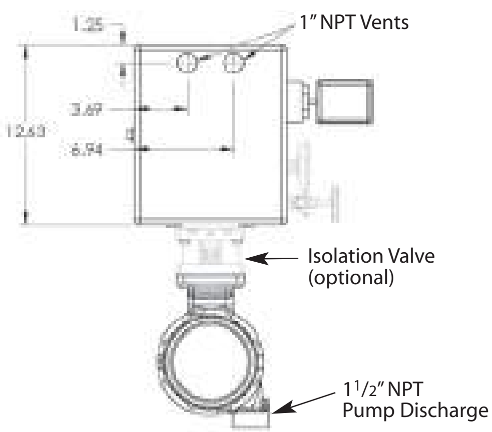


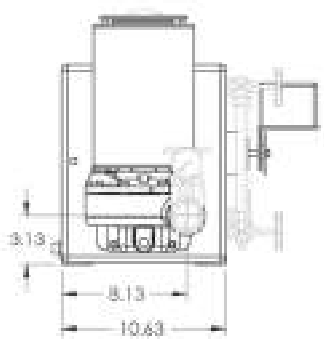
ELECTRIC PUMPS

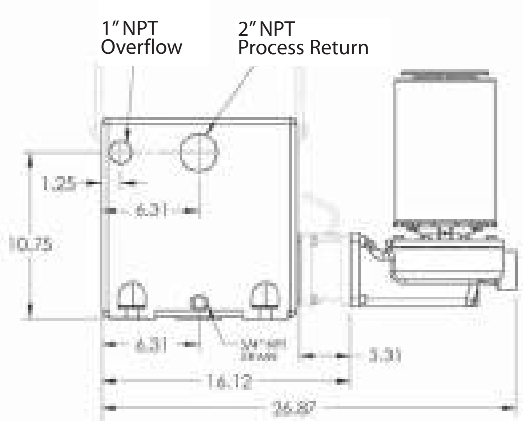
ELECTRIC PUMPS

J SIMPLEX • 4200
6 Gallon Receiver

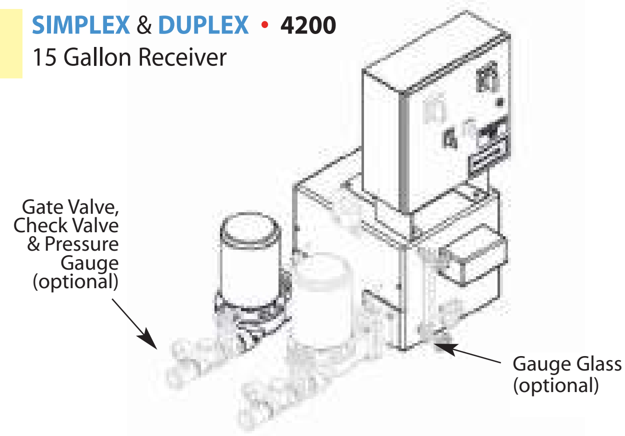


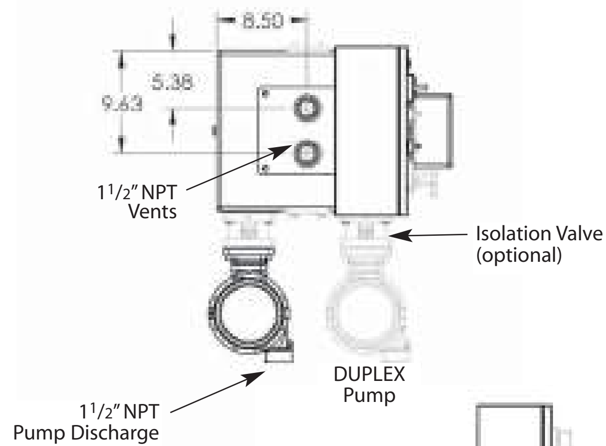


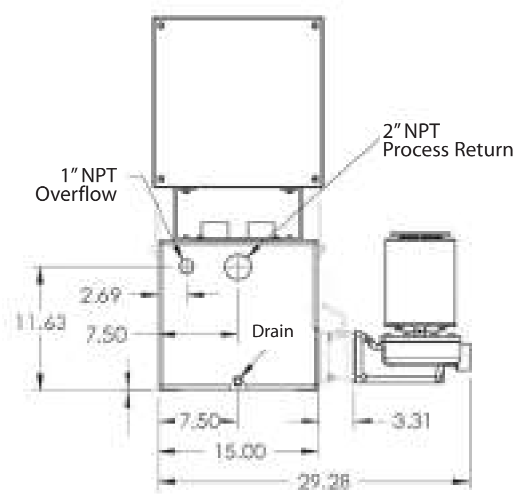




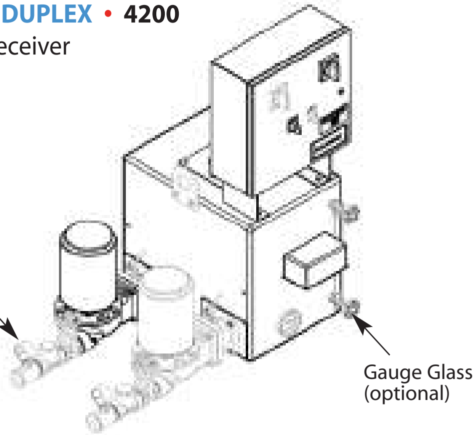
J SIMPLEX & DUPLEX • 4200
15 Gallon Receiver

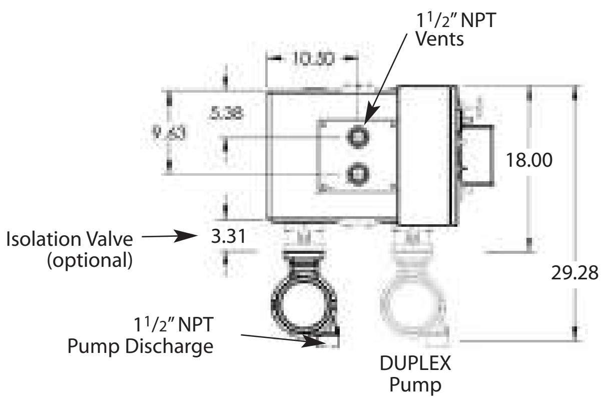


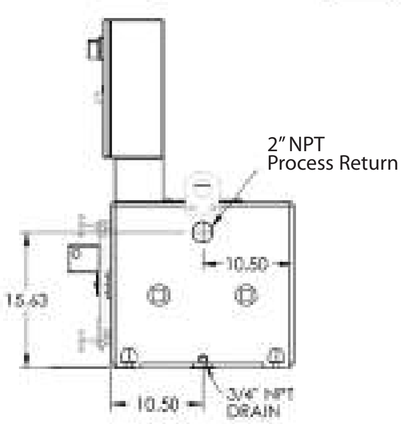




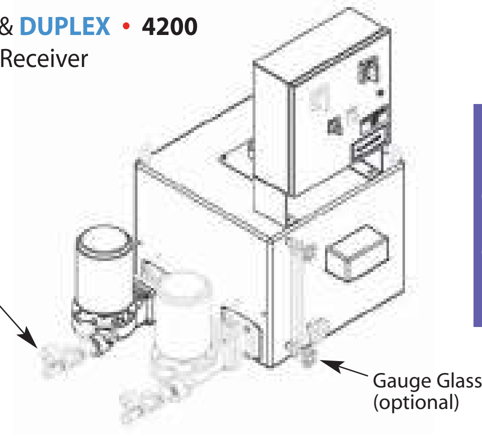
J **SIMPLEX & DUPLEX • 4200**
24 Gallon Receiver

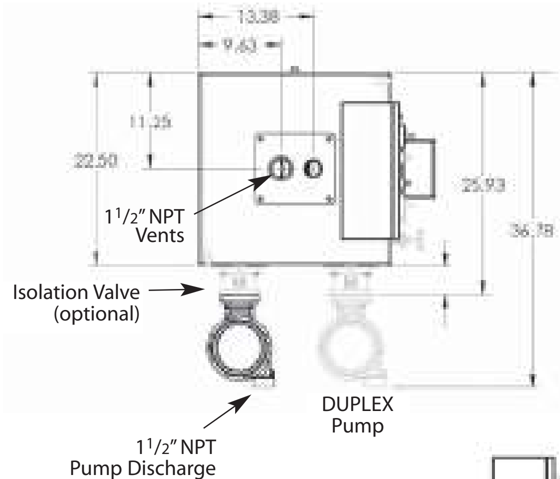


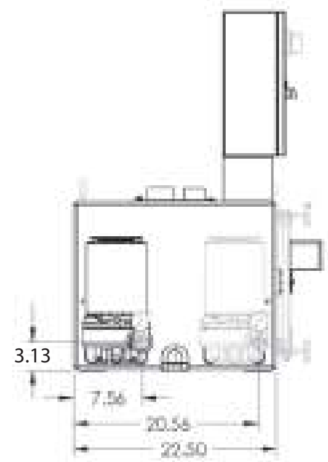


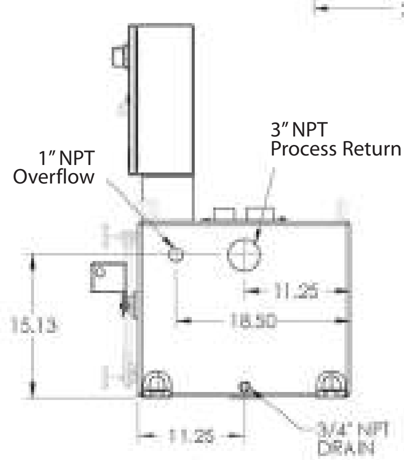


J **SIMPLEX & DUPLEX • 4200**
36 Gallon Receiver



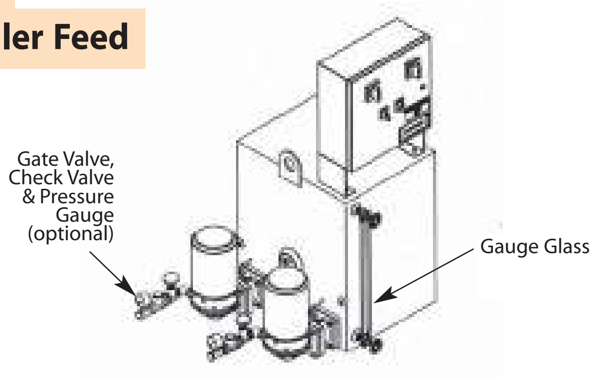


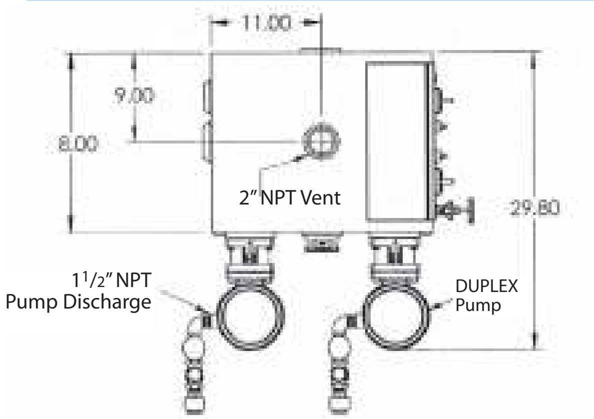


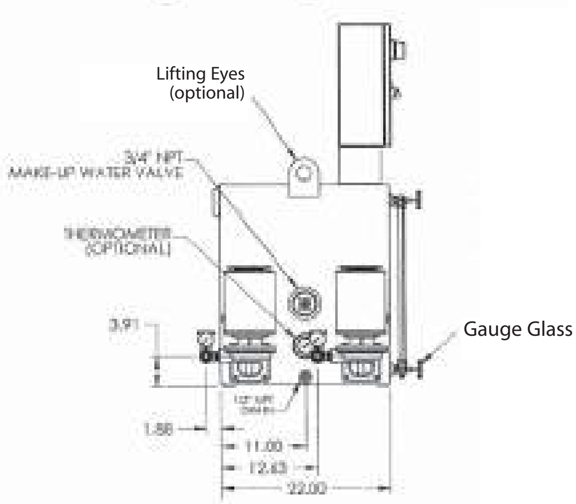


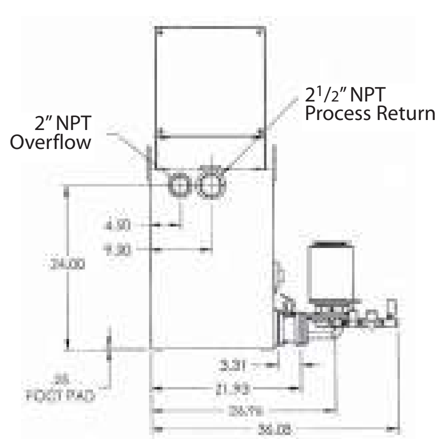
G
SIMPLEX & DUPLEX • 4100/4300
45 Gallon Receiver

Boiler Feed



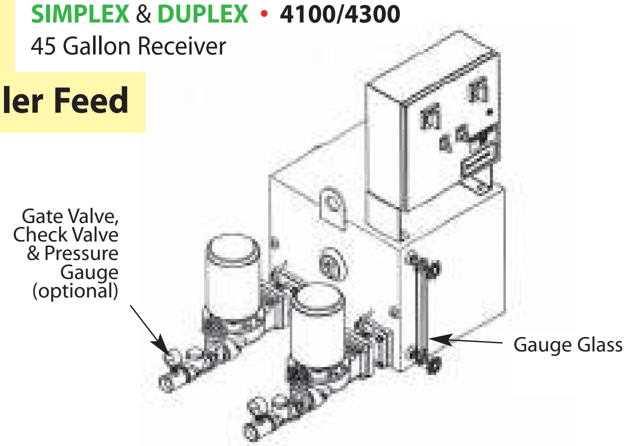


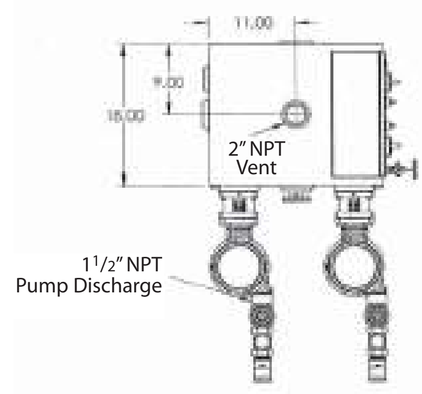


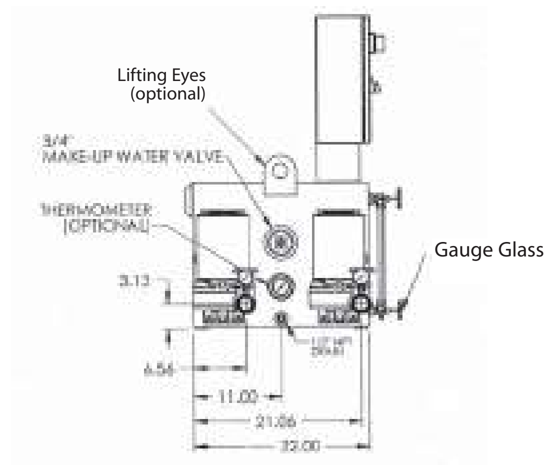


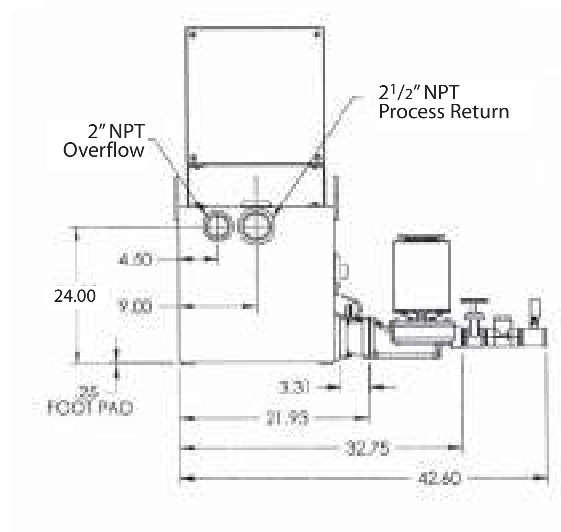
J
SIMPLEX & DUPLEX • 4100/4300
45 Gallon Receiver

Boiler Feed



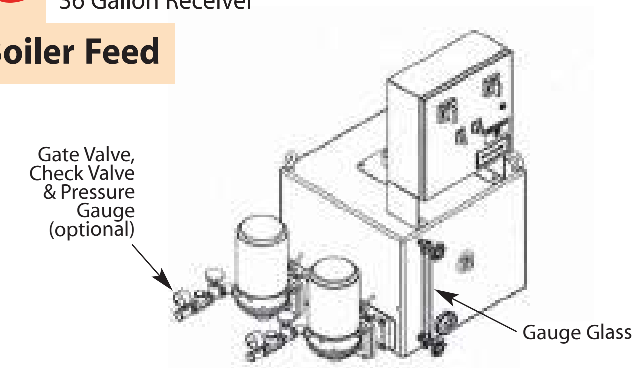


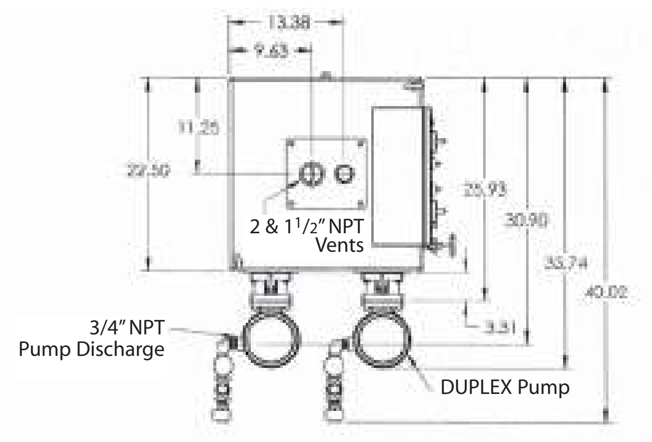


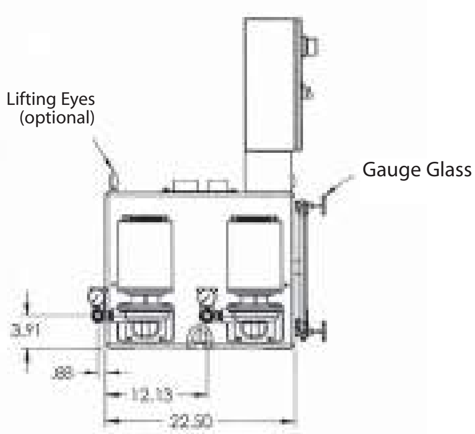


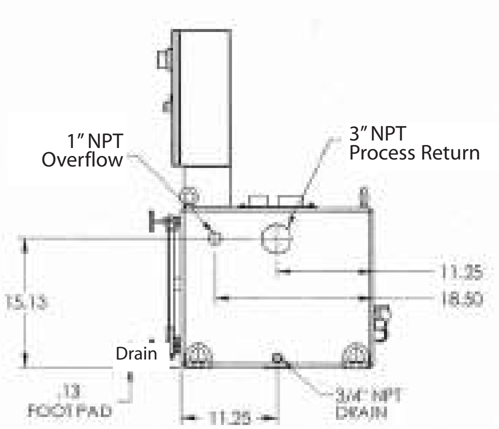
G SIMPLEX & DUPLEX • 4100/4300
36 Gallon Receiver

Boiler Feed



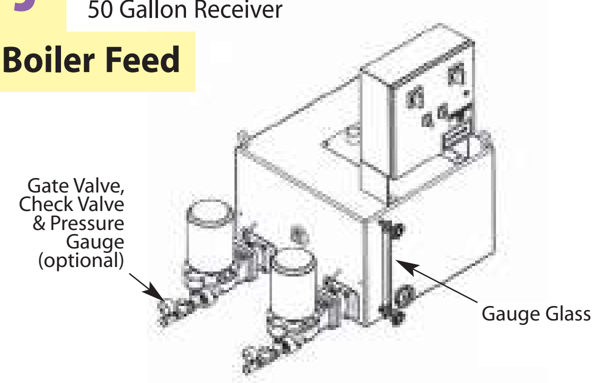


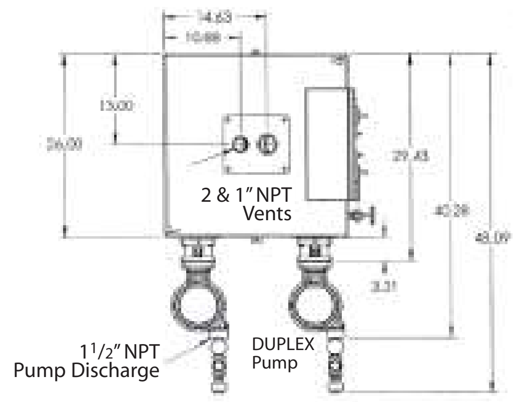


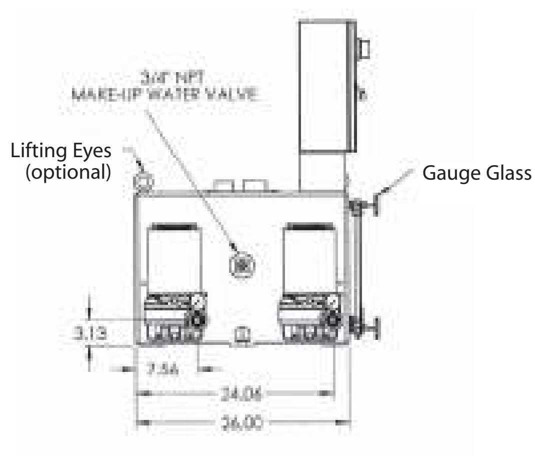


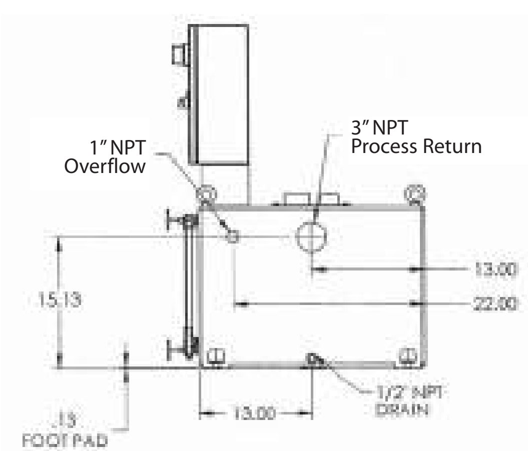
J SIMPLEX & DUPLEX • 4100/4300
50 Gallon Receiver

Boiler Feed



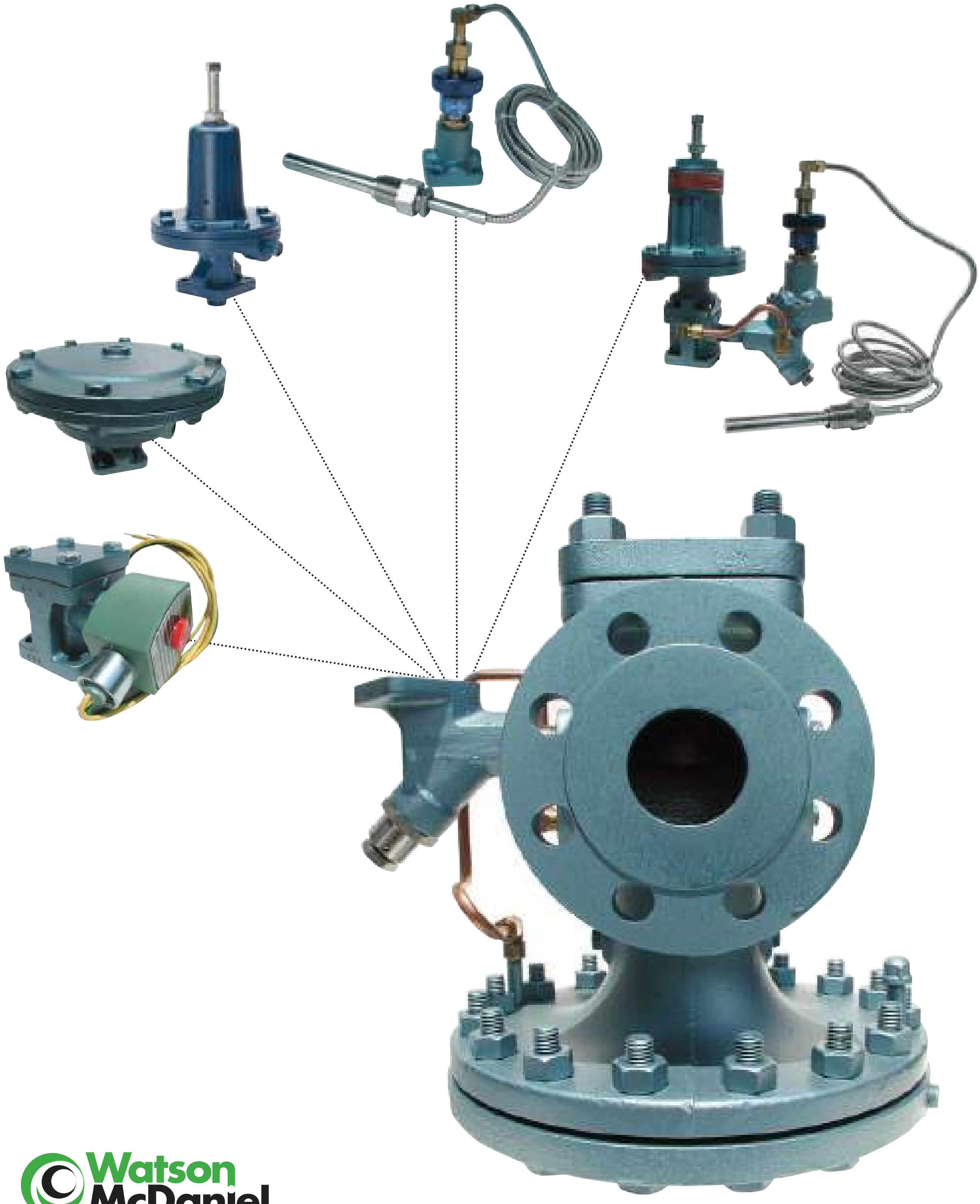






Pilot-Operated Regulating Valves

Pilot-Operated
REGULATORS



HD Regulating Valve & Pilots

Table of Contents

HD Main Valve
Ductile Iron

Most Common HD Pilots

PP & PP5
PRESSURE
Spring-Loaded

PT
TEMPERATURE
Liquid Filled

PA
PRESSURE
Air-Loaded

PS
On/Off
(Solenoid)

HD Main Valve is used in conjunction with the appropriate Pilot(s) to control Steam Pressure or Process Temperature

HD Regulator with
PP-**PRESSURE** Pilot
*(See Page **210**)*

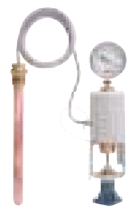
HD Regulator with
PT-**TEMPERATURE** Pilot
*(See Page **214**)*

HD Regulator with PP-**PRESSURE** Pilot
& PT-**TEMPERATURE** Pilot
*(See Page **214**)*

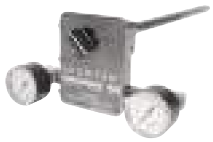
HD Regulator with
PA-Air Loaded **PRESSURE** Pilot
*(See Page **218**)*

HD Regulator with
PTRP- **TEMPERATURE** Pilot
*(See Page **222**)*

Other HD Pilots



PTRP
TEMPERATURE



PTR & PTL
TEMPERATURE
Controllers

PBP
BACK PRESSURE

PDP
DIFFERENTIAL
PRESSURE

The Watson McDaniel HSP Pilot-Operated Pressure Regulating Valve is constructed of Cast Carbon Steel for higher pressure and temperature ratings when compared to ductile iron.

The **HD-Series Pilot-Operated Regulators** are used on steam applications for pressure reduction or controlling product temperature (when steam is used in heating applications). The Pilot-operated regulators are more accurate and available in higher capacity than Direct-Operated regulators. The HD Series regulators use a pilot valve (several types and styles including Pressure, Temperature, ON-OFF solenoid, etc) to control the operation of the Main Valve. The HD series has a Ductile Iron Body; Pilot and Main-Valve are selected separately.

The **HSP Pressure Regulator** has a Cast Carbon Steel body; available with pressure pilot only.

1) Select HD Main Valve

The HD Series Pilot-Operated Regulating Valves are used for controlling pressure and temperature in industrial and HVAC steam applications.

Typical Applications

- **Pressure** Regulating
- **Temperature** Regulating
- **Pressure-Temperature** Control
- **Back Pressure** Control
- **Differential Pressure** Control

2) Select HD Pilot(s)

Model: **PP**

For Pressure Control

- HD Main Valve *with*
- PP Pressure Pilot

Model: **PT**

For Temperature Control

- HD Main Valve *with*
- PT Temperature Pilot

Model: **PT**

Model: **PP**

For Combination Pressure & Temperature Control

- HD Main Valve *with*
- PT Pressure Pilot &
- PP Temperature Pilot

Combination Pilots

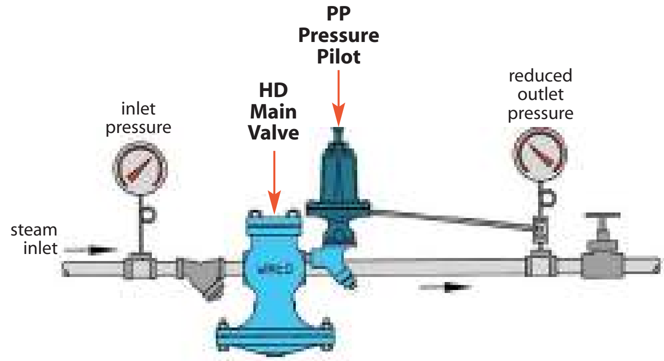
The HD-Series Steam regulating valve can be used with up to three pilots simultaneously to control the operation of the valve. An example is when steam is used to heat water in a Heat Exchanger. The Temperature Pilot will maintain precise control of outlet water temperature by controlling the amount of steam flow through the valve while a Pressure Pilot limits the maximum outlet steam pressure of the regulator to the Heat exchanger. A third pilot (Solenoid pilot) can be added to electrically activate or de-activate the system.

Introduction • Typical Applications

HD Main Valve
with
PP-Pressure Pilot

Reducing Pressure

Several choices of pilot valves can be used for pressure reduction on steam applications. The opening of the pressure pilot controls the operation of the Main Valve. The PP & PP5 are referred to as spring loaded pressure pilots because an adjustable control spring is used to apply the opening force to the pilot valve. Pressure adjustment screw is located on top of pressure pilot. The PA pilot is referred to as an Air Loaded pressure pilot because Air Pressure is used to apply the opening force to the pilot valve. The PA pilot allows for convenient and remote adjustment of steam pressure using a small air regulator.

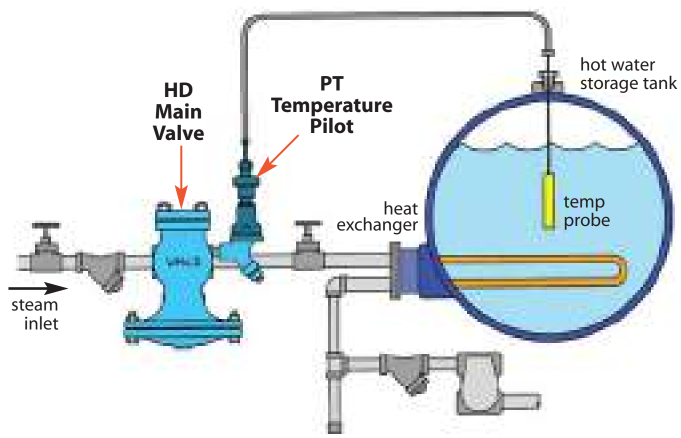


HD Main Valve
with
PT-Temperature Pilot

Controlling Temperature

When steam is used on heating applications, several choices of pilots are available. The PT pilot (most common) is referred to as a "solid liquid fill" and contains a temperature probe connected by a length of capillary tubing to a bellows in the pilot valve. When the temperature bulb is heated the liquid inside the probe expands the bellows and closes off the pilot valve. PTRP pilot operates in a similar fashion except this style is referred to as a vapor tension unit.

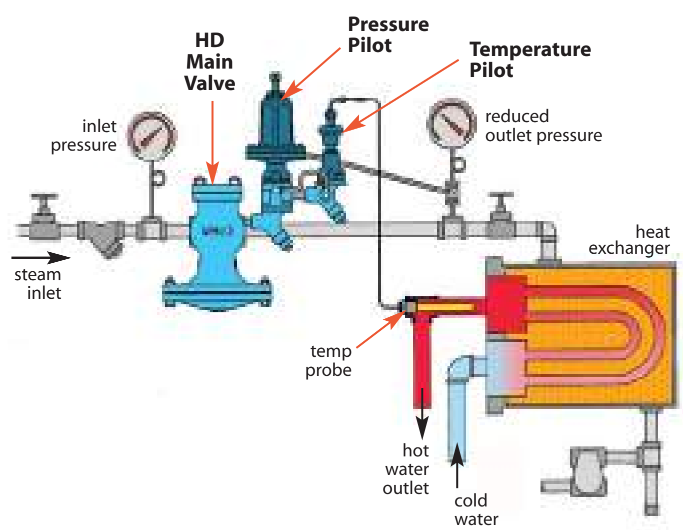
The PTL temperature controller uses a bi-metal element to sense temperature and deliver an appropriate air signal to a PA air pilot that controls the operation of the HD main valve.

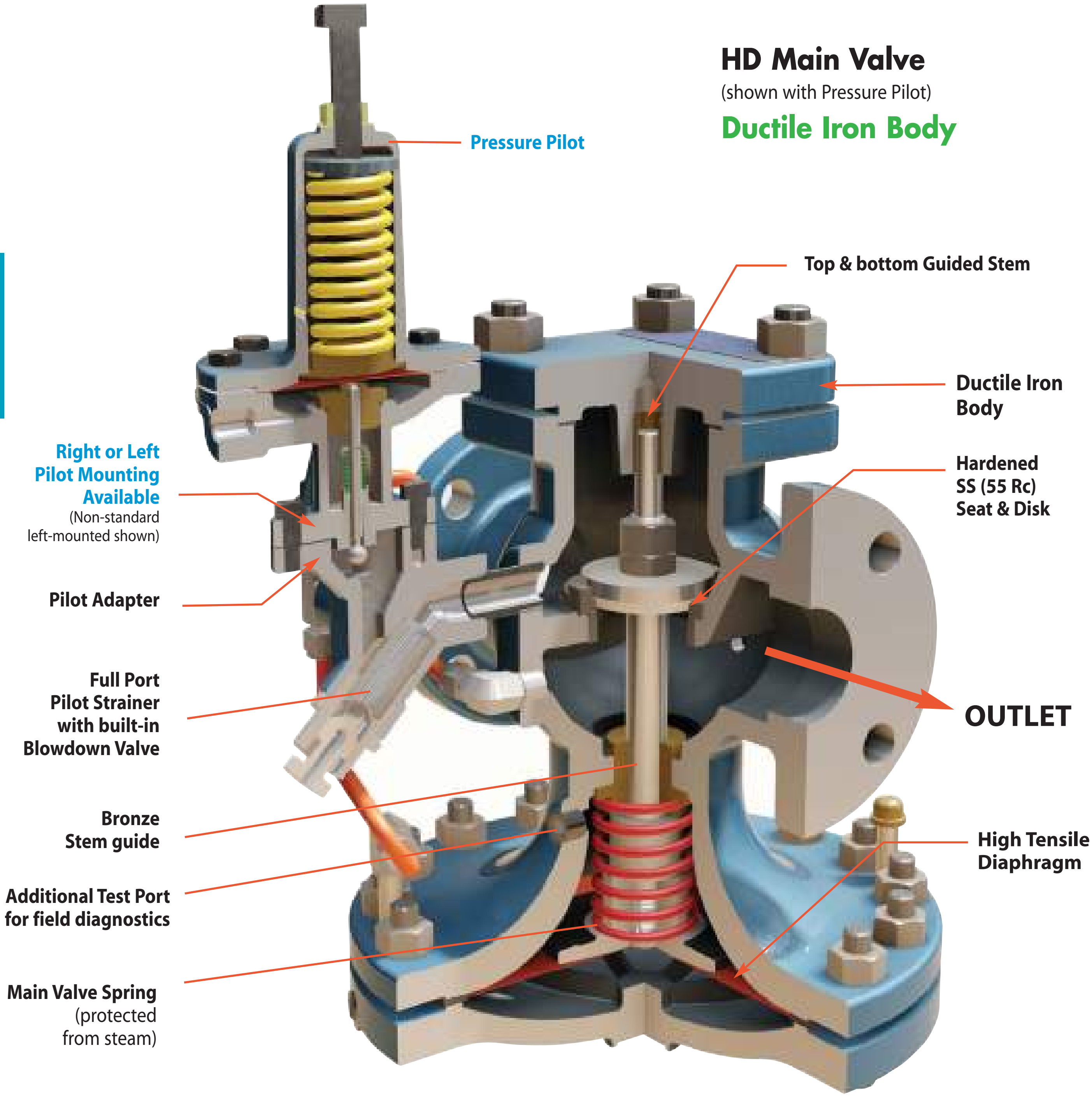


HD Main Valve
with
PP-Pressure Pilot
and
PT-Temperature Pilot

Controlling Temperature & Limiting Pressure to a Maximum Value

The PT & PP Pilot combination is used when it's required to control **temperature** while limiting **downstream pressure** to a maximum value. When the PT & PP Pilot combination is used, the downstream pressure is limited to a maximum setting by the pressure pilot, while the temperature pilot maintains the correct temperature of the process.





Features of the HD Regulating Valve

- No external power source is required.
- Pressure & temperature pilots can be used in combination, eliminating the need for a separate pressure and temperature regulator.
- Ductile iron body for higher pressure ranges and increased safety when compared to cast iron.
- Full port strainer and blowdown valve on pilot adapter for ultimate protection against dirt and scale.
- Hardened stainless steel trim (55 Rc) for extended life even in the most demanding applications.
- The innovative design allows the pilot to be mounted on either side of the regulator and is easily field-reversible without having to rebend tubing.
- Tubing and pilot adapter is pre-mounted on main valve. The control pilot requires only four bolts to complete the installation.

HD Pilot-Operated Regulating Valve

Introduction

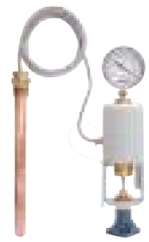
PP & PP5
PRESSURE
Pilot
Spring-Loaded

PA
PRESSURE
Pilot
Air-Loaded

PT
TEMPERATURE
Pilot
Liquid Filled

PBP
BACK
PRESSURE
Pilot

PS
ON/OFF
(Solenoid)



PTRP
TEMPERATURE
Pilot
Vapor Tension

PDP
DIFFERENTIAL
PRESSURE
Pilot

Typical Configurations

The **HD Series Pilot-Operated Regulating Valve** was designed for extremely accurate control of temperature and pressure in steam service applications. The HD-Series is made of Ductile Iron for extended pressure and temperature ratings when compared to cast iron. Several different control pilots can be mounted to the valve to control pressure, temperature, or a combination of both. When two or more pilots are used together (both a pressure and a temperature pilot) an additional pilot adapter for the second pilot is required (must indicate when ordering). The most common pilots are the PP-Pilot for pressure reducing, and the PT-Pilot for temperature control. **The Standard Main Valve** is used for an inlet steam pressure range of 15-300 PSI. The **Low-pressure Main Valve** contains a different main valve spring and is available for an inlet pressure range of 5-20 PSI. The Main Valve and Pilot are purchased separately.

Pressure Control

When controlling pressure, there are several options you can use for a pilot. The **PP**-Pilot and the **PP5**-Pilot are both **spring-adjusted** pressure pilots. The **PP**-Pilot is used on general-purpose pressure reducing applications and the **PP5**-Pilot is used when higher accuracy is required. The **PA**-Pilot is air controlled and allows for easier and remote adjustment of steam pressure.

Temperature Control

Several choices of pilot valves can be used for temperature control when steam is used on heating applications. The **PT** style pilot (most common) is referred to as a "solid liquid fill" and contains a temperature probe connected by a length of capillary tubing to a bellows in the pilot valve. When the temperature bulb is heated the liquid inside the probe expands the bellows and closes off the pilot valve. **PTRP** pilot operates in a similar fashion except this style is referred to as a vapor tension unit.

The **PTL** temperature controller uses a bi-metal element to sense temperature and deliver an appropriate air signal to a **PA** air pilot that controls the operation of the HD main valve.

Temperature-Pressure Control

The **PP** & **PT-**Pilot combination is used when it is desirable to control both the **pressure** and **temperature** of a system with only one regulating valve. The unique features of this modular valve allow this to be accomplished quite easily. When the **PP** & **PT-**Pilot combination is used, the downstream pressure is limited to a maximum setting by the pressure pilot, while the temperature pilot maintains the correct temperature.

On-Off Operation

Electrical **On-off control** of the regulator is possible by using the **PS**-Solenoid Pilot. The **PS**-Pilot allows the regulator to be shut off or turned on **electrically**. Normally the regulator is equipped with either a **PP**-Pressure Pilot or **PT**-Temperature Pilot in addition to the **PS**-Solenoid Pilot.

Back Pressure

When controlling the back pressure in a steam system, the **BP**-Pilot is used in conjunction with the **HD-Series** Regulator. This controls the pressure on the upstream side of the regulator.

Differential Pressure

The **PDP**-Pilot is used when trying to balance two different media sources that are being blended.

Stainless Diaphragm Option

The HD regulator is supplied standard with a high tensile strength Phosphor Bronze diaphragm which has been determined thru experience and testing to be the absolute best diaphragm material choice for steam applications. Stainless Steel diaphragms are offered as an option because certain industry specifications have been written requiring stainless steel. Note: Stainless steel is prone to work hardening and will not last as long as phosphor bronze; only use if required by the specification to do so.

Stainless Tubing Option

Copper tubing is supplied as standard. Copper tubing offers excellent corrosion resistance and is easy to bend and manipulate and normally outlasts the life span of the valve. Stainless Steel tubing is offered as an option.

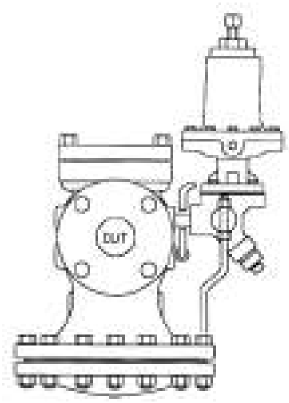
Reduced port trim Option:

Regulators should be sized to meet the application not to fit the pipe size. Over sizing a regulator may cause overshoot which leads to erratic pressure or temperature control often referred to as "hunting." A valve with reduced port trim has a reduced seat and disc size for a given pipe size, (refer to capacity charts).

Low pressure (differential and inlet) Option:

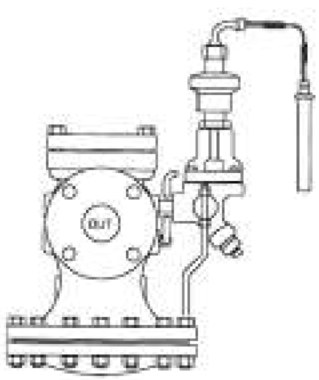
Regulators require a minimum Inlet pressure as well as a minimum pressure drop across the valve to operate properly. The HD Standard Main valve requires a minimum inlet pressure of 15 PSIG and minimum differential pressure of 10 PSI. The Low Pressure Main valve requires 5 PSIG minimum inlet pressure and 3 PSI minimum differential pressure. Low pressure main valve uses a EPDM diaphragm.

HD Main Valve
with
PP-Pressure Pilot
Spring-Loaded



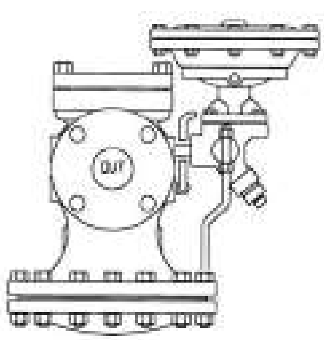
Shown with **PP** Pressure control Pilot. Spring-loaded pressure pilots are the most typical method of controlling downstream pressure in Steam Systems. Adjustment screw on top of pilot controls downstream steam pressure.

HD Main Valve
with
PT-Temperature Pilot



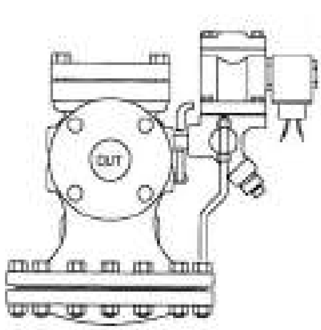
Shown with Temperature control Pilot: The **PT** Temperature Pilot will control the flow of steam flowing through the HD valve based on the temperature of the sensing bulb. The liquid-filled sensing Bulb is available in standard 8 ft and 15 ft capillary lengths. Other lengths available.

HD Main Valve
with
PA-Pressure Pilot
Air-Loaded



Shown with Air-loaded pressure control pilot. Air-loaded pressure pilots are used to reduce and control pressure in steam systems. They are used as an alternative to the more common spring-loaded pilot. The **PA** Air-loaded pressure pilot allows for remote adjustment of the valve using a small air regulator to alter the air pressure to the top of the pilot.

HD Main Valve
with
PS On/Off Control Solenoid Pilot

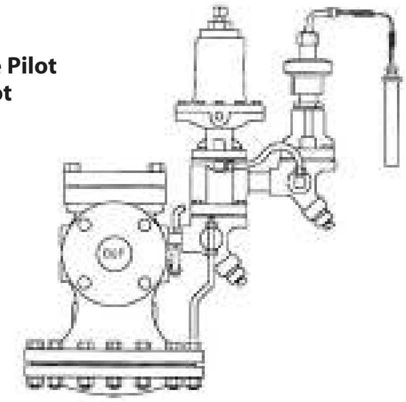


Shown with **PS** ON-OFF (solenoid Pilot) control pilot: The **PS** ON-OFF (solenoid) Pilot allows for the HD valve to be opened and closed using an electrical switch to activate a small solenoid valve. The **PS** Pilot can be used for system automation or as a safety shut down device. The ON-OFF pilot is most often used in conjunction with a Pressure or Temperature control pilot.

HD Regulator & Pilot Combinations

HD Main Valve

with
- **PT-Temperature Pilot**
- **PP-Pressure Pilot**

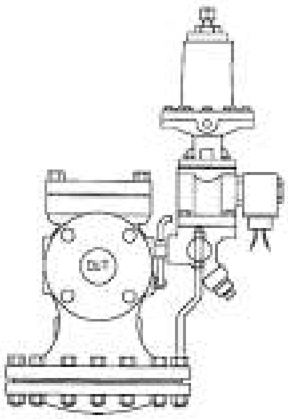


The **PT** Temperature Pilot will maintain the proper flow of steam through the main valve to keep the process it's controlling at the proper temperature. The **PP** pressure Pilot will LIMIT the downstream pressure to a maximum value. This combination of Pilots is very convenient when the Steam Pressure in the supply line is greater than the maximum pressure allowed to the process heat exchanger. This eliminates using a separate Pressure reducing valve prior to the temperature control valve.

NOTE: When two or more pilots are used on the same valve: An additional Pilot Adapter for Second Pilot is required: Use part number: **BADAPTER**

HD Main Valve

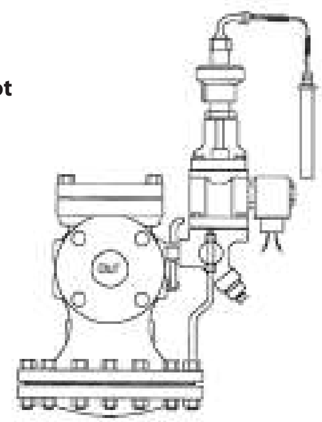
with
- **PP-Pressure Pilot**
- **PS1 On/Off Control Solenoid Pilot**



The **PP** Pressure Pilot will maintain the desired downstream set pressure as long as the **PS** ON-OFF (solenoid) Pilot is in the ON position. Available in either Normally-ON or Normally-OFF configuration; an electrical signal turns valve OFF or ON.

HD Main Valve

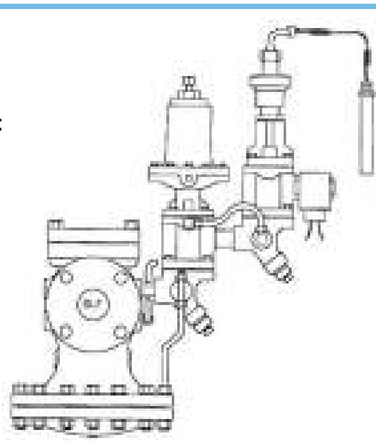
with
- **PT-Temperature Pilot**
- **PS1 On/Off Control Solenoid Pilot**



The **PT** Temperature Pilot will maintain the proper flow of steam through the main valve to keep the process it's controlling at the proper temperature as long as the **PS** ON-OFF (solenoid) Pilot is in the ON position. Available in either Normally-ON or Normally-OFF configuration; an electrical signal turns valve OFF or ON.

HD Main Valve

with
- **PP-Pressure Pilot**
- **PT-Temperature Pilot**
- **PS1 On/Off Control Solenoid Pilot**



The **PT** Temperature Pilot will maintain the proper flow of steam through the main valve to keep the process it's controlling at the proper temperature as long as the **PS** ON-OFF (solenoid) Pilot is in the ON position. The **PP** Pressure Pilot will LIMIT the downstream pressure to a maximum value.

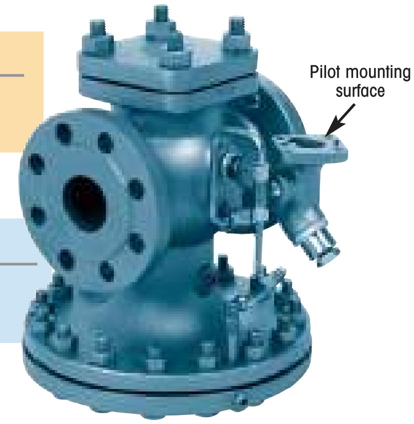
NOTE: When two or more pilots are used on the same valve: An additional Pilot Adapter for Second Pilot is required: Use part number: **BADAPTER**

HD Main Valve • Ductile Iron

Main Valve	**HD-Series**
Sizes	**1/2" – 6"**
Connections	**NPT: 1/2" - 2"** **FLG: 1" - 6"**
Body Material	**Ductile Iron**
PMO Max. Operating Pressure	**300 PSIG**
Design Pressure/ Temperature Ratings TMA/PMA	NPT 450 PSIG @ 650° F 150# FLG 150 PSIG @ 566° F 300# FLG 450 PSIG @ 650° F

STANDARD Main Valve Spring:
Inlet Pressure: **15-300 PSIG**
Example Model Code: **HD-12-N**

LOW-PRESSURE Main Valve Spring:
Inlet Pressure: **5-20 PSIG**
Example Model Code: **HD-12-N-LP**



Model Code Configuration Chart

Models		Code	Size	Code	Connection Type	Options	(Suffix)
HD	Full Port	**12**	1/2"	**N**	NPT (1/2"–2")	**SSD**	SS Diaphragm
HDR	Reduced Port	**13**	3/4"	**BSP**	BSPT (1/2"–2")	**SSXT**	SS External Tubing
		14	1"	**F150**	150# FLG (1" – 6")	**LP**	Low Pressure Main Valve Spring with EPDM Diaphragm
		15	1 1/4"	**F300**	300# FLG (1" – 6")		
		16	1 1/2"				
		17	2"				Note: For more than one Option, combine suffixes. **Example: SSD-SSXT**
		18	2 1/2"				
		19	3"				
		20	4"				
		22	6"				

Model Codes below are for HD Main Valve ONLY. Control Pilot must be ordered separately. When two or more pilots are used on the same valve, a pilot adapter must be ordered also. Use Part Number BADAPTER.

Size/Connection	**STANDARD** Inlet Pressure 15 - 300 PSI	**LOW-PRESSURE** Inlet Pressure 5 - 20 PSI	Weight lbs
1/2" NPT	**HD-12-N**	**HD-12-N-LP**	24
3/4" NPT	**HD-13-N**	**HD-13-N-LP**	24
1" NPT	**HD-14-N**	**HD-14-N-LP**	30
1" 150# FLG	**HD-14-F150**	**HD-14-F150-LP**	31
1" 300# FLG	**HD-14-F300**	**HD-14-F300-LP**	34
1 1/4" NPT	**HD-15-N**	**HD-15-N-LP**	50
1 1/2" NPT	**HD-16-N**	**HD-16-N-LP**	51
1 1/2" 150# FLG	**HD-16-F150**	**HD-16-F150-LP**	54
1 1/2" 300# FLG	**HD-16-F300**	**HD-16-F300-LP**	60
2" NPT	**HD-17-N**	**HD-17-N-LP**	72
2" 150# FLG	**HD-17-F150**	**HD-17-F150-LP**	80
2" 300# FLG	**HD-17-F300**	**HD-17-F300-LP**	82
2 1/2" 150# FLG	**HD-18-F150**	**HD-18-F150-LP**	105
2 1/2" 300# FLG	**HD-18-F300**	**HD-18-F300-LP**	109
3" 150# FLG	**HD-19-F150**	**HD-19-F150-LP**	150
3" 300# FLG	**HD-19-F300**	**HD-19-F300-LP**	158
4" 150# FLG	**HD-20-F150**	**HD-20-F150-LP**	230
4" 300# FLG	**HD-20-F300**	**HD-20-F300-LP**	250
6" 150# FLG	**HD-22-F150**	**HD-22-F150-LP**	450
6" 300# FLG	**HD-22-F300**	**HD-22-F300-LP**	472

Ordering Instructions:

NOTE: When two or more pilots are used on the same valve: An additional Pilot Adapter for Second Pilot is required: (Not required for Solenoid Pilot)

Use part number: (**BADAPTER**)

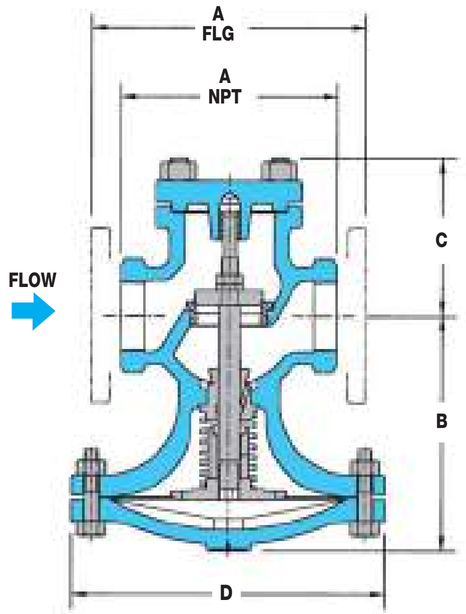
Options & Adders:	Code
Low Pressure Main Valve:	**LP**
Reduced Port Valves:	**HDR**
Stainless Steel Diaphragm:	**SSD**
Stainless Steel External Tubing:	**SSXT**
Required for secondary Pilot: (Not required for Solenoid Pilot)	**BADAPTER**

Example Model Codes for Main Valve:

1) **HD-15-N**
(HD Series Valve with 1 1/4" Threaded, NPT connections)
2) **HDR-16-F150**
(HD Series Valve, Reduced Port with 1 1/2" 150# Flanged connections)
3) **HD-20-F300-SSXT**
(HD Series Valve with 4" 300# Flanged connections & SS External tubing)

HD Series

HD Main Valve • Ductile Iron



HD-Series DIMENSIONS – *inches*

	(A) Face-To-Face						Weight (lbs)		
Size	**NPT**	**150#**	**300#**	**B**	**C**	**D**	**NPT**	**150#**	**300#**
1/2"	4 3/8			5 1/2	3 3/8	6 1/2	18		
3/4"	4 3/8			5 1/2	3 3/8	6 1/2	18		
1"	5 3/8	5 1/2	6	6 1/4	3 1/2	7	23	40	45
1 1/4"	6 1/2			7 3/8	4 7/8	8 3/4	43		
1 1/2"	7 1/4	6 7/8	7 3/8	7 3/8	4 7/8	8 3/4	43	55	60
2"	7 1/2	8 1/2	9	8 1/4	5 3/8	10 7/8	65	75	85
2 1/2"		9 3/8	10	9	5 3/4	11 3/4		100	105
3"		10	10 3/4	8 7/8	6 3/4	13 1/4		130	145
4"		11 7/8	12 1/2	10 7/8	7 1/2	14 3/4		215	235
6"		15 1/8	16	14 1/8	10	19 3/4		420	470

Option: Stainless diaphragms and external tubing - consult factory

Standard pilot mounting is on the right side of the regulator when looking into the outlet port (as shown). Pilot mounting on HD regulators are field-reversible.

Pilot-Operated REGULATORS

OPERATING PRESSURES

Inlet Pressure Range: (for Main Valve):
15 PSIG (Standard Main Valve)
5 PSIG (Low-Pressure Main Valve)

Minimum Differential Pressure (for Main Valve):*
10 PSI (Standard Main Valve)
3 PSI (Low-Pressure Main Valve)

** Not required for Temperature Pilot applications*

MATERIALS	
Body	**Ductile Iron**
Cover	**Ductile Iron**
Gasket	Grafoil/Garlock
Cover Screws	Steel
Pilot Adapter	**Ductile Iron/Cast Steel**
Screen	Stainless Steel
Tubing	Copper
Valve Seat	Hardened SST (55Rc)
Valve Disc	Hardened SST (55Rc)
Diaphragm	Phosphor Bronze (standard) EPDM (Low Pressure Main Valve)

Ordering Instructions: HD Series Regulator with a Pilot

Model Code for Main Valve:	**HD-19-F150**	HD Series Valve with 3" 150# Flanges
Model Code for Pilot:	**PP-B**	Pressure Pilot, 20-100 PSIG (Blue spring color)

HD Valve with Pressure Pilot

Model Code for Main Valve: **HD-17-F150**
(2" HD Series Valve with 150# Flanges)

Model Code for Pilot: **PP-B**
(Pressure Pilot with 20-100 PSIG Range)

HD Valve with Temperature Pilot

Model Code for Main Valve: **HD-17-F150**
(2" HD Series Valve with 150# Flanges)

Model Code for Pilot: **PTU-14-8**
(Temperature Pilot (100-160° F) with 8 Ft. Capillary)

HD Valve with Pressure & Temperature Pilots

* If 2 Pilots are used on the same valve, a Secondary Pilot Adapter is required.

Model Code for Main Valve: **HD-17-F150**
(2" HD Series Valve with 150# Flanges)

Model Code for Pilot: **PP-B**
(Pressure Pilot with 20-100 PSIG Range)

Model Code for Pilot: **PTU-14-8**
(Temperature Pilot (100-160° F) with 8 Ft. Capillary)

Model Code for Secondary Pilot Adapter*: **BADAPTER**

Pressure Regulating with PP & PP5 Spring-loaded Pilot

Pressure Pilot	(Standard: 1.0 psig accuracy)	**PP**
	(High-accuracy: 0.5 psig accuracy)	**PP5**
Pilot Body Material		**Cast Steel**
Max Inlet Pressure		**300 PSIG**
Reduced Outlet Pressure Range		**3-200 PSIG**
Inlet Pressure Range		
(with **HD** Standard main valve)		**15-300 PSIG**
(with **HD** Low-Pressure (LP) main valve)		**5-20 PSIG**
Minimum Differential Pressure		
(with **HD** Standard main valve)		**10 PSI**
(with **HD** Low-Pressure (LP) main valve)		**3 PSI**

Typical Applications

The **PP & PP5 Pressure Pilots** are used with the HD Regulator to control steam pressure in steam mains or for process equipment. Pilot-operated regulators maintain constant downstream pressure even when the inlet pressure to the valve fluctuates or steam usage varies. The PP-Pressure Pilot is adequate for controlling pressure in most industrial applications. For increased accuracy use the PP5 Pilot.

PP-Pressure Pilot (Standard) **1.0 PSIG accuracy**
PP5-Pressure Pilot (Special Applications) **0.5 PSIG accuracy**

Features

- The **PP**-Pilot can maintain downstream pressure to ±1 PSIG
- **PP5**-Pilot can maintain downstream pressure to ±0.5 PSIG
- Choices of three overlapping pressure ranges
- Pilot is easily installed on pilot adapter using four bolts, no tubing connections are required
- Full port strainer and blowdown valve on pilot adapter for protection of pilot from dirt and scale
- Solid floating diaphragm is more failure resistant
- Watson McDaniel's pilots can be used with other manufacturers' regulators

Options

- Pressure pilot can be used with temperature pilot to eliminate the need for two separate regulators
- Solenoid pilot can be added for remote on/off control of regulator

Example: **PP-B Pilot at 20-100 PSIG**

Reduced Pressure Range PSI	Model Code	Spring Color	Weight lbs
PP-Pressure Pilot (for Standard Industrial Applications) 1.0 PSIG accuracy			
3-25	**PP-Y**	Yellow	10
20-100	**PP-B**	Blue	10
80-200	**PP-R**	Red	10
PP5-Pressure Pilot (Special Applications) 0.5 PSIG accuracy			
1-10	**PP5-Y***	Yellow	25
10-25	**PP5-B***	Blue	25

* A Spacer (model # BAP-SPACE) is required when using PP5 Pressure Pilots on a 3" & 4" HD Main Valve.

HD Main Valve
with
PP-Pressure Pilot

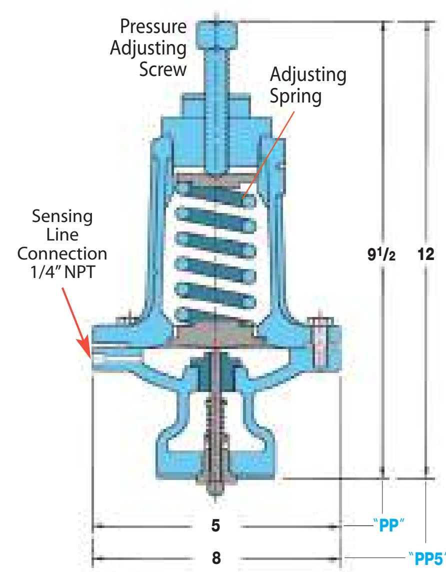
Model Code for Main Valve: **HD-17-F150**
(2" HD Series Valve with 150# Flanges)

Model Code for Pilot: **PP-B**
(Pressure Pilot with 20-100 PSIG Range)

MATERIALS for PP Pressure Pilot	
PP Pilot Body	**WCb 216 Cast Steel**
PP5 Pilot Body	**Cast Iron**
Head & Seat Gasket	302 SS
Diaphragm	Phosphor Bronze
Head & Seat Assembly	Hardened SST (55 Rc)

MATERIALS for HD Main Valve	
Body	**Ductile Iron**
Cover	**Ductile Iron**
Gasket	Grafoil/Garlock
Cover Screws	Steel
Pilot Adapter	**Ductile Iron/Cast Steel**
Screen	Stainless Steel
Tubing	Copper
Valve Seat	Hardened SST (55 Rc)
Valve Disc	Hardened SST (55 Rc)
Diaphragm	Phosphor Bronze

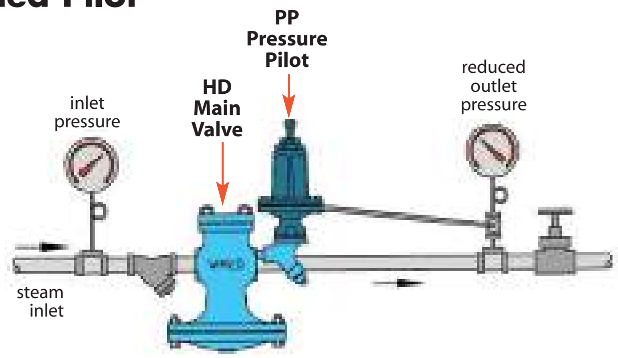
Units: inches

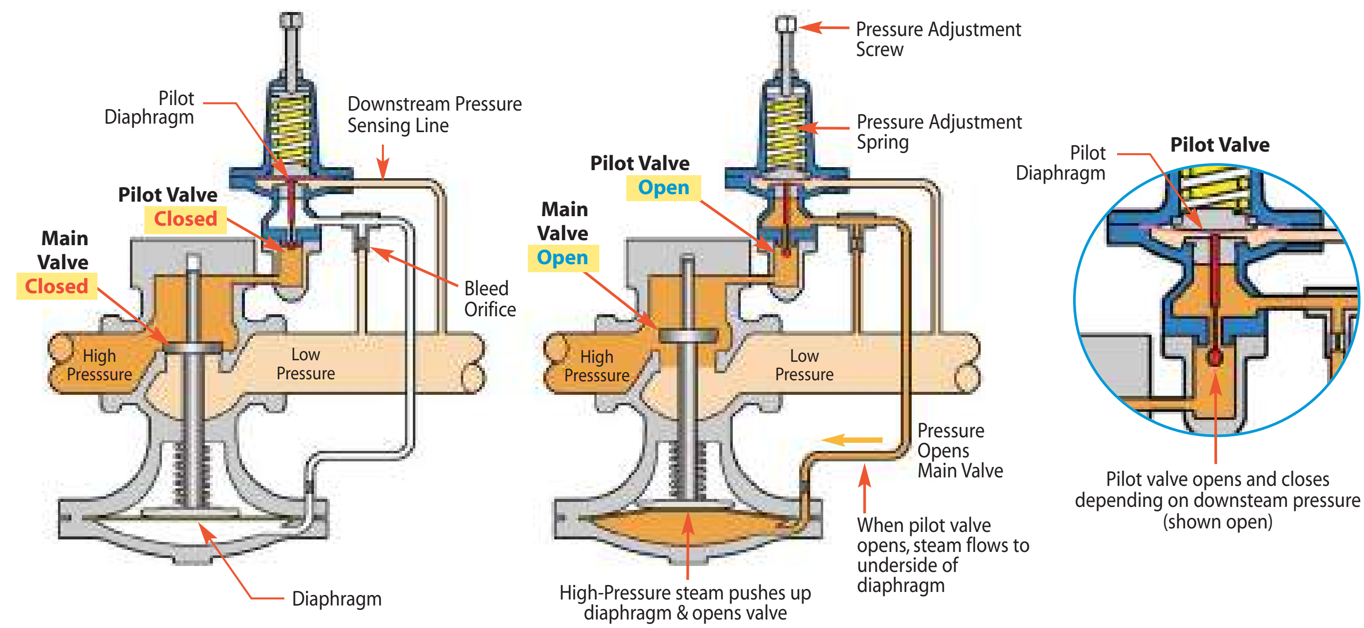


Pressure Regulating with PP & PP5 Spring-loaded Pilot

Reducing Pressure

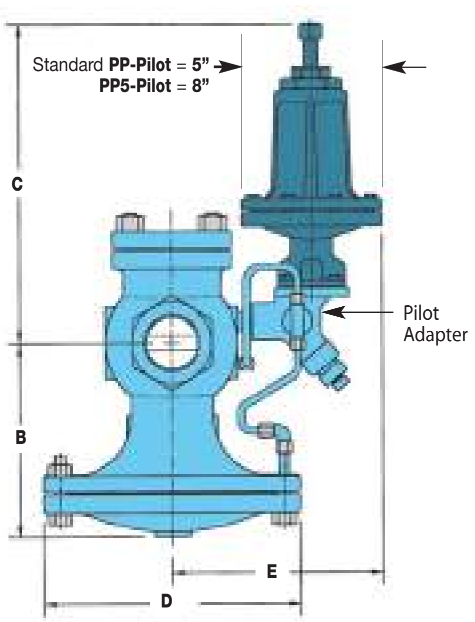
The **PP**-Pilot and the **PP5**-Pilot are both **spring-adjusted** pressure pilots. The **PP**-Pilot is used on typical general-purpose pressure reducing applications. The **PP5**-Pilot is used when higher accuracy is required and is capable of maintaining a control pressure window of less than 1 PSI.





How it Works

The Pressure Pilot controls the operation of the HD Regulator. The sensing line connects the pressure pilot to the downstream side of the regulator. Pressure in the sensing line applies an upward force to the pilot diaphragm to compress the adjustment spring. When system pressure equals set point, the diaphragm moves upwards against the force of the adjusting spring, closing pilot valve. When the pilot valve is shut, steam cannot pass thru to the underside of the regulator diaphragm, closing the regulator. When the steam pressure falls below its set point, the pilot valve opens allowing steam to lift the main valve diaphragm which opens up the regulating valve.



DIMENSIONS HD-Series – *inches*

	Face-To-Face							Weight (lbs)	
Size	**NPT**	**150#**	**300#**	**B**	**C***	**D**	**E****	**NPT**	**FLG**
1/2"	4 3/8	-	-	5 1/2	11 7/8	6 1/2	7 3/4	18	-
3/4"	4 3/8	-	-	5 1/2	11 7/8	6 1/2	7 3/4	18	-
1"	5 3/8	5 1/2	6	6 1/4	11 7/8	7	7 3/4	23	35
1 1/4"	6 1/2	-	-	7 3/8	11 7/8	8 3/4	8 1/4	43	-
1 1/2"	7 1/4	6 7/8	7 3/8	7 3/8	11 7/8	8 3/4	8 1/4	43	60
2"	7 1/2	8 1/2	9	8 1/4	11 7/8	10 7/8	8 1/2	65	85
2 1/2"	-	9 3/8	10	9	11 7/8	11 3/4	8 1/2	-	105
3"	-	10	10 3/4	8 7/8	11 7/8	13 1/4	9 1/2	-	145
4"	-	11 7/8	12 1/2	10 7/8	11 7/8	14 3/4	10 1/2	-	235
6"	-	15 1/8	16	14 1/8	12 1/2	19 3/4	11 3/4	-	470

For PP5 Pilot: * *For sizes 1/2" to 1 1/2" add 2 1/2" to "C" dimension;*
For sizes 2" to 6" add 5" to "C" dimension.
** *Add 1 1/2" to "E" dimension for all sizes.*

Back Pressure Regulating with PBP Back-Pressure Pilot

Back Pressure Pilot	**PBP**
Pilot Body Material	**Ductile Iron**
Max Inlet Pressure	**300 PSIG**
Reduced Outlet Pressure Range	**10-200 PSIG**
Inlet Pressure Range (when used with **HD** Standard main valve)	**15-300 PSIG**
Inlet Pressure Range (when used with **HD-LP** Low-Pressure main valve)	**5-20 PSIG**

Minimum Differential Pressure:
10 PSI (Standard Main Valve)
3 PSI (Low Pressure Main Valve)

Typical Applications

The **PBP-Back Pressure Pilot**, used with the **HD** regulator, maintains upstream pressure in steam systems. These regulators are commonly used to supply flash steam to low pressure mains.

Features

- The PBP-Pilot can maintain upstream pressure to ±1 PSIG
- Choices of three overlapping pressure ranges
- Pilot is easily installed using four bolts. No tubing connection required
- Full port strainer and blowdown valve on pilot adapter for protection of pilot from dirt and scale
- Solid floating (no penetration hole) pilot diaphragm resists failure
- Watson McDaniel's pilots can be used with other manufacturers' regulators

Option

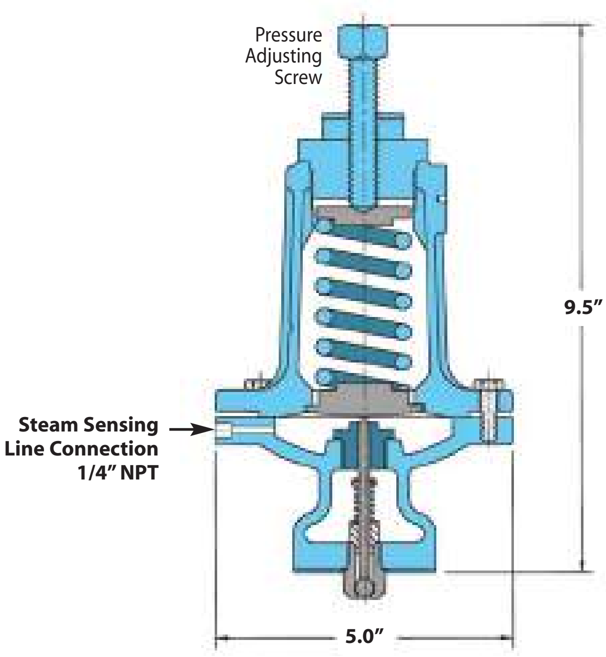
- Can be used with solenoid pilot for on/off control

Reduced Pressure Range PSI	Model Code	Spring Color	Weight lbs
10-25	**PBP-Y**	Yellow	10
20–100	**PBP-B**	Blue	10
80-200	**PBP-R**	Red	10

OPERATING PRESSURES

Inlet Pressure Range:
15-300 PSIG (Standard Main Valve)
5-20 PSIG (Low Pressure Main Valve)

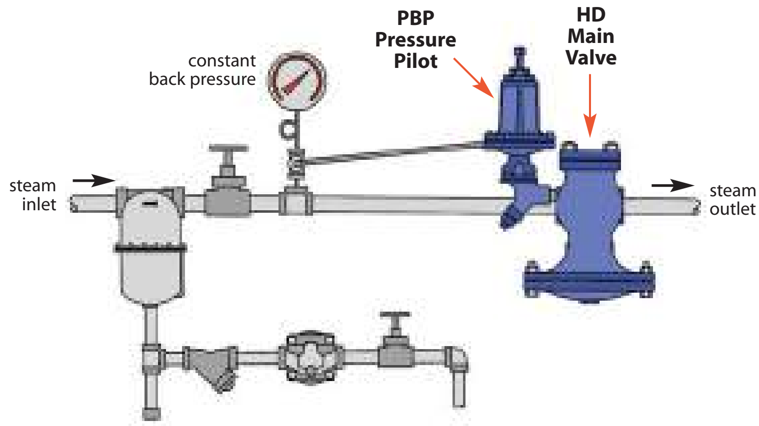
Minimum Differential Pressure:
10 PSI (Standard Main Valve)
3 PSI (Low Pressure Main Valve)

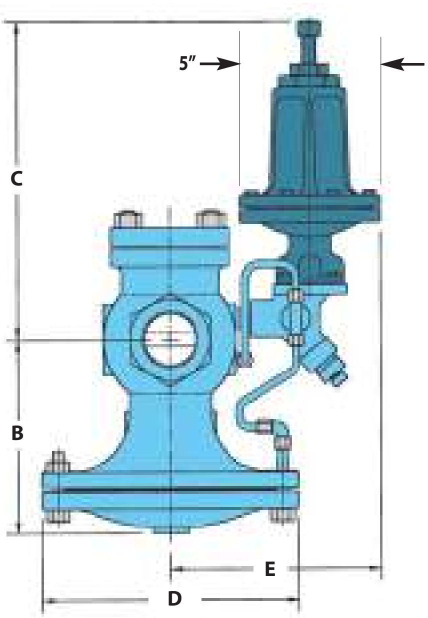


Back Pressure Regulating with PBP Back-Pressure Pilot

Back Pressure

The **PBP** Back-Pressure Pilots are used with HD Regulators to maintain upstream pressures in steam systems. When the upstream pressure reaches the pilot set point, the regulator opens. The HD Regulator with a PBP Back-Pressure Pilot is commonly used to supply steam to low-pressure mains. The PBP Back-Pressure Pilot maintains a constant back-pressure on the inlet side of the regulator. Should not be used in place of a safety relief valve.





DIMENSIONS HD-Series – *inches*

	Face-To-Face							Weight (lbs)	
Size	NPT	150#	300#	B	C*	D	E**	NPT	FLG
1/2"	$4\frac{3}{8}$			$5\frac{1}{2}$	$11\frac{7}{8}$	$6\frac{1}{2}$	$7\frac{3}{4}$	18	
3/4"	$4\frac{3}{8}$			$5\frac{1}{2}$	$11\frac{7}{8}$	$6\frac{1}{2}$	$7\frac{3}{4}$	18	
1"	$5\frac{3}{8}$	$5\frac{1}{2}$	6	$6\frac{1}{4}$	$11\frac{7}{8}$	7	$7\frac{3}{4}$	23	35
$1\frac{1}{4}$"	$6\frac{1}{2}$			$7\frac{3}{8}$	$11\frac{7}{8}$	$8\frac{3}{4}$	$8\frac{1}{4}$	43	
$1\frac{1}{2}$"	$7\frac{1}{4}$	$6\frac{7}{8}$	$7\frac{3}{8}$	$7\frac{3}{8}$	$11\frac{7}{8}$	$8\frac{3}{4}$	$8\frac{1}{4}$	43	60
2"	$7\frac{1}{2}$	$8\frac{1}{2}$	9	$8\frac{1}{4}$	$11\frac{7}{8}$	$10\frac{7}{8}$	$8\frac{1}{2}$	65	85
$2\frac{1}{2}$"		$9\frac{3}{8}$	10	9	$11\frac{7}{8}$	$11\frac{3}{4}$	$8\frac{1}{2}$		105
3"		10	$10\frac{3}{4}$	$8\frac{7}{8}$	$11\frac{7}{8}$	$13\frac{1}{4}$	$9\frac{1}{2}$		145
4"		$11\frac{7}{8}$	$12\frac{1}{2}$	$10\frac{7}{8}$	$11\frac{7}{8}$	$14\frac{3}{4}$	$10\frac{1}{2}$		235
6"		$15\frac{1}{8}$	16	$14\frac{1}{8}$	$12\frac{1}{2}$	$19\frac{3}{4}$	$11\frac{3}{4}$		470

MATERIALS for PBP Back-Pressure Pilot	
Pilot Body & Cover	**Cast Steel**
Head & Seat Gasket	302 SS
Diaphragm	Phosphor Bronze
Head & Seat Assembly	Hardened SST (55 Rc)

MATERIALS for HD Main Valve	
Body	**Ductile Iron**
Cover	**Ductile Iron**
Gasket	Grafoil/Garlock
Cover Screws	Steel
Pilot Adapter	**Ductile Iron/Cast Steel**
Screen	Stainless Steel
Tubing	Copper
Valve Seat	Hardened SST (55 Rc)
Valve Disc	Hardened SST (55 Rc)
Diaphragm	Phosphor Bronze

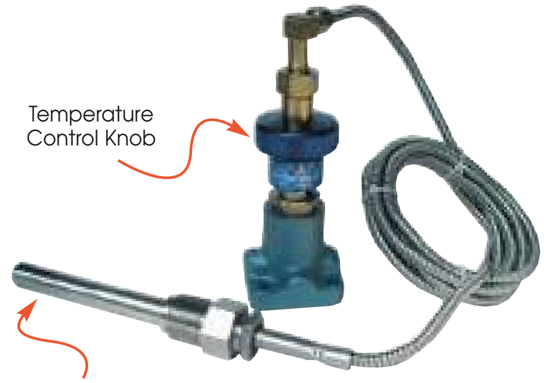
HD Main Valve
with
PBP-Pressure Pilot

Model Code for Main Valve: **HD-17-F150**
(2" HD Series Valve with 150# Flanges)

Model Code for Pilot: **PBP-B**
(Back-Pressure Pilot with 20-100 PSIG Range)

Temperature Regulating with PT Temperature Pilot

Temperature Pilot	**PT**
Pilot Body Material	**Ductile Iron**
Max Inlet Pressure	**300 PSIG**
Temperature Control Range	**60-300˚F**
Steam Inlet Pressure Range (Standard) (when Standard Temperature Pilot is used with **HD** Standard main valve)	**15-300 PSIG**
Steam Inlet Pressure Range (Low) (when Low-Pressure Temperature Pilot is used with **HD-LP** Low-Pressure main valve)	**5-20 PSIG**



Typical Applications

The PT-Temperature Pilots are used with the HD regulator to control temperature in various processes and systems. Some examples are: oil heaters, ovens, process heaters, vats, dryers and jacketed kettles. Thermostatic sensing bulb comes with standard 8-ft. or 15-ft. capillary lengths. Temperature adjustment is accomplished by rotating an adjustment knob to the desired temperature setting.

The **HD** Regulator can be used with both the **PP-Pressure Pilot** and **PT-Temperature Pilot** simultaneously to limit pressure and control temperature in process applications.

Using both the temperature and pressure pilots on the same regulator eliminates the need for two separate regulators to control temperature and pressure.

Features

- Temperature adjustment made simple and easy by rotating an adjustment knob to the desired temperature setting
- Thermostatic sensing bulb comes with an 8-ft. or 15-ft. length capillary
- Capillary is armor-protected to resist damage
- Overheat protection bellows is incorporated into sensing bulb; 200˚F overheat protection up to 350˚F
- Full port strainer and blowdown valve on pilot adapter for protection of pilot from dirt and scale

Options

- Temperature Pilot can be combined with Pressure and Solenoid pilots
- Capillary lengths up to 25-ft. maximum
- Thermowells* for isolating sensing bulb from process liquid are available in brass or 316 stainless steel
- Extended length wells available for increased insertion depth of sensing bulb
- 316 Stainless Steel Sensing Bulb

LOW PRESSURE PT Pilot (pressures under 15 PSIG)
Use Code **LP**: Low pressure Temperature Pilot is required for steam pressure under 15 PSI. (Range 5 - 20)
PILOT: Example Model Code: **PTU-12-8-LP**

LOW PRESSURE HD Main Valve (pressures under 15 PSIG)
Use Code **LP**: A Low Pressure Main Valve must be used in conjuction with a Low Pressure Temperature Pilot for steam pressure under 15 PSIG (Range 5 - 20)
MAIN VALVE: Example Model Code: **HD-13-N-LP**

Options & Adders:

Code **LP** - Low Pressure Pilot

Code **20** 20 ft. Capillary Length
Code **25** 25 ft. Capillary Length

Example: **PTU-29-8** (with standard 8 ft capillary) is changed to 20 ft of capillary. Model code becomes **PTU-29-20**

Code **SSBBAC** - *SS bulb, bushing & 8 ft. armored capillary

*Note: The standard sensing bulb is copper. A 316 SS Bulb and bushing with 8 ft. armoured capillary is available for corrosive applications or to meet SWDA requirements. Use code **SSBBAC**

For Temperature Pilot	
Temperature Ranges	
60 - 120°F	(16 - 49°C)
100 - 160°F	(38 - 71°C)
120 - 180°F	(49 - 82°C)
160 - 220°F	(71 - 104°C)
200 - 260°F	(93 - 127°C)
240 - 300°F	(116 - 149°C)

Model Codels for Individual Thermowells for PT & PTU Pilots

Model Code	Description of Thermowell
WELL-TU-BR	Brass Thermowell for PTU pilot
WELL-TU-SS	Stainless steel Thermowell for PTU pilot
WELL-T-BR-EXT	Extended brass Thermowell for PT pilot
WELL-T-SS-EXT	Extended stainless steel Thermowell for PT pilot

* **Thermowells:**
Wells isolate sensing bulb from the process liquid and are available in Brass or Stainless Steel. When placed on the side of a tank or vessel, the sensing bulb can be removed without having to drain the process fluid.

Temperature Regulating with PT Temperature Pilot

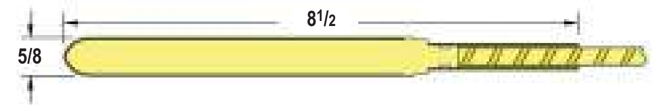
PT Pilots with 8 Ft. Capillary & Sensing Bulbs

Bulb Type	Temperature Range	Pilot Model Code
PT	60˚F-120˚F	PT-12-8
	100˚F-160˚F	PT-14-8
	120˚F-180˚F	PT-29-8
	160˚F-220˚F	PT-30-8
	200˚F-260˚F	PT-31-8
	240˚F-300˚F	PT-32-8
PTU	60˚F-120˚F	PTU-12-8
	100˚F-160˚F	PTU-14-8
	120˚F-180˚F	PTU-29-8
	160˚F-220˚F	PTU-30-8
	200˚F-260˚F	PTU-31-8
	240˚F-300˚F	PTU-32-8
PTUBW Brass Well	60˚F-120˚F	PTUBW-12-8
	100˚F-160˚F	PTUBW-14-8
	120˚F-180˚F	PTUBW-29-8
	160˚F-220˚F	PTUBW-30-8
	200˚F-260˚F	PTUBW-31-8
	240˚F-300˚F	PTUBW-32-8
PTUSW SS Well	60˚F-120˚F	PTUSW-12-8
	100˚F-160˚F	PTUSW-14-8
	120˚F-180˚F	PTUSW-29-8
	160˚F-220˚F	PTUSW-30-8
	200˚F-260˚F	PTUSW-31-8
	240˚F-300˚F	PTUSW-32-8
PTBW Brass Well	60˚F-120˚F	PTBW-12-8
	100˚F-160˚F	PTBW-14-8
	120˚F-180˚F	PTBW-29-8
	160˚F-220˚F	PTBW-30-8
	200˚F-260˚F	PTBW-31-8
	240˚F-300˚F	PTBW-32-8
PTSW SS Well	60˚F-120˚F	PTSW-12-8
	100˚F-160˚F	PTSW-14-8
	120˚F-180˚F	PTSW-29-8
	160˚F-220˚F	PTSW-30-8
	200˚F-260˚F	PTSW-31-8
	240˚F-300˚F	PTSW-32-8

All Sensing Bulbs are Copper

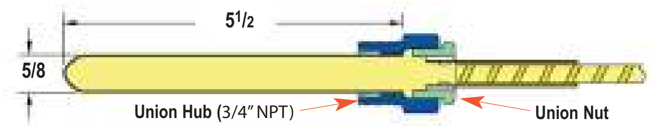
Dimension (inches)

PT



Plain copper sensing bulb that is directly immersed into the fluid. Normally the PT bulb type is lowered down vertically into the top of a tank or vat to a desired vertical insertion depth.

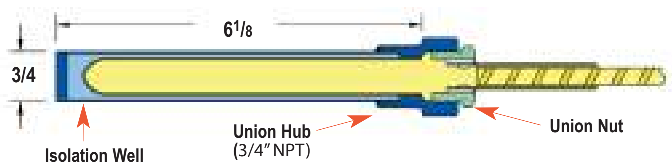
PTU



Copper sensing bulb with Union connection allowing it to be screwed into the side of a tank or pipe. The sensing bulb is in direct contact with the process fluid. Sensing bulb can be removed by unscrewing union nut (union hub remains in place).

PTUBW & PTUSW (PTU style copper sensing bulb with Thermowell)

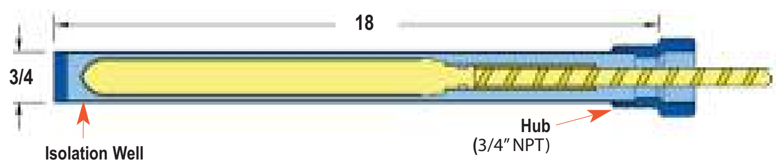
PTUBW: Brass Well
PTUSW: 316L SS Well



The Isolation Well, which isolates the copper sensing bulb from the process fluid, is available in either Brass or 316L Stainless Steel. Sensing bulb can be removed by unscrewing union nut. Union Hub & Isolation Well remain in place which allows the removal of the sensing bulb without having to drain the tank. Stainless Steel Isolation Wells are used to protect the copper sensing bulb from corrosive fluids. Brass wells have better heat transfer.

PTBW & PTSW (PT style copper sensing bulb with Extended Length Thermowell)

PTBW: Brass Well
PTSW: 316L SS Well



For deeper & variable insertion depths into tanks or vats; up to 18" deep. The extended length Isolation Well isolates the copper sensing bulb from the liquid and allows the copper sensing bulb insertion depth to be adjusted to a depth of up to 18". They are available in either Brass or 316L Stainless Steel. Isolation Well remains in place which allows the removal of the sensing bulb without having to drain the tank.

Example Model Codes:

PT-14-15	**PT** Plain Sensing Bulb (no threaded connection), 100-160 °F, 15 Ft. Capillary Length
PTUBW-30-8	**PTUBW** Sensing Bulb with Threaded Union Connection & Brass Well, 160-220 °F, 8 Ft. Capillary Length
PTBW-31-20-LP	**PTBW** Plain Sensing Bulb with Extended Brass Well, 200-260 °F, 20 Ft. Capillary Length with Low Pressure Option

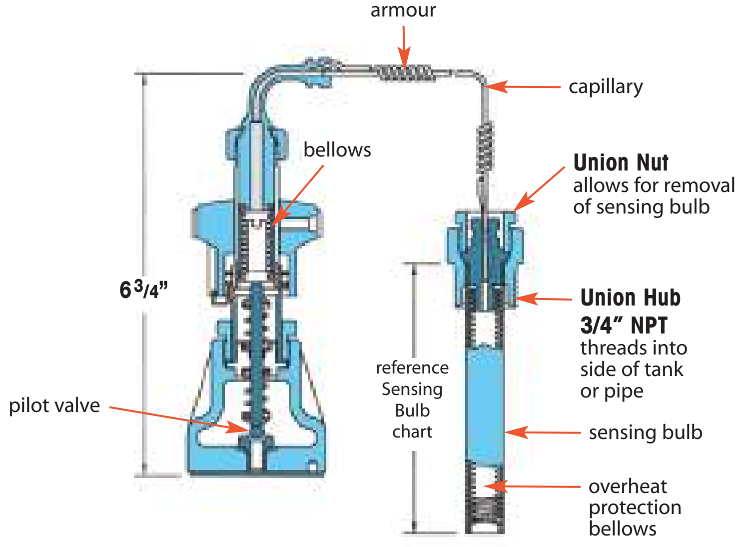
Model Code Configuration for Temperature Pilot

Example Model: **PTBW-31-8-LP**

Bulb Type		Code	Temperature Range	Code	Capillary Length	Code	Options (Suffix)
PT	Plain Sensing Bulb (no threaded connection)	**12**	60°F - 120°F	**8**	8 Feet	**LP**	Low Pressure (required under 15 PSI)
PTU	Sensing Bulb with Threaded Union Connection	**14**	100°F - 160°F	**15**	15 Feet	**SSBBAC**	SS bulb, bushing & armored capillary
PTUBW	Sensing Bulb with Threaded Union Connection & Brass Well	**29**	120°F - 180°F	**20**	20 Feet		
PTUSW	Sensing Bulb with Threaded Union Connection & 316L SS Well	**30**	160°F - 220°F	**25**	25 Feet		
PTBW	Plain Sensing Bulb with Extended Length Brass Well	**31**	200°F - 260°F				
PTSW	Plain Sensing Bulb with Extended Length 316L SS Well	**32**	240°F - 300°F				

Temperature Regulating with PT Temperature Pilot

PT Pilot Dimensions



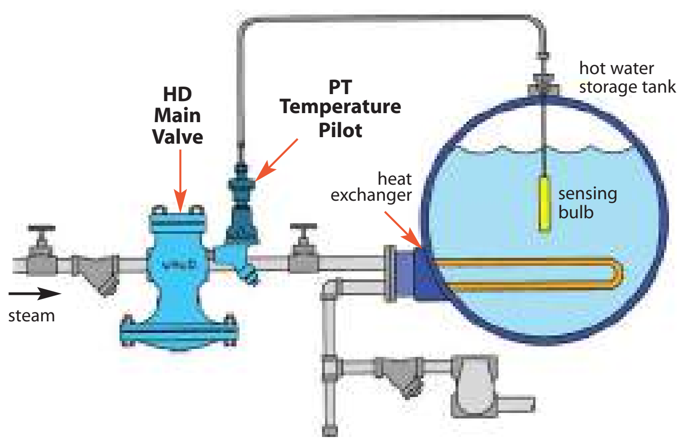
Controlling Temperature of a large Tank of Water using PT-Temperature Pilot

HD Main Valve
with
PT-Temperature Pilot

Controlling Temperature

PT-pilot is used for temperature control when steam is used on heating applications. The PT style pilot is a "solid liquid fill" design made up of a temperature probe connected by a length of capillary tubing to a bellows in the pilot valve. When the temperature bulb is heated the liquid inside the probe expands the bellows and closes off the pilot valve. The opening and closing of the pilot controls the flow of steam thru the main valve; which maintains system temperature. PT-pilot controls temperature through a range of 60-300˚F.

An overheat protection bellows is incorporated into sensing bulb.

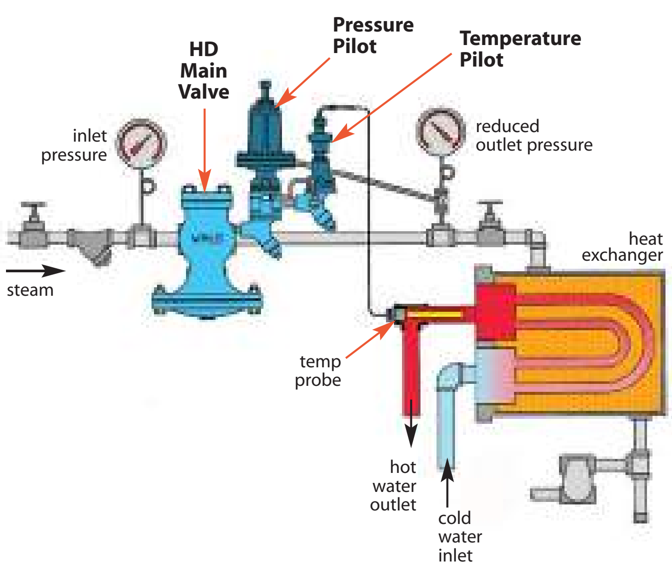


Controlling Temperature and Limiting Pressure using PT-Temperature Pilot & PP-Pressure Pilot

HD Main Valve
with
- **PP-Pressure Pilot**
- **PT-Temperature Pilot**

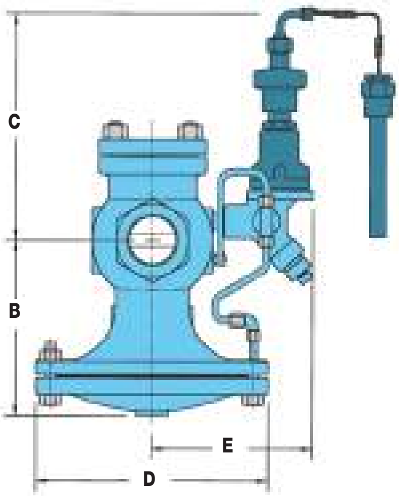
Controlling Temperature & Limiting Pressure to a Maximum Value

The **PT** & **PP** Pilots combination is used when it's required to control **temperature** while limiting **downstream pressure** to a maximum value. When the **PT** & **PP** Pilots combination is used, the downstream pressure is limited to a maximum setting by the pressure pilot, while the temperature pilot maintains the correct temperature of the process. This eliminates the need for a separate pressure reducing valve.

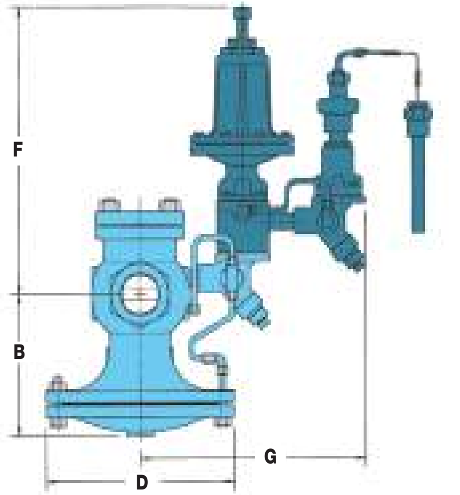


Temperature Regulating with PT Temperature Pilot

HD Valve
with
Temperature Pilot



HD Valve
with
Temperature & Pressure Pilot



DIMENSIONS HD-Series – *inches*

Size	Face-To-Face NPT	Face-To-Face 150#	Face-To-Face 300#	B	C	D	E	F	G	Weight (lbs) NPT	Weight (lbs) FLG
1/2"	4 3/8	–	–	5 1/2	9 1/4	6 1/2	6 1/2	14 1/2	10 1/4	18	–
3/4"	4 3/8	–	–	5 1/2	9 1/4	6 1/2	6 1/2	14 1/2	10 1/4	18	–
1"	5 3/8	5 1/2	6	6 1/4	9 1/4	7	8 1/4	14 1/2	10 1/4	23	35
1 1/4"	6 1/2	–	–	7 3/8	9 1/4	8 3/4	7 1/4	14 1/2	10 3/4	43	–
1 1/2"	7 1/4	6 7/8	7 3/8	7 3/8	9 1/4	8 3/4	7 1/4	14 1/2	10 3/4	43	60
2"	7 1/2	8 1/2	9	8 1/4	9 1/4	10 7/8	7 1/2	14 1/2	11 1/4	65	85
2 1/2"	–	9 3/8	10	9	9 1/4	11 3/4	7 3/4	14 1/2	11 1/4	–	105
3"	–	10	10 3/4	8 7/8	9 1/4	13 1/4	8 1/2	14 1/2	12	–	145
4"	–	11 7/8	12 1/2	10 7/8	9 1/4	6 1/2	9 1/2	14 1/2	13	–	235
6"	–	15 1/8	16	14 1/8	9 3/4	19 3/4	10 3/4	15	14 1/4	–	470

For Pressure Pilot

Pressure Ranges	Model
3-25 PSIG	PP-Y
20-100 PSIG	PP-B
80-200 PSIG	PP-R

HD Main Valve
with
PT-Temperature Pilot

Model Code for Main Valve: **HD-17-F150**
(2" HD Series Valve with 150# Flanges)

Model Code for Pilot: **PTU-14-8**
(Temperature Pilot (100-160° F) with 8 Ft. Capillary)

HD Main Valve
with
- **PP-Pressure Pilot**
- **PT-Temperature Pilot**

Model Code for Main Valve: **HD-17-F150**
(2" HD Series Valve with 150# Flanges)

Model Code for Pilot: **PP-B**
(Pressure Pilot with 20-100 PSIG Range)

Model Code for Pilot: **PTU-14-8**
(Temperature Pilot (100-160° F) with 8 Ft. Capillary)

Model Code for Secondary Pilot Adapter*: **BADAPTER**

* If 2 Pilots are used on the same valve, a Secondary Pilot Adapter is required.

MATERIALS for PT Temperature Pilot

Pilot Body	**Ductile Iron**
Bellows	Phosphor Bronze
Head & Seat Assembly	Hardened SST (55 Rc)

MATERIALS for PP Pressure Pilot

Pilot Body & Cover	**Ductile Iron or Cast Steel**
Head & Seat Gasket	302 SS
Diaphragm	Phosphor Bronze
Head & Seat Assembly	Hardened SST (55 Rc)

MATERIALS for HD Main Valve

Body	**Ductile Iron**
Cover	**Ductile Iron**
Gasket	Grafoil/Garlock
Cover Screws	Steel
Pilot Adapter	**Ductile Iron/Cast Steel**
Screen	Stainless Steel
Tubing	Copper
Valve Seat	Hardened SST (55 Rc)
Valve Disc	Hardened SST (55 Rc)
Diaphragm	Phosphor Bronze

Pressure Control with PA Air-Loaded Pilot

Pressure Pilot (Air)	**PA**
Pilot Body Material	**Ductile Iron**
Max Inlet Pressure	**300 PSIG**
Reduced Outlet Pressure Range	**3-200 PSIG**
Inlet Pressure Range (when used with **HD** Standard main valve)	**15-300 PSIG**
Inlet Pressure Range (when used with **HD-LP** Low-Pressure main valve)	**5-20 PSIG**

Minimum Differential Pressure:
10 PSI (Standard Main Valve)
3 PSI (Low Pressure Main Valve)

Note: Temperature Range: 0-350˚F when used with PTL & PTR temperature controllers

Typical Applications

The **PA** Air-Loaded **Pressure Pilot** is used with the **HD** Regulator to control steam pressure on steam mains and process equipment. The principal advantage the **PA-Air Pilot** has over standard spring-loaded pilots is that pressure adjustments to the regulator can be made from a remote location. A regulator that is located in a difficult to reach or inaccessible location can be adjusted by a remote control panel board. The **PA-Air Pilot** can also be used in conjunction with the **PTL** or **PTR** pneumatic temperature controllers for controlling temperature in process applications.

How it Works

When air pressure is applied to the upper chamber of the air pilot it exerts a downward force on the air pilot's diaphragm. This force controls the outlet pressure of the steam through the regulating valve. The control process is similar to a spring loaded pressure pilot except that the air pressure takes the place of the spring. There are three separate models of air pilots that make up the complete range depending on the steam pressure that needs to be controlled and the control air pressure available. See Pressure Adjusting Ranges chart.

Features

- Pressure adjustments to the regulator can be done from a remote location using an air signal
- Air-operated pilot ensures instant response and extremely accurate control
- Full port strainer and blowdown valve on pilot adapter for protection of pilot from dirt and scale
- Controls pressure settings within ±1 PSIG

DIMENSIONS – *inches*

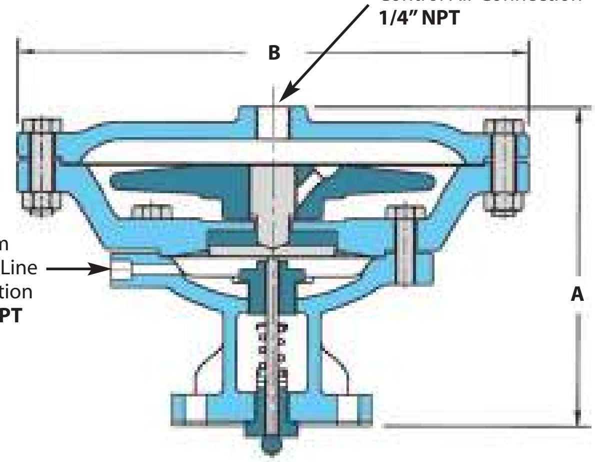
Model	A	B
PA1	5 1/4	5
PA4	5 1/4	7 7/8
PA6	5 1/4	9 1/2

MAXIMUM CONTROL AIR PRESSURE ON AIR PILOT IS 125 PSIG

PRESSURE ADJUSTING RANGES

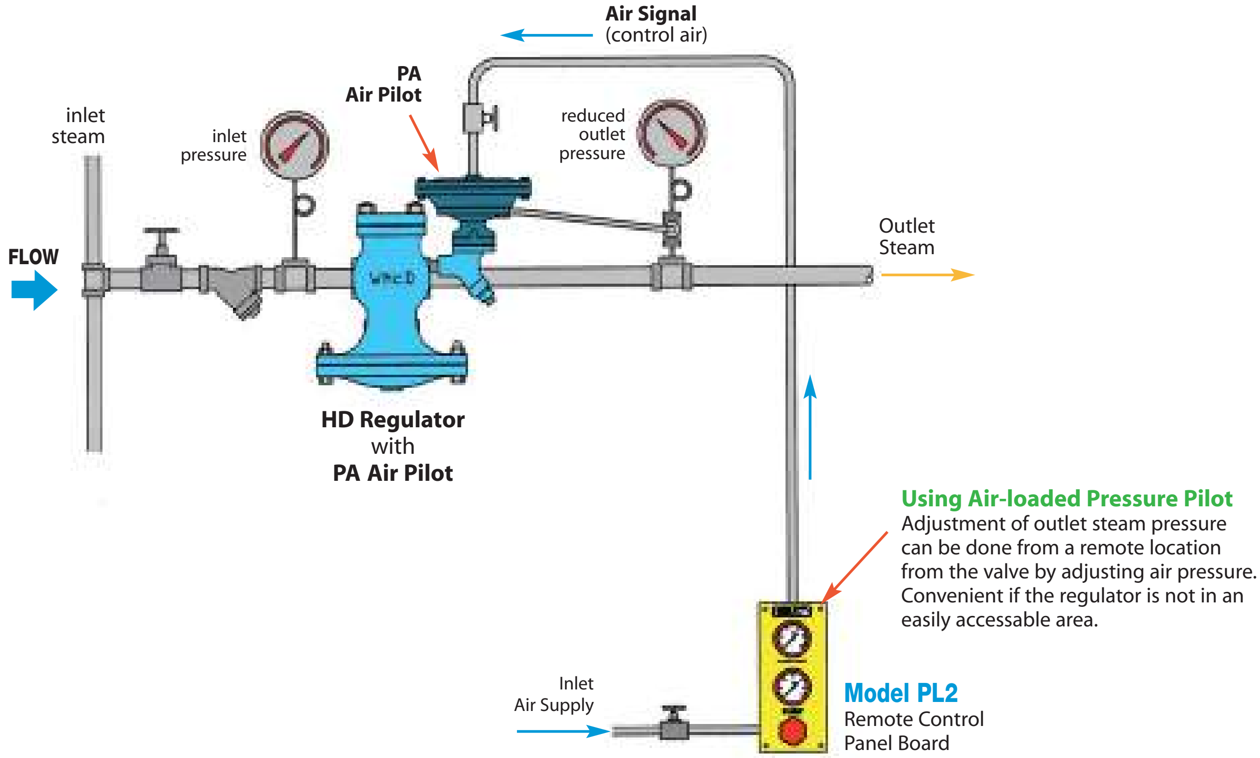
Model	Pressure Ranges	Description
PA1	**3-125 PSIG**	**1:1** ratio of steam pressure to control air pressure
PA4	**3-200 PSIG**	**4:1** ratio of steam pressure to control air pressure
PA6	**20-200 PSIG**	**6:1** ratio of steam pressure to control air pressure

The larger Diaphragm area of the **PA4** & **PA6** Air Pilots allow the use of lower control air pressure to regulate higher pressure steam.



Pressure Control with PA Air-Loaded Pressure Pilot

Pressure Reducing Station Using HD Regulator with an Air Pilot

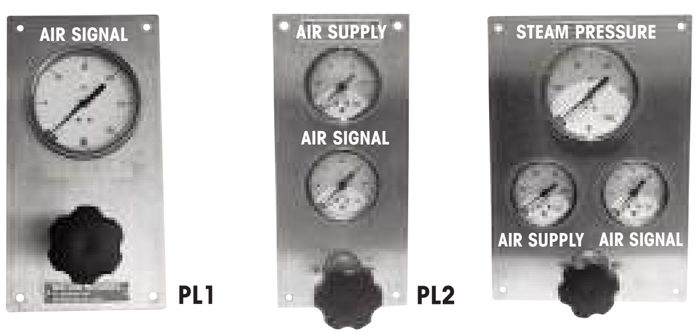


Description of Operation

The **PA-Air Pilot** is being used in conjunction with the **PL2 Control Panel Board** to regulate steam pressure. A small air regulator on the panel board can be adjusted to control the air pressure to the pilot. One gauge on the panel board measures air line pressure to the panel board and the other gauge shows the air pressure being sent to the pilot. Steam pressure at the outlet of the regulator is controlled by the air pressure signal to the pilot. Depending on the air pilot model chosen (**PA1**, **PA4**, **PA6**), there will be a 1:1, 4:1, or 6:1 ratio of outlet steam pressure to air pressure.

REMOTE CONTROL PANEL BOARDS

Three different options of remote control panel boards can be used along with the Air Pilots. Supply air is fed directly through the control panel board to the air pilot. You can choose one of the three options of control panel boards when using the air piloted regulators. Minimum of 5 PSIG air supply pressure is required.



PL1 PL2 PL3

PL1

The **PL1** is made up of an air pressure regulator with adjustment knob and pressure gauge that measures the amount of air pressure going to the pilot (air signal). Steam pressure of the system is controlled by adjusting the air pressure regulator.

PL2

The **PL2** is the same as the PL1 with the addition of an extra air pressure gauge for measuring the air supply pressure to the control panel board.

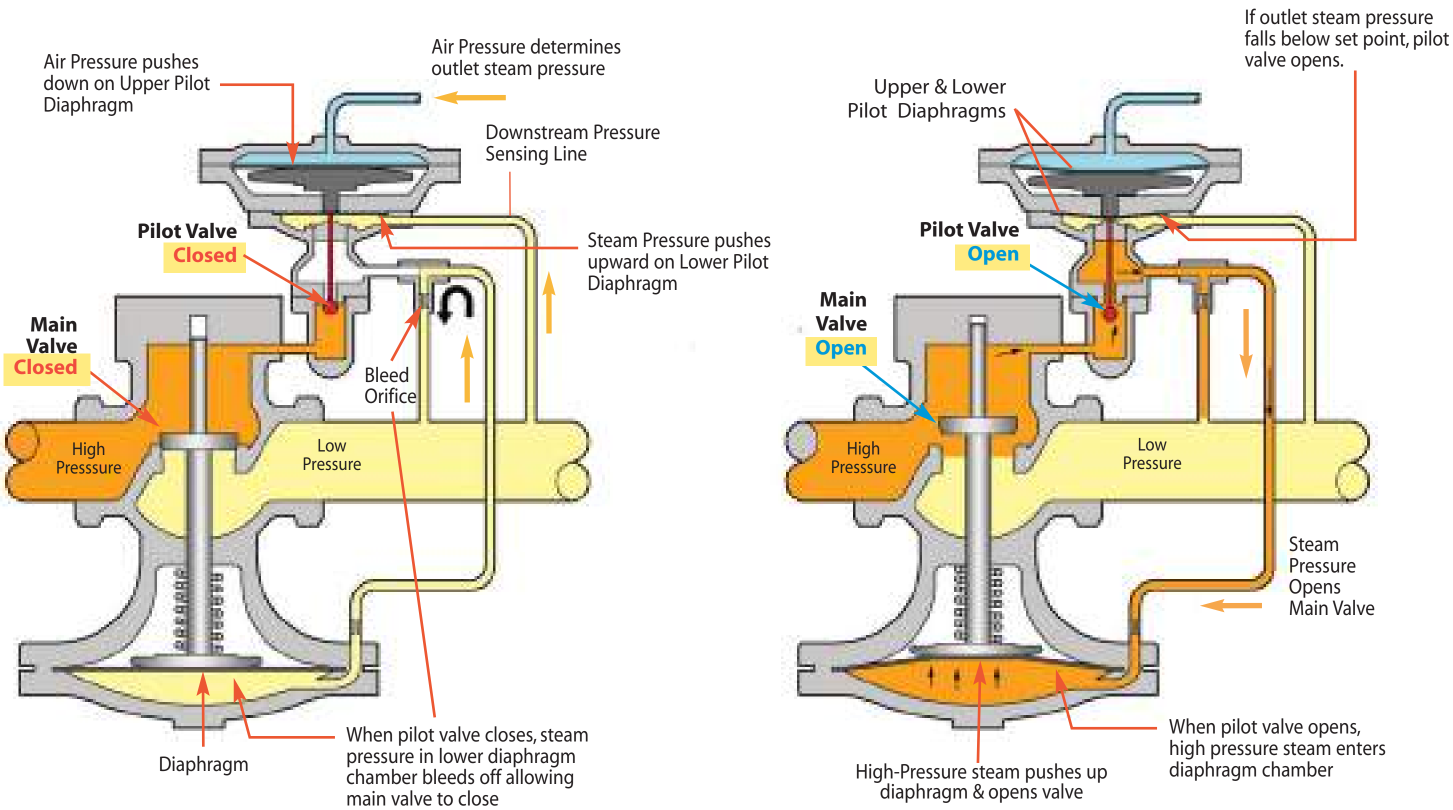
PL3

The **PL3** is the same as the PL2 with the addition of a Steam Pressure Gauge for measuring steam pressure on the outlet side of the regulating valve.

Pressure Control with PA Air-Loaded Pilot

How it Works

When air pressure is applied to the upper chamber of the air pilot, it exerts a downward force on the air pilot's diaphragm. The lower chamber of the air pilot is connected to the outlet side of the regulator using a sensing line. The purpose of the sensing line is to sense the pressure on the outlet side of the regulator and direct it under the lower pilot diaphragm to push it upwards. When the intended set pressure is reached, the pilot valve closes, which then closes off the flow path of steam to the underside of the diaphragm chamber in the regulator body. The regulator modulates open and closed maintaining the desired downstream pressure. To change downstream pressure, increase or decrease air pressure to pilot accordingly.

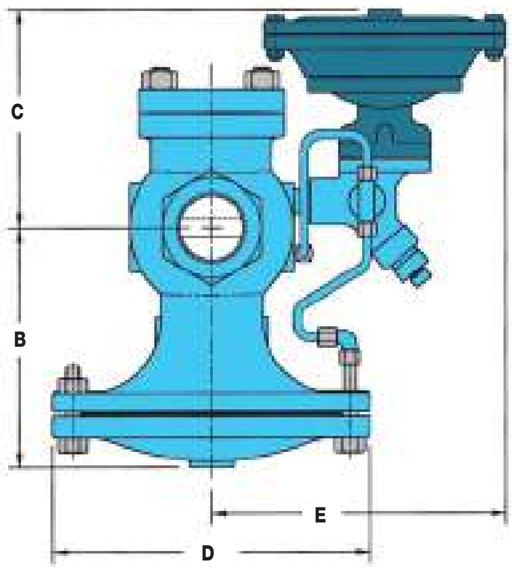


MAXIMUM CONTROL AIR PRESSURE ON AIR PILOT IS 125 PSIG

PRESSURE ADJUSTING RANGES		
Model	**Pressure Ranges**	**Description**
PA1	**3-125 PSIG**	**1:1** ratio of steam pressure to control air pressure
PA4	**3-200 PSIG**	**4:1** ratio of steam pressure to control air pressure
PA6	**20-200 PSIG**	**6:1** ratio of steam pressure to control air pressure

The larger Diaphragm area of the **PA4** & **PA6** Air Pilots allow the use of lower control air pressure to regulate higher pressure steam.

Pressure Control with PA Air-Loaded Pilot



Size	Face-To-Face NPT	150#	300#	B	C*	D	E**	Weight (lbs) NPT	FLG
1/2"	4 3/8			5 1/2	7 1/2	6 1/2	7 3/4	18	
3/4"	4 3/8			5 1/2	7 1/2	6 1/2	7 3/4	18	
1"	5 3/8	5 1/2	6	6 1/4	7 1/2	7	7 3/4	23	35
1 1/4"	6 1/2			7 3/8	7 1/2	8 3/4	8 3/8	43	
1 1/2"	7 1/4	6 7/8	7 3/8	7 3/8	7 1/2	8 3/4	8 3/8	43	60
2"	7 1/2	8 1/2	9	8 1/4	7 1/2	10 7/8	8 3/4	65	85
2 1/2"		9 3/8	10	9	7 1/2	11 3/4	8 3/4		105
3"		10	10 3/4	8 7/8	7 1/2	13 1/4	9 1/2		145
4"		11 7/8	12 1/2	10 7/8	7 1/2	14 3/4	10 1/2		235
6"		15 1/8	16	14 1/8	8 1/4	19 3/4	11 3/4		470

DIMENSIONS HD-Series – *inches*

** Add 2 1/2" to "C" dimension for PA4 or PA6 Air Pilots on 2" thru 4" valves.*
*** Add 1 1/2" to "E" dimension for PA4, and 2 1/4"" for PA6.*

Pilot-Operated REGULATORS

MATERIALS for PA Pressure Pilot	
Pilot Body & Cover	**Ductile Iron**
Head & Seat Gasket	302 SS
Cover Screws	Steel, GR5
Head & Seat Assembly	Hardened SST (55 Rc)

MATERIALS for HD Main Valve	
Body	**Ductile Iron**
Cover	**Ductile Iron**
Gasket	Grafoil/Garlock
Cover Screws	Steel
Pilot Adapter	**Ductile Iron/Cast Steel**
Screen	Stainless Steel
Tubing	Copper
Valve Seat	Hardened SST (55 Rc)
Valve Disc	Hardened SST (55 Rc)
Diaphragm	Phosphor Bronze

HD Main Valve
with
PA-Pressure Pilot
Air-Loaded

Model Code for Main Valve: HD-17-F150
(2" HD Series Valve with 150# Flanges)

Model Code for Pilot: PA4
(Air Pilot, 4:1 ratio of steam pressure to control air pressure)

OPERATING PRESSURES

Inlet Pressure Range:
15-300 PSIG (Standard Main Valve)
5-20 PSIG (Low Pressure Main Valve)

Minimum Differential Pressure:
10 PSI (Standard Main Valve)
3 PSI (Low Pressure Main Valve)

CONTROL AIR PRESSURE RANGE

A-Pilot Control Pressure:
3-125 PSIG (depending on pilot selected and desired outlet pressure)

How to Size / Order

PA - AIR PILOT

Specify:
- Air Pilot **PA1**, **PA4** or **PA6**
- Remote Control Panel Board **PL1**, **PL2** or **PL3**

REGULATOR BODY

Specify:
- **HD** regulator body
- Regulator size or capacity and pressure range of steam required
- End connections (threaded, 150/300# flanged)

On/Off Control using an Electric Solenoid

- Max Inlet Pressure: 250 PSIG

Solenoid Pilot (Electric)	**PS1 & PS2**
Pilot Body Material	**Cast Iron**
Valve Head & Seat	**Stainless Steel**
Max Inlet Pressure	**250 PSIG**
Pressure Range	
PS1	**0-180 PSIG**
PS2	**180-250 PSIG**

Typical Applications

Typically used for automatic operation, remote control, programmed cycling, sequential function interlocks with other equipment, and emergency shut-off in case of power failure.

How it Works

The **PS-Solenoid Pilot** can be used in conjunction with Pressure, Temperature, or Air Pilots to electrically control on/off operation of the **HD** Regulator. When the solenoid pilot is used, the regulator can be turned on or off by electrically activating or de-activating the solenoid.

Normally Closed (NC) – Standard
The normally CLOSED Solenoid Pilot remains closed in the non-activated state. The regulating valve will remain closed until an electrical signal is sent to the solenoid pilot. The signal is required to allow the regulator to operate. This is known as a fail-safe condition.

Normally Open (NO) – Optional
The normally OPENED Solenoid Pilot remains open in the non-activated state. The regulating valve will function normally unless an electrical signal is used to shut off the solenoid pilot.

Features

- Available normally opened (NO) or normally closed (NC)
- Full-port strainer and blow-down valve on pilot adapter to eliminate failure caused by contaminated steam systems

Options

- Normally open solenoid
- NEMA Ratings: NEMA 4 and NEMA 7
- Voltage: 24 VAC, 120 VAC, 240 VAC

Standard Solenoid Pilots Available	
Steam Inlet Pressure	0-180 PSIG 180-250 PSIG
NEMA Ratings	NEMA 4 – Waterproof (standard) NEMA 7 – Explosion-proof (optional)
Voltage	24 Volts AC 110-120 Volts AC 220-240 Volts AC
Control Action	Normally Closed (standard) Normally Open (special ordered)

Model Code	PMO PSIG	Weight lbs
PS1	15-180	4.5
PS2	180-250	5.5
PS1-LP	0-20	4.5

Use PS1-LP for Low Pressure applications under 15 PSI.

Model Code Configuration Chart

Models	Pressure PSI	Code	Voltage	Code	Action	Code	Rating
PS1	15-180 PSIG	**24**	24 VAC	**NC**	Normally Closed (Standard)	**N4**	Standard. Meets enclosure Type 4 (water proof).
PS2	180-250 PSIG	**120**	110 -120 VAC	**NO**	Normally Open (special ordered)	**N7**	Meets NEMA 4 & 7 Rating (water proof & explosion proof)
PS1-LP	0-20 PSIG	**240**	220 - 240 VAC				

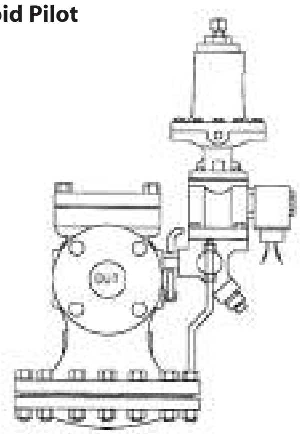
Example Model Codes:

1) **PS1-120-NC-N4** NEMA 4 (standard)
2) **PS1-120-NC-N7** NEMA 4 & 7 (waterproof & explosion proof)

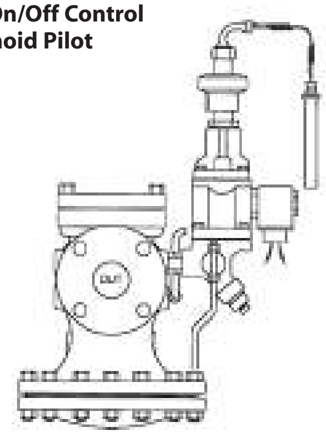
Solenoid Pilot

HD Series

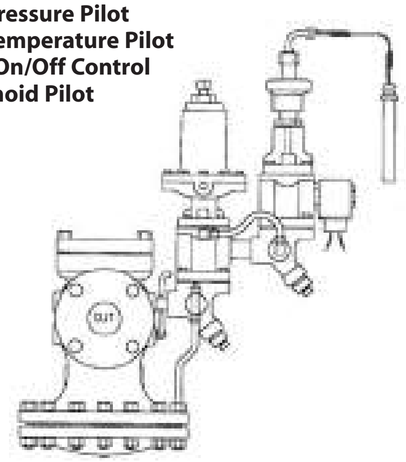
HD Main Valve
with
PS1 On/Off Control Solenoid Pilot

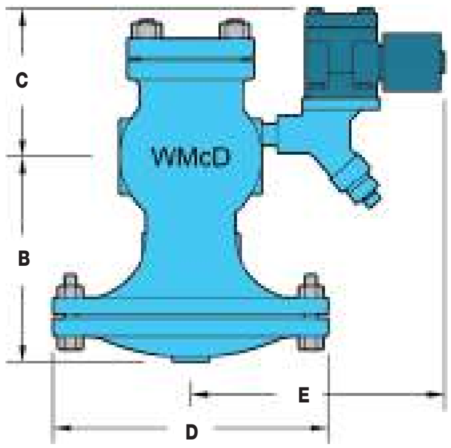


HD Main Valve
with
- **PT-Temperature Pilot**
- **PS1 On/Off Control Solenoid Pilot**



HD Main Valve
with
- **PP-Pressure Pilot**
- **PT-Temperature Pilot**
- **PS1 On/Off Control Solenoid Pilot**





DIMENSIONS HD-Series – *inches*

Size	Face-To-Face							Weight (lbs)	
	NPT	150#	300#	B	C*	D	E**	NPT	FLG
1/2"	4 3/8			5 1/2	7 1/2	6 1/2	7 3/4	18	
3/4"	4 3/8			5 1/2	7 1/2	6 1/2	7 3/4	18	
1"	5 3/8	5 1/2	6	6 1/4	7 1/2	7	7 3/4	23	35
1 1/4"	6 1/2			7 3/8	7 1/2	8 3/4	8 3/8	43	
1 1/2"	7 1/4	6 7/8	7 3/8	7 3/8	7 1/2	8 3/4	8 3/8	43	60
2"	7 1/2	8 1/2	9	8 1/4	7 1/2	10 7/8	8 3/4	65	85
2 1/2"		9 3/8	10	9	7 1/2	11 3/4	8 3/4		105
3"		10	10 3/4	8 7/8	7 1/2	13 1/4	9 1/2		145
4"		11 7/8	12 1/2	10 7/8	7 1/2	14 3/4	10 1/2		235
6"		15 1/8	16	14 1/8	8 1/4	19 3/4	11 3/4		470

MATERIALS for On/Off Solenoid Pilot

Pilot Body & Cover	**Ductile Iron**
Seat Gasket	302 SS
Cover Screws	Steel, GR5
Internals	Stainless Steel

MATERIALS for HD Main Valve

Body	**Ductile Iron**
Cover	**Ductile Iron**
Gasket	Grafoil/Garlock
Cover Screws	Steel
Pilot Adapter	**Ductile Iron/Cast Steel**
Screen	Stainless Steel
Tubing	Copper
Valve Seat	Hardened SST (55 Rc)
Valve Disc	Hardened SST (55 Rc)
Diaphragm	Phosphor Bronze

OPERATING PRESSURES

Inlet Pressure Range:
15 PSIG (Standard Main Valve)
5 PSIG (Low Pressure Main Valve)

Minimum Differential Pressure:
10 PSI (Standard Main Valve)
3 PSI (Low Pressure Main Valve)

Pneumatic Temperature **Controllers** (must be used with PA-Air Pilot)

Temperature Controller	PTL	PTR
Temperature Adjustment Range	**50 - 350 ˚F**	**0 - 300 ˚F**
Maximum Air Supply Pressure	**35 PSIG**	**35 PSIG**
Sensing Bulb	**Bi-Metallic**	**Hydraulic Fill**
Max. Pressure	**250 PSIG**	**250 PSIG**
Max. Temperature	**400˚F**	**350˚F**
Material	**Copper**	**Copper**
Optional Material	**Stainless Steel**	**Stainless Steel**
Capillary Length	**N/A**	**4-ft.**

- **Temperature Range:** **PTR: 0-300˚F**
  PTL: 50-350˚F

PTL
(mounts directly on tank or vessel)

PTR
(mounts remotely with 4-ft. capillary)

Typical Applications

The **PTL** and **PTR Pneumatic Temperature Controllers** operate over a wider temperature range and react faster than our standard **PT** temperature pilot. This makes them a preferable choice for instantaneous hot water applications.

How it Works

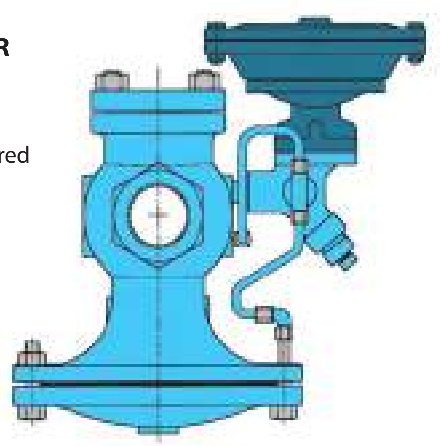
The **PTL** and **PTR Pneumatic Temperature Controllers** are used in conjunction with a **PA-Air Pilot** to control the operation of the **HD** Regulator. The **PTL** uses a bi-metallic element to sense temperature and the **PTR** uses a hydraulically-filled bulb (with 4-ft. capillary) to sense temperature. The air supply is connected to the inlet of the controller and the air output signal is fed directly to an Air Pilot, which controls the opening and closing of the steam regulating valve.

Features

- Accurate and rapid response to temperature changes
- Temperature control range of 0-350 ˚F

Model Code	Product Description Bulb & Capillary	Capillary Length	Weight lbs
PTL-E7	Pneumatic temperature controller, direct mount	N/A	5.3
PTR-E8	Pneumatic temperature controller, remote mount	4′	3.0

for **PTL** & **PTR**
Pneumatic
Temperature
Controller,
Air Pilot is required



OPERATING PRESSURES

Inlet Pressure Range:
15-300 PSIG (Standard Main Valve)
5-20 PSIG (Low Pressure Main Valve)

Minimum Differential Pressure:
10 PSI (Standard Main Valve)
3 PSI (Low Pressure Main Valve)

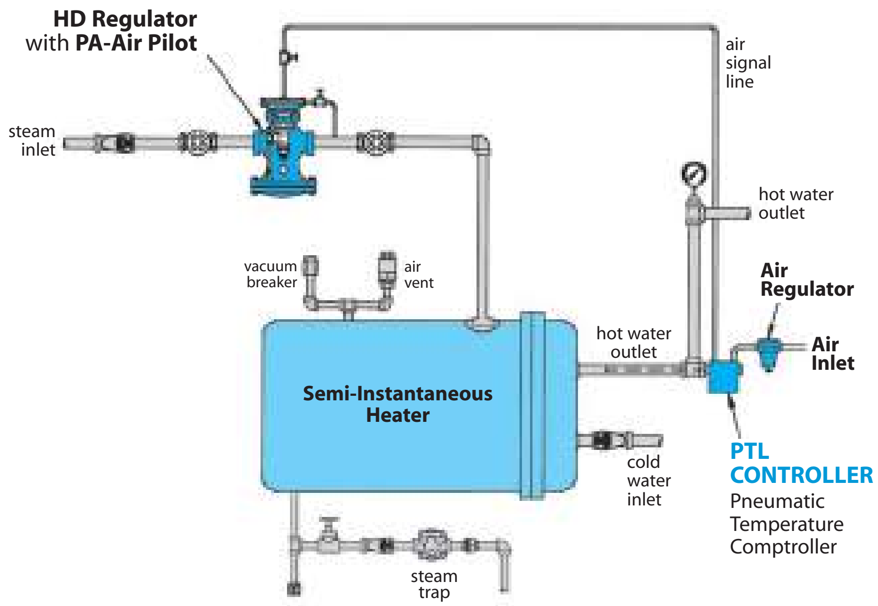
How to Size / Order

PTL & PTR PNEUMATIC TEMPERATURE CONTROLLER
Specify: • **PTL** or **PTR** controller model (air pilot required for operation)

AIR PILOT
Specify: • **PA1**, **PA4** or **PA6** Air Pilot model (refer to Air Pilot section)

REGULATOR BODY
Specify:
• **HD** regulator body
• Regulator size or capacity
• End connections (threaded, 150/300# flanged)

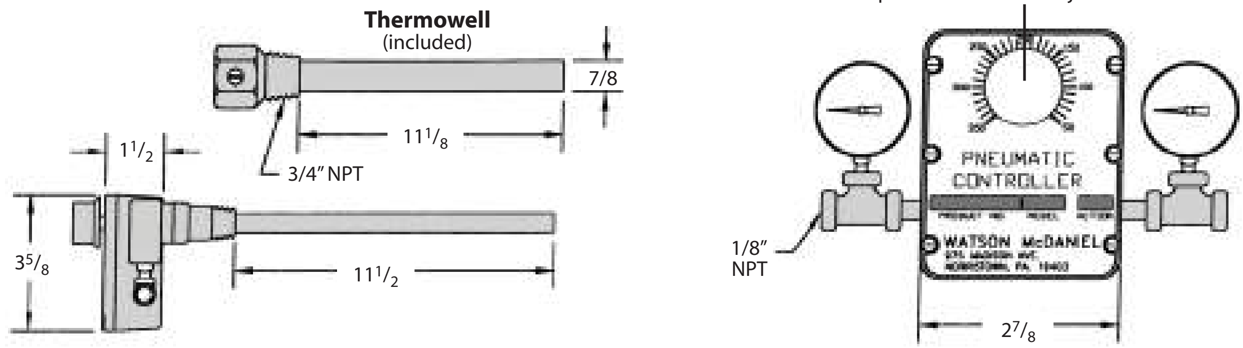
Pneumatic Temperature Controllers (must be used with PA-Air Pilot)



Description of Operation

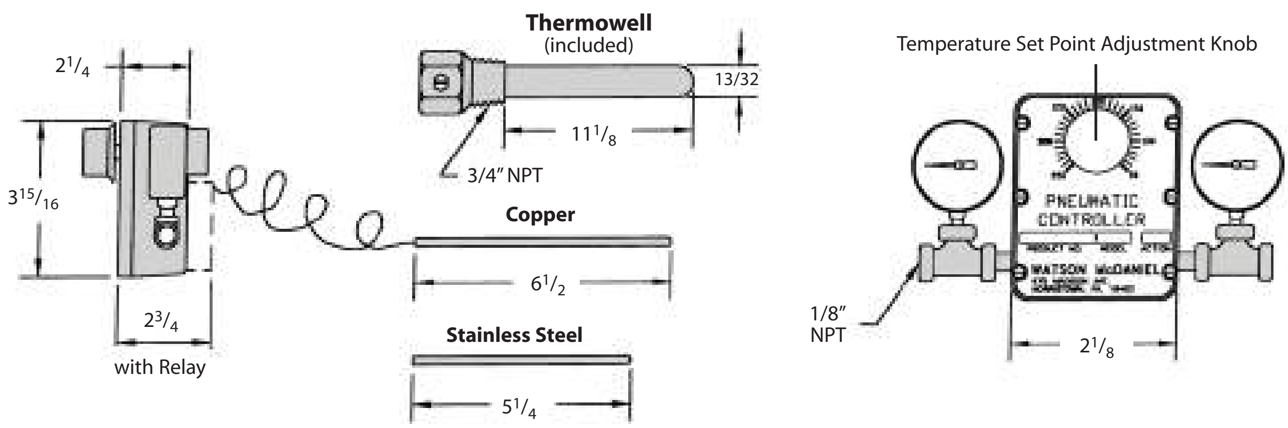
The **PTL Pneumatic Temperature Controller** senses outlet water temperature on a semi-instantaneous hot water heater. When the outlet water temperature falls below the set point, the PTL pneumatic temperature controller sends an air signal to the **PA Air Pilot**, which opens the regulator, allowing steam to heat the tank. When the water reaches the desired set temperature, the PTL pneumatic temperature controller shuts off the air signal to the **PA Air Pilot** and the regulator closes, cutting off steam to the heater.

Model PTL (DIRECT Mounted)



Units: inches

Model PTR (REMOTE Mounted)



Temperature Control with PTRP Temperature Pilot

Model	**PTRP**
Pilot Body Material	**Cast Steel**
Max Inlet Pressure	**300 PSIG**
Temperature Control Range	**20-440° F**
Steam Inlet Pressure Range (when Standard Temperature Pilot is used with **HD** Standard main valve)	**15-300 PSIG**
Steam Inlet Pressure Range (when Low-Pressure Temperature Pilot is used with **HD-LP** Low-Pressure main valve)	**5-20 PSIG**

Pilot-Operated REGULATORS

LOW PRESSURE PTRP-LP Pilot (pressures under 15 PSIG)

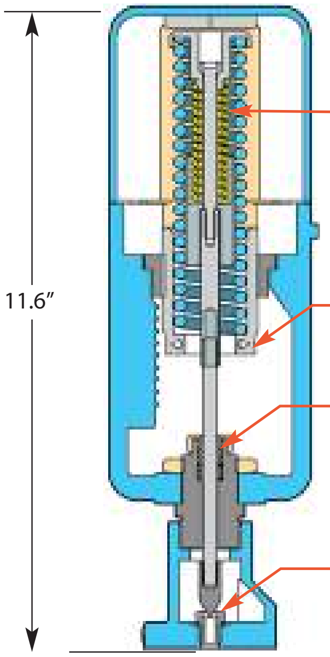
Use Code **LP**: Low pressure Temperature Pilot is required for steam pressure under 15 PSI. (Range 5 - 20)

PILOT: Example Model Code: PTRP-LP-06-08-S15

LOW PRESSURE HD Main Valve (pressures under 15 PSIG)

Use Code **LP**: A Low Pressure Main Valve must be used in conjuction with a Low Pressure Temperature Pilot for steam pressure under 15 PSIG (Range 5 - 20)

MAIN VALVE: Example Model Code: HD-13-N-LP



Typical Applications

The **PTRP-Temperature Pilot** is used with the HD Regulator to control temperature in various processes and systems. The PTRP uses a vapor tension system to actuate the bellows in the temperture pilot giving it a faster reaction time and better temperature sensitivity than the standard PT pilot. They can be used on: oil heaters, ovens, process heaters, vats, dryers, jacketed kettles, and semi-Instantaneous water heaters.

Features

- Stainless steel valve and seat
- Standard bulb & capillary is copper, which has the best heat transfer properties.
- Standard capillary length is 8 ft. with 316 stainless steel armour-protection

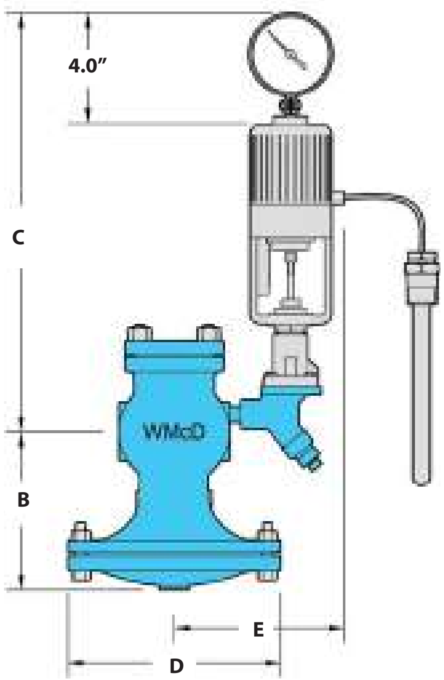
Options

- **Capillary Lengths:** Available in 8, 12, 16, 20 & 24-ft.
- **Special Materials:** Sensing bulb, thermowells, and capillary are available in special corrosion resistant materials.
  - 316 stainless steel capillary, bulb & bushing
  - 316 stainless steel armor with standard capillary
- **Thermowell (Separable Socket):** Available in stainless steel or copper
- **Temperature Sensing Dial:** Indicates temperature of process being controlled
- **SDWA Compliance (Safe Drinking Water Act);** Consult factory

Specifications

Dial Thermometer:	4" dial, stainless steel case, swivel and angle adjustment (Model PTRP-94 only)
Housing:	Die cast aluminum, epoxy powder coated grey finish
Bellows:	High pressure brass, corrosion resistant, tin plated finish (not shown)
Over-Temperature Protection:	Upper range limit +100° F

PTRP Series Pilots
HD Series



DIMENSIONS HD-Series – *inches*

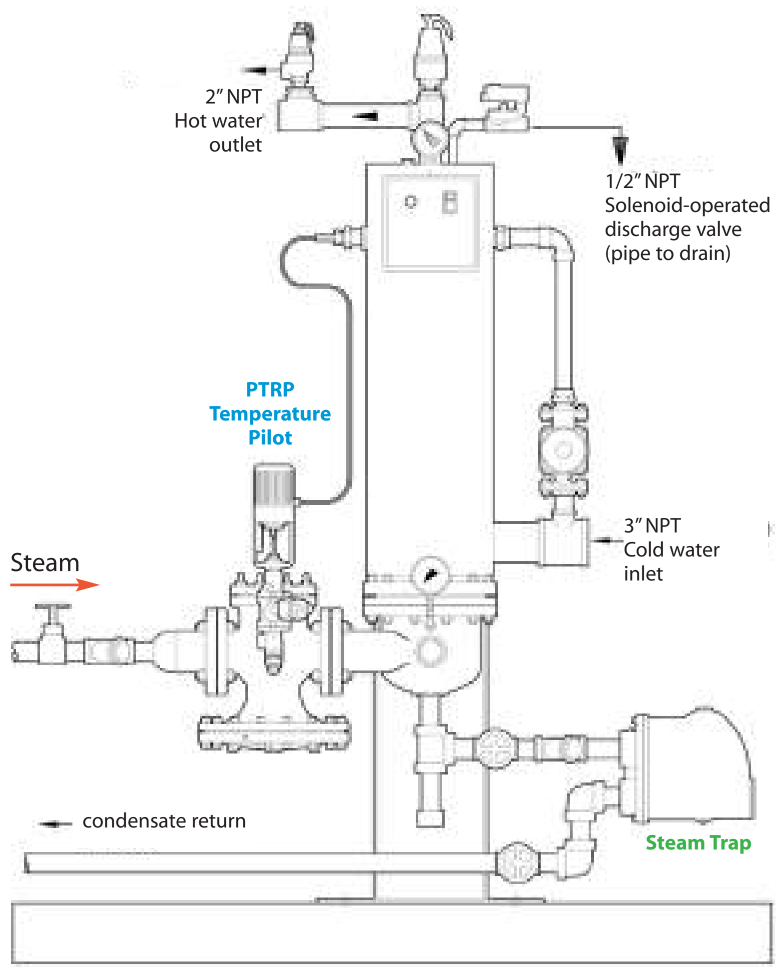
Size	Face-To-Face NPT	Face-To-Face 150#	Face-To-Face 300#	B	C	D	E	Weight (lbs) NPT	Weight (lbs) FLG
1/2"	$4\frac{3}{8}$			$5\frac{1}{2}$	14	$6\frac{1}{2}$	$7\frac{3}{4}$	18	
3/4"	$4\frac{3}{8}$			$5\frac{1}{2}$	14	$6\frac{1}{2}$	$7\frac{3}{4}$	18	
1"	$5\frac{3}{8}$	$5\frac{1}{2}$	6	$6\frac{1}{4}$	14	7	$7\frac{3}{4}$	23	35
$1\frac{1}{4}$"	$6\frac{1}{2}$			$7\frac{3}{8}$	14	$8\frac{3}{4}$	$8\frac{1}{4}$	43	
$1\frac{1}{2}$"	$7\frac{1}{4}$	$6\frac{7}{8}$	$7\frac{3}{8}$	$7\frac{3}{8}$	14	$8\frac{3}{4}$	$8\frac{1}{4}$	43	60
2"	$7\frac{1}{2}$	$8\frac{1}{2}$	9	$8\frac{1}{4}$	14	$10\frac{7}{8}$	$8\frac{1}{2}$	65	85
$2\frac{1}{2}$"		$9\frac{3}{8}$	10	9	14	$11\frac{3}{4}$	$8\frac{1}{2}$		105
3"		10	$10\frac{3}{4}$	$8\frac{7}{8}$	14	$13\frac{1}{4}$	$9\frac{1}{2}$		145
4"		$11\frac{7}{8}$	$12\frac{1}{2}$	$10\frac{7}{8}$	14	$14\frac{3}{4}$	$10\frac{1}{2}$		235
6"		$15\frac{1}{8}$	16	$14\frac{1}{8}$	$14\frac{1}{2}$	$19\frac{3}{4}$	$11\frac{3}{4}$		470

MATERIALS for PTRP Pilot

Pilot Body	Cast Steel
Valve and Seat	Stainless steel
Support Bracket	Aluminum
Bulb & Capillary	Copper (optional stainless steel)
All Other Parts	Brass

MATERIALS for HD Main Valve

Body	**Ductile Iron**
Cover	**Ductile Iron**
Gasket	Grafoil/Garlock
Cover Screws	Steel
Pilot Adapter	**Ductile Iron/Cast Steel**
Screen	Stainless Steel
Tubing	Copper
Valve Seat	Hardened SST (55 Rc)
Valve Disc	Hardened SST (55 Rc)
Diaphragm	Phosphor Bronze



HD Valve with PTRP-Temperature Pilot Application

A semi-instantaneous steam-to-water heater is a common application where the simple benefits of a self-contained, pilot-operated regulator with temperature sensing pilot may be favored over more complex and expensive control valves. The thermally sensitive bulb of the PTRP pilot contains a fluid that creates a vapor which increases or decreases in pressure as the sensing bulb – sensing the heated water – temperature increases or decreases. This vapor pressure is transmitted hydraulically to the bellows, which actuates the pilot and HD regulator to control the flow of steam into the heater. At start-up, the pilot is manually-adjusted to raise the temperature set point and allow steam to flow through the pilot and valve. As the heated water nears the temperature set point, the vapor pressure in the sensing bulb increases and expands the bellows, closing the pilot and regulator to proportionally limit the steam supply.

Temperature Control

Sensing Bulb Selection & Installation:

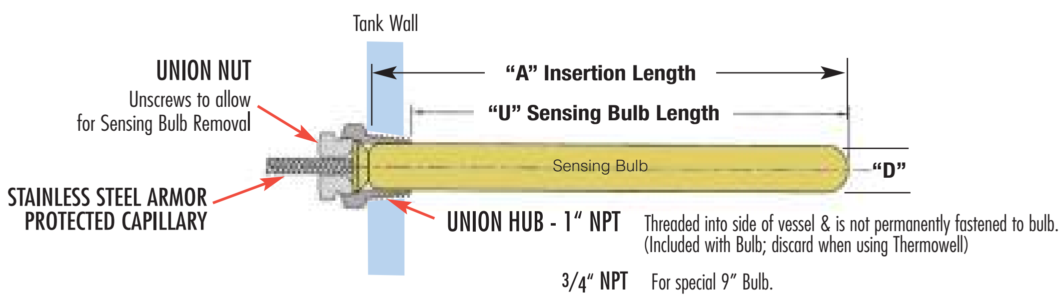
The sensing bulb and capillary is available in either Copper (standard) or Stainless Steel (for corrosive applications). Copper has the best heat transfer properties and should always be chosen unless used in corrosive service. Sensing bulb length is dependent upon the capillary length required; longer capillary lengths require a longer bulb to hold the additional actuating fluid. When installing the sensing bulb, the Union Hub is first threaded into a tank or piping system. The bulb slides thru the Union Hub and held in place by threading in the Union Nut. The angled seating surface of the bulb forms a metal-to-metal seal to the Union Hub, preventing the leakage of process fluid.

Sensing Bulb & Capillary

ORDER CODE	Sensing Bulb Material	Capillary Tubing Material	Capillary Length in Feet				"D" Bulb Dia.
				8, 12, 16	20	24	
S15	**Copper** (Brass Union Hub)	Copper with Stainless Steel Spiral Armor	A	13"	16"	20"	1"
			U	12.25"	15.25"	19.25"	
S16	**Stainless Steel** (Stainless Steel Union Hub)	Stainless Steel with Stainless Steel Spiral Armor	A	13"	16"	20"	1"
			U	12.25"	15.25"	19.25"	
SB15* (special 9")	**Copper** (Brass Union Hub) (9" bulb)	Copper with Stainless Steel Spiral Armor	A	9"	9"	9"	3/4"
			U	8.25"	8.25"	8.25"	
SB16* (special 9")	**Stainless Steel** (Stainless Steel Union Hub) (9" bulb)	Stainless Steel with Stainless Steel Spiral Armor	A	9"	9"	9"	3/4"
			U	8.25"	8.25"	8.25"	

***Note for 9" Bulb:**

Care should be taken when using 9" bulbs, and they should only be used in applications where space considerations exist. They should not be used when the temperature of the actuator housing is higher than the sensing bulb temperature, as this condition may create erratic temperature control. The temperature of the actuator housing is affected by the surrounding ambient temperature as well as the steam temperature flowing through the valve and may reach 140°F.



Thermowell Option (ordered separately)

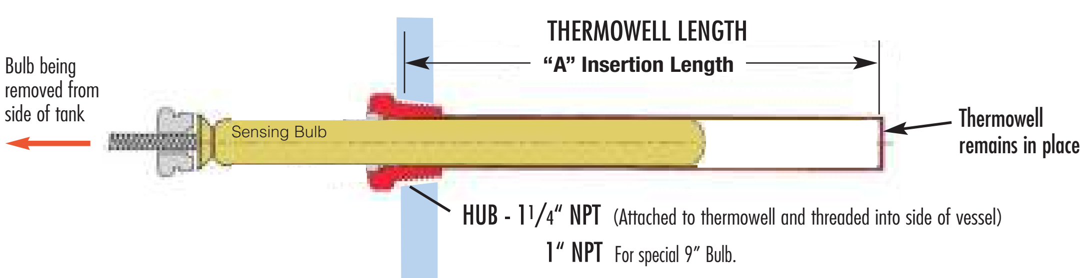
Thermowells isolate and protect the sensing bulb from the process fluid; available in either brass (better heat transfer properties) or Stainless Steel for corrosion resistance. They allow for sensing bulb removal and replacement without having to drain liquid from the system. For corrosive applications, a Stainless Steel thermowell (with a copper sensing bulb) can be used. For best temperature control use a copper sensing bulb with a brass thermowell. Thermowells are also recommended for applications with excessive system pressures or extremely turbulent flow to protect the sensing bulb from damage.

Note: to ensure minimum response time, Heat Transfer Paste should be applied to the sensing bulb before installation into the thermowell.

THERMOWELLS - Model Numbers & Lengths

Brass Model No.	Stainless Steel Model No.	Nominal Length	"A" INSERTION LENGTH (in.)		Capillary Length in Feet
			BULB	THERMOWELL	
536-S2	**536-S6**	13"	12.25	13.00	8, 12 or 16
536-SE2	**536-SE6**	16"	15.25	16.00	20
536-WE2	**536-WE6**	20"	19.25	20.00	24
535-M2*	**535-M6***	9"	8.25	9.00	8, 12 or 16

Notes: 1) Other connections and lengths may be available, consult factory.
2) External pressure rating on Brass is 500 PSI max.
3) External pressure rating on 316 SS is 1000 PSI max.



Model Code Chart with Temperature Ranges (8 ft. Capillary Lengths)

Range Code	Nominal Range (°F)	Recommended Working Span (°F)	Model Code NON-Indicating	Model Code Indicating	Weight lbs
01	20 - 70	40 to 65 °F	PTRP-91-01-08	PTRP-94-01-08	8
02*	40 - 90	65 to 85 °F	PTRP-91-02-08	PTRP-94-03-08	8
03	30 - 115	85 to 110 °F	PTRP-91-03-08	PTRP-94-03-08	8
04	50 - 140	110 to 135 °F	PTRP-91-04-08	PTRP-94-04-08	8
05	75 - 165	135 to 160 °F	PTRP-91-05-08	PTRP-94-05-08	8
06	105 - 195	160 to 190 °F	PTRP-91-06-08	PTRP-94-06-08	8
07	125- 215	190 to 210 °F	PTRP-91-07-08	PTRP-94-07-08	8
09	155- 250	210 to 245 °F	PTRP-91-09-08	PTRP-94-09-08	8
10	200 - 280	245 to 275 °F	PTRP-91-10-08	PTRP-94-10-08	8
11	225 - 315	275 to 310 °F	PTRP-91-11-08	PTRP-94-11-08	8
12	255 - 370	305 to 365 °F	PTRP-91-12-08	PTRP-94-12-08	8
13	295 - 420	365 to 415 °F	PTRP-91-13-08	PTRP-94-13-08	8
14	310 - 440	415 to 435 °F	PTRP-91-14-08	PTRP-94-14-08	8

* The recommended working span typically falls within the upper third of the nominal temperature range.

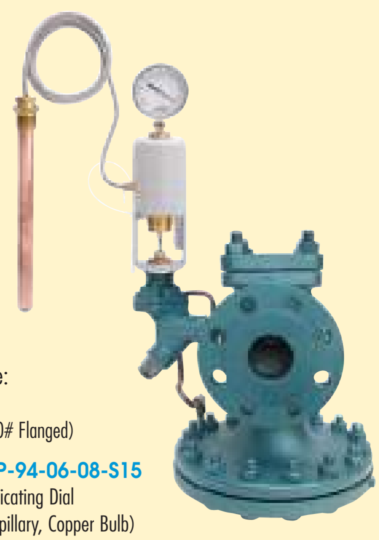
CROSS REFERENCE: **PTRP** = Spence T-14

Model Code Configuration Chart

Models		Temperature Range		Capillary Length		Bulb	
PTRP-91	Non-Indicating	**01 – 14**	Refer to Temperature Range Chart	**08**	8 Feet (std)	**S15**	(copper bulb) (standard)
PTRP-94	Indicating Dial			**12**	12 Feet	**S16**	(SS bulb)
PTRP-LP-91	Non-Indicating			**16**	16 Feet	**SB15**	(9" copper bulb)
PTRP-LP-94	Indicating Dial			**20**	20 Feet	**SB16**	(9" SS bulb)
				24	24 Feet		

Note: Thermowells are ordered separately.
LP = Low Pressure Models.

HD Main Valve with **PTRP Temperature Pilot**



Model Code for Main Valve:
HD-17-F150
(2" HD Series Valve with 150# Flanged)

Model Code for Pilot: **PTRP-94-06-08-S15**
(Temperature Pilot with Indicating Dial (105-195°F) with 8 Ft. Capillary, Copper Bulb)

How to write proper model number:

Explanation of Model Number:	PTRP-91	06	08	S15
	Model	Temp. Range	Cap. Length	Bulb Type
Model Number:	**PTRP-91-06-08-S15**			

Model PTRP-94 contains Temperature Indicating Dial
Model PTRP-91 is Non-Indicating

Example Model Codes:

1) **PTRP-91-06-08-S15** (105°F - 195°F Temp Range, 8 ft. Capillary, 12" Copper Bulb)
2) **PTRP-94-06-08-S15** (105°F - 195°F Temp Range, with Dial Thermometer, 8 ft. Capillary, 12" Copper Bulb)

Differential Pressure

Differential Pressure Pilot	**PDP**
Body Material	**Ductile Iron**
Max Inlet Pressure	**300 PSIG**
Reduced Outlet Pressure Range	**3-200 PSIG**
Inlet Pressure Range	
(with **HD** Standard main valve)	**15-300 PSIG**
(with **HD-LP** Low-Pressure main valve)	**5-20 PSIG**
Minimum Differential Pressure	
(with **HD** Standard main valve)	**10 PSI**
(with **HD-LP** Low-Pressure main valve)	**3 PSI**

Typical Applications

The **PDP-Differential Pressure Pilot** is used with the **HD Regulator** to maintain steam pressure at a set differential pressure above another media source. This is typical on an oil burner where steam used for atomization is injected into the oil burner at a set pressure above the incoming oil supply pressure. When oil pressure fluctuates (based on demand), the steam pressure will maintain a constant differential pressure above the oil pressure.

Features

- The PDP-Differential Pressure Pilot is used to maintain downstream steam pressure to a set differential pressure above loading pressure
- Accuracy to within ±2 PSI
- 3 overlapping spring ranges to choose from
- Pilot is installed using only four bolts
- Full port strainer and blowdown valve on pilot adapter for ultimate protection from dirt and scale
- Solid floating diaphragm
- Watson McDaniel's pilots can be used with other manufacturers' regulators

Options

- Solenoid pilot can be added for remote on/off control of regulator

MATERIALS for PDP Differential Pressure Pilot	
Pilot Body & Cover	**Ductile Iron & Cast Steel**
Seat Gasket	302 SS
Diaphragm	Phosphor Bronze
Head & Seat Assembly	Hardened SST (55 Rc)

OPERATING PRESSURES

Inlet Pressure Range:
15-300 PSIG (Standard Main Valve)
5-20 PSIG (Low Pressure Main Valve)

Minimum Differential Pressure:
10 PSI (Standard Main Valve)
3 PSI (Low Pressure Main Valve)

Pressure Range PSI	Model Code	Spring Color	Weight lbs
3-25	**PDP-Y**	Yellow	16
20-100	**PDP-B**	Blue	16
80-200	**PDP-R**	Red	16

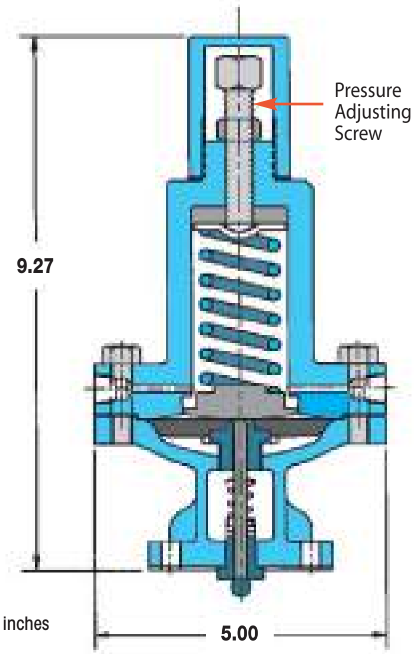
How to Size / Order

PDP - DIFFERENTIAL PRESSURE PILOT

Specify: • Reduced pressure range –
Example: **PDP-Y:** PDP Pilot with 3-25 PSIG spring

REGULATOR BODY

Specify:
- **HD** regulator body
- Regulator size or capacity
- End connections (threaded, 150/300# flanged)

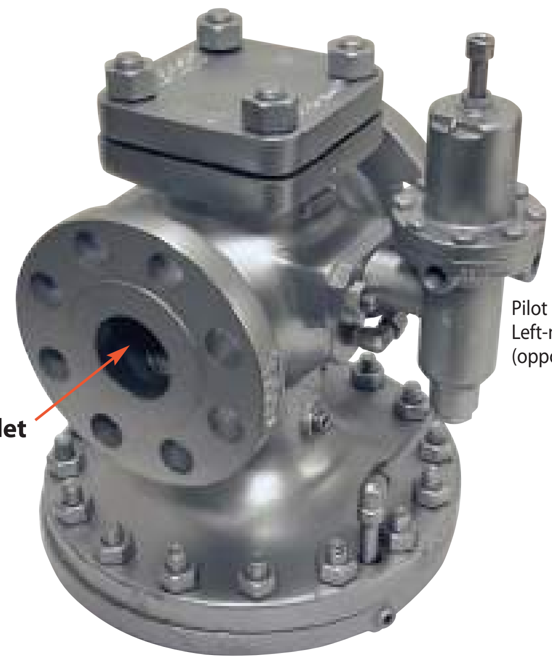


HSP Pressure Regulating Valve

Cast Steel

Cast Steel Pressure Regulating Valve

Model	**HSP Series**
Sizes	**1", 1½", 2", 3", 4"**
Connections	**150#/300# Flange**
Body Material	**Cast Steel**
PMO Max. Operating Pressure	**450 PSIG**
TMO Max. Operating Temperature	**650°F**
PMA Max. Allowable Pressure	**550 PSIG @ 650°F**
TMA Max. Allowable Temperature	**650°F @ 550 PSIG**



OPERATING PRESSURES

Inlet Pressure Range:
15-450 PSIG (standard Main Valve)
5-20 PSIG (low-pressure Main Valve)

Minimum Differential Pressure:
10 PSIG (standard Main Valve)
3 PSIG (low-pressure Main Valve)

PRESSURE-ADJUSTING SPRING RANGES

Pressure Ranges	Identifying Colors
10-40 PSIG	yellow
25-100 PSIG	blue
75-300 PSIG	red

Typical Applications

The **HSP Series** Main Valve with **integral Pressure Pilot** reduces steam pressure in steam system piping mains and process applications. This pilot-operated regulator is specifically used in applications where the properties and benefits of Cast Steel are desired and/or specified. Using steel as the material of construction for the main valve body extends the pressure-temperature rating of the regulator. A unique two-bolt pilot adapter design and field-reversible tubing offer even greater versatility to this type of regulator, further reducing maintenance downtime. These valves share the same design and proven reliability of the Watson McDaniel HD-Series Regulators, providing extremely accurate control of downstream system pressure even when inlet pressure to the regulator fluctuates or steam usage varies.

Features

- Cast Steel body for higher pressure and temperature ratings
- New, convenient bolt-on pilot design simplifies installation
- New diaphragm design improves performance and extends life
- Hardened stainless steel trim for extended life
- Optional Stellite trim available
- Full port strainer and blowdown valve on pilot adapter for ultimate protection from dirt and scale
- Maintains downstream pressure to ±1.0 PSIG
- Choice of three overlapping spring ranges
- Pre-mounted pilot & tubing simplifies installation

Pilot Mounting

Standard pilot mounting is on the right side of the regulator when looking into the outlet port. For opposite-mounting, specify when ordering. Pilot mounting on HSP regulators are field-reversible.

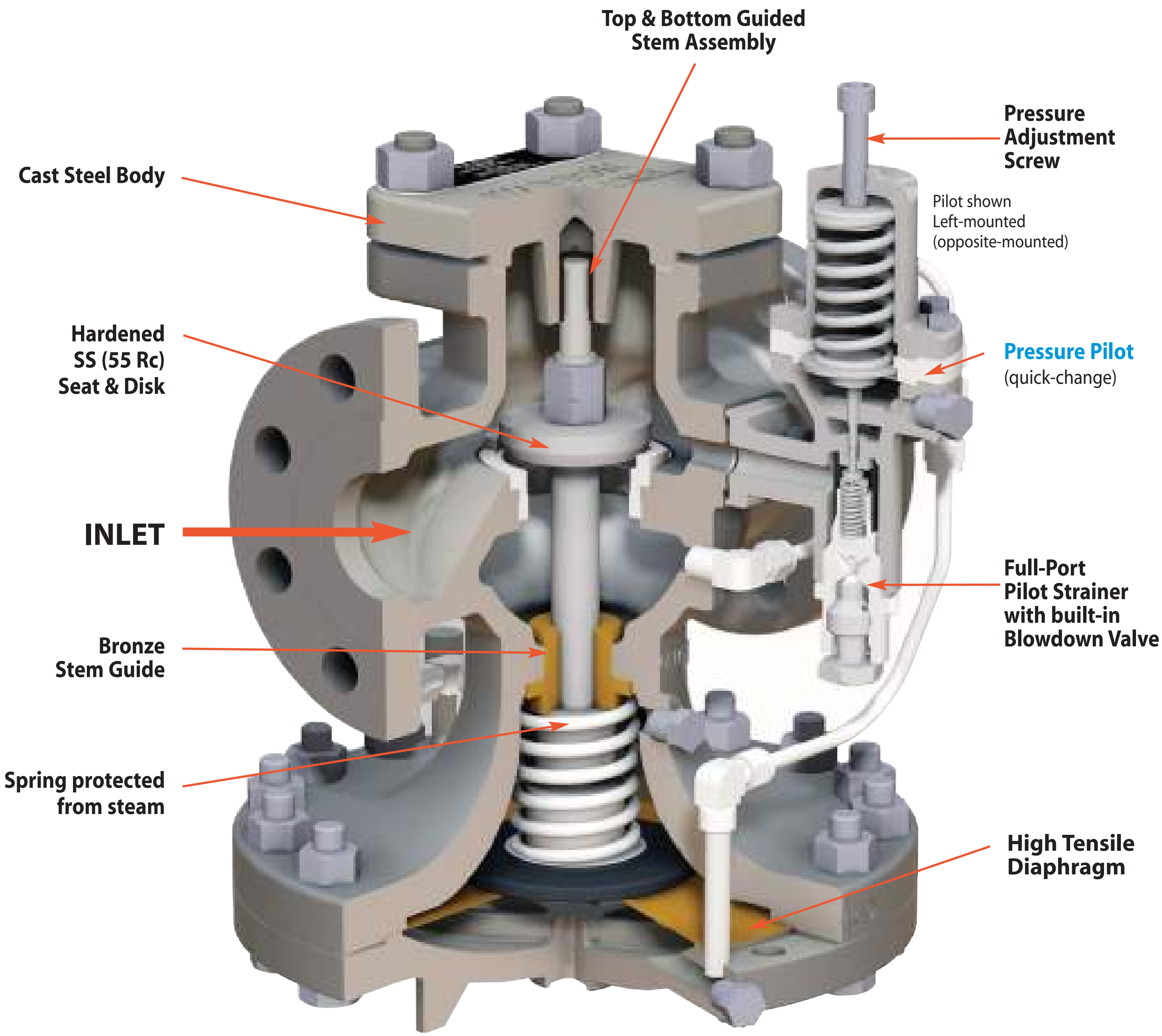
Pressure Pilot

The spring-adjusted Pilot is used for general purpose pressure reducing applications.

MATERIALS for HSP Regulator

Body	**ASTM A-216 GR WCB**
Cover	ASTM A-216 GR WCB
Diaphragm Cover	ASTM A-216 GR WCB
Pilot	ASTM A-216 GR WCB
Gaskets	Garlock 3400/grafoil SLS
Seat	420F SS (optional Stellite seat, consult factory)
Disc	420F SS
Diaphragm	Bronze
Diaphragm for LP Model	EPDM
Mfg. Bolts	SA-193 GR B7
Spring	302 SS
Stem	416 SS

Cast Steel Pressure Regulating Valve



Pressure Regulator shown with Left-mounted Pilot (right-mounted is standard)

Cast Steel Pressure Regulating Valve

Model includes HSP Main Valve with Pressure Pilot

Size/Connection		Model Code	Pressure Pilot Range (PSI)	Weight lbs
1"	150# FLG	HSP-14-F150-Y	10-40	36
		HSP-14-F150-B	25-100	
		HSP-14-F150-R	75-300	
	300# FLG	HSP-14-F300-Y	10-40	38
		HSP-14-F300-B	25-100	
		HSP-14-F300-R	75-300	
1 1/2"	150# FLG	HSP-16-F150-Y	10-40	60
		HSP-16-F150-B	25-100	
		HSP-16-F150-R	75-300	
	300# FLG	HSP-16-F300-Y	10-40	64
		HSP-16-F300-B	25-100	
		HSP-16-F300-R	75-300	
2"	150# FLG	HSP-17-F150-Y	10-40	87
		HSP-17-F150-B	25-100	
		HSP-17-F150-R	75-300	
	300# FLG	HSP-17-F300-Y	10-40	90
		HSP-17-F300-B	25-100	
		HSP-17-F300-R	75-300	
3"	150# FLG	HSP-19-F150-Y	10-40	170
		HSP-19-F150-B	25-100	
		HSP-19-F150-R	75-300	
	300# FLG	HSP-19-F300-Y	10-40	175
		HSP-19-F300-B	25-100	
		HSP-19-F300-R	75-300	
4"	150# FLG	HSP-20-F150-Y	10-40	255
		HSP-20-F150-B	25-100	
		HSP-20-F150-R	75-300	
	300# FLG	HSP-20-F300-Y	10-40	265
		HSP-20-F300-B	25-100	
		HSP-20-F300-R	75-300	

Pilot Ranges

Code	Color	PSIG
Y	Yellow	10-40
B	Blue	25-100
R	Red	75-300

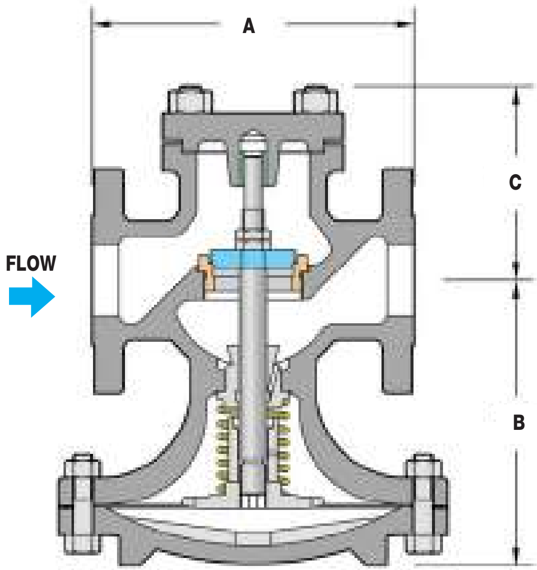
Model Configuration Chart

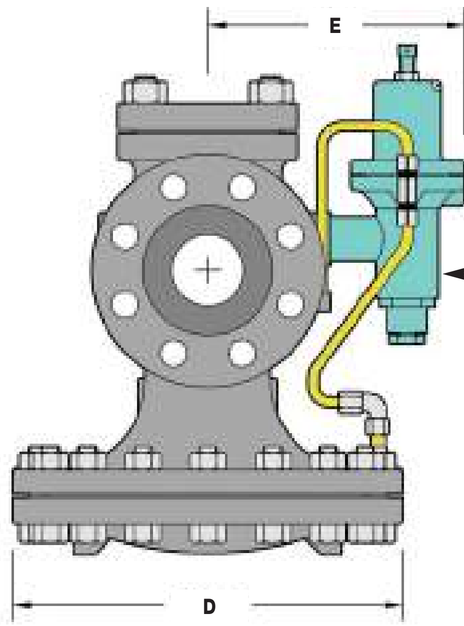
Models		Code	Size	Code	Connection	Code	Pressure Range (PSIG)	Code	Options (Suffix)
HSP	Full Port	14	1"	F150	150# Flanged	Y	10-40 (yellow)	SSXT	Stainless Steel External Tubing
HSPR	Reduced Port	16	1 1/2"	F300	300# Flanged	B	25-100 (blue)	ST	Stellite Trim
		17	2"			R	75-300 (red)	LP	Low Pressure Main Valve Spring
		19	3"					SSD	SS Diaphragm
		20	4"						

Example Model Codes:

1) **HSP-17-F150-Y** (HSP Full port valve, 2" 150# Flg, 10-40 PSIG, with no options)
2) **HSPR-17-F300-B-ST** (HSP Reduced port valve, 2" 300# Flg, 25-100 PSIG, with Stellite Trim)

Cast Steel **Pressure** Regulating Valve

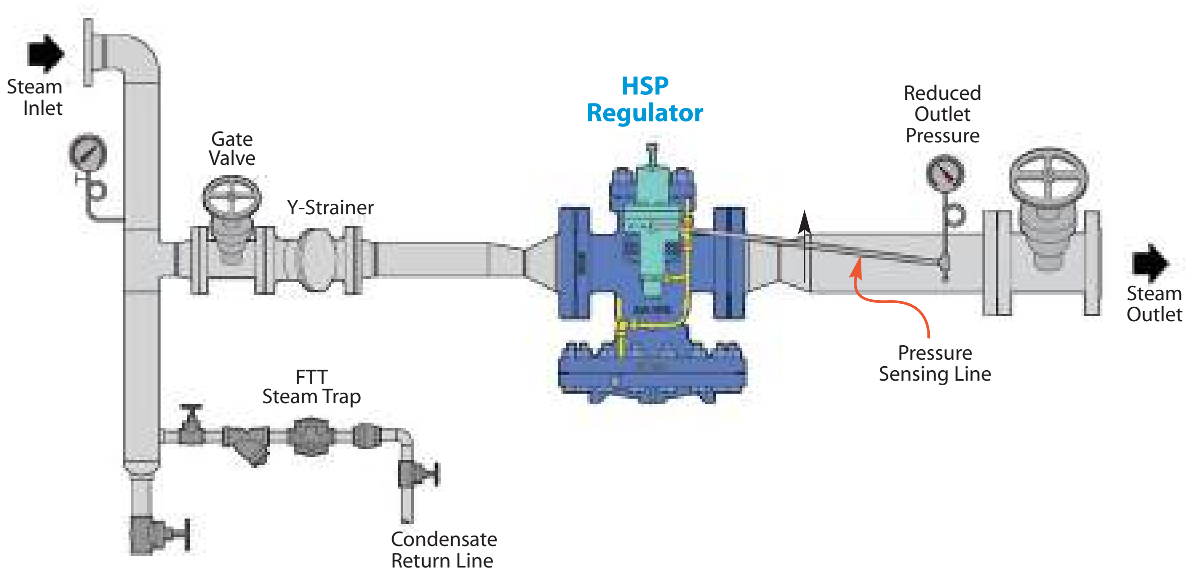




Standard pilot mounting is on the right side of the regulator when looking into the outlet port (as shown). Pilot mounting on HSP regulators are field-reversible.

DIMENSIONS HSP Series – *inches*

	(A) Face-To-Face						Weight (lbs)	
Size	150#	300#	B	C	D	E	150#	300#
1"	5 1/2	6	6 1/4	3 1/2	7	6 3/8	40	45
1 1/2"	6 7/8	7 3/8	7 3/8	4 7/8	8 3/4	7 1/16	55	60
2"	8 1/2	9	8 1/4	5 3/8	10 7/8	7 3/16	75	85
3"	10	10 3/4	8 7/8	6 3/4	13 1/4	8 3/16	130	145
4"	11 7/8	12 1/2	10 7/8	7 1/2	14 3/4	9 5/16	215	235

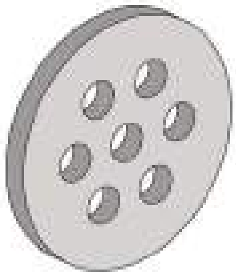


Pressure Reducing Station for Steam Application

Noise Reduction

Noise Attenuation Equipment is used to reduce unwanted or excessive noise that commonly occurs in pressure reducing stations.

Noise Reduction Capability: **5-10 dBA**



Series-A Orifice Plate

Full Model Code	Size	Pressure PSI
WSA-12-250	1/2"	5-250
WSA-13-250	3/4"	5-250
WSA-14-250	1"	5-250
WSA-15-7	1 1/4"	5-7
WSA-15-250	1 1/4"	10-250
WSA-16-250	1 1/2"	5-250
WSA-17-20	2"	5-20
WSA-17-250	2"	25-250
WSA-18-5	2 1/2"	5
WSA-18-40	2 1/2"	7-40
WSA-18-250	2 1/2"	50-250
WSA-19-5	3"	5
WSA-19-30	3"	7-30
WSA-19-250	3"	40-250
WSA-20-5	4"	5
WSA-20-30	4"	7-30
WSA-20-250	4"	40-250
WSA-22-5	6"	5
WSA-22-10	6"	7-10
WSA-22-250	6"	12-250

Notes: 1) 300# Flange plates available. Consult Factory. (WSB)
2) Must specify Inlet Pressure to the regulating valve when ordering

Description

Selection: Series A orifice plates are custom engineered to maximize noise attenuation and reduce dbA to the lowest achievable value. The number and diameter of holes will be determined based on application conditions, and the plate diameter will typically be equal to the recommended downstream pipe size. Therefore, the following information is required for selection:

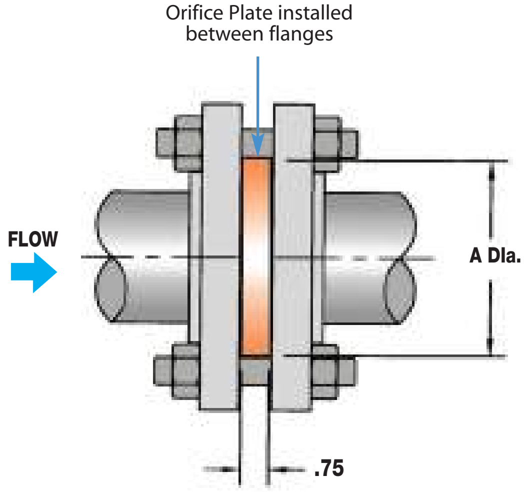
- Inlet (Supply) Pressure to the HD/HSP Regulator
- Outlet (Downstream) Pressure of the HD/HSP Regulator
- Steam Flow Rate (lb/hr)

How it Works

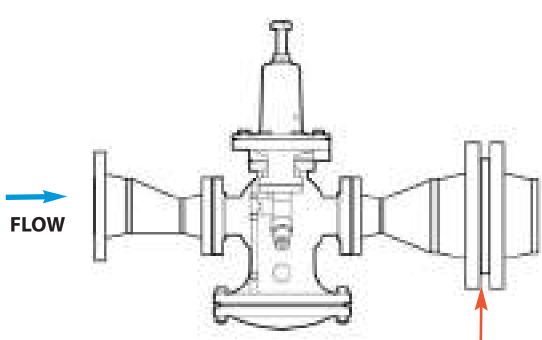
The **Series-A** Orifice Plate with its drilled orifice pattern is installed after the pressure regulating valve to smooth out turbulence caused by the pressure drop across the regulator. Noise reduction levels of **5-10 dBA** can typically be achieved.

Installation

The Series-A Orifice Plate is installed between ANSI flanges immediately after the regulator. If the regulator is a flanged unit, the orifice plate is placed at the flange outlet connection.



Series-A Typical Hook-up



Series-A DIMENSION (A) – *inches*

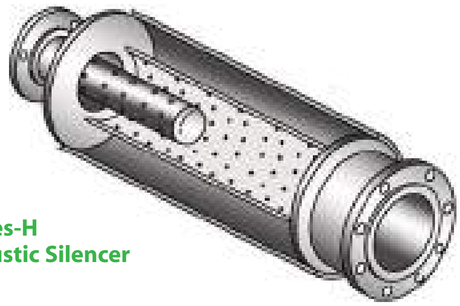
Pipe Size	125# Flange	250# Flange
2"	6	4 3/16
2 1/2"	7	4 15/16
3"	7 1/2	5 11/16
4"	9	6 15/16
6"	11	9 11/16

Note: Other sizes available. Consult factory.

Noise Reduction

Noise Attenuation Equipment is used to reduce unwanted or excessive noise that commonly occurs in pressure reducing stations.

Noise Reduction Capability: 20-30 dBA



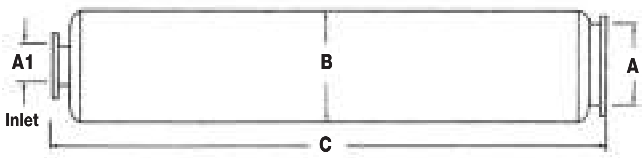
Series-H
Acoustic Silencer

How it Works

The **Series-H** Acoustic Silencer incorporates a **Dual Diffuser** tube design. The inner tube has a drilled orifice pattern and the outer tube contains an integral layer of sound absorbing insulation. Noise reduction levels of **20-30 dBA** can typically be achieved.

Installation

The **Series-H** Diffuser Tube should be installed immediately downstream of the regulator, as shown below.

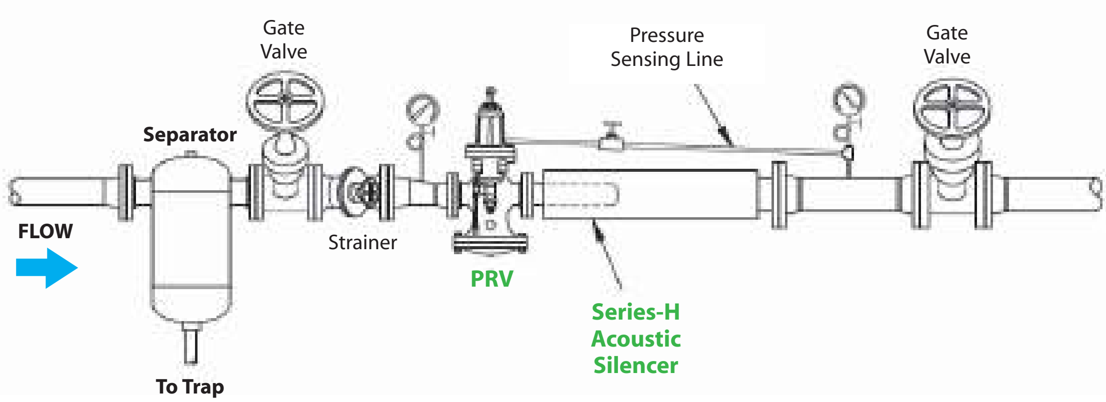


Series-H DIMENSIONS – *inches*

Model	A1	A	B	C	Weight (lbs)
LCV-8	4	8	14	57	145
LCV-10	6	10	16	71	210
LCV-12	6	12	18	81	295

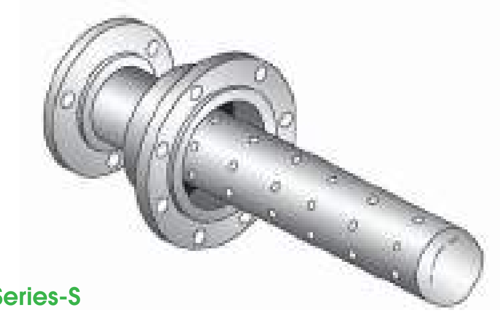
Note: Other sizes available. Consult factory.

Series-H Typical Hook-up



Noise Reduction

Noise Reduction Capability: 10-15 dBA



Series-S
Acoustic Diffuser

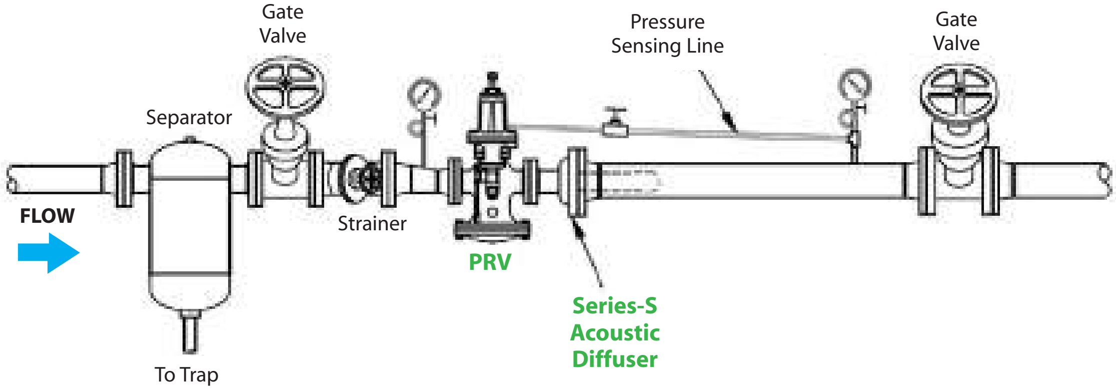
How it Works

The **Series-S** Acoustic Diffuser incorporates a single tube with a drilled orifice pattern which reduces downstream turbulence. Noise reduction levels of **10-15 dBA** can typically be achieved.

Installation

The **Series-S** Diffuser Tube should be installed immediately downstream of the regulator, as shown below.

Series-S Typical Hook-up



Model Selection Chart for Series-S Diffuser

Steam Capacity (lbs/hr)	Valve Inlet Pressure (PSIG)															
	15	20	25	30	40	50	60	75	90	100	125	150	175	200	225	250
1000	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3
1500	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3	S-3
2000	S-4	S-4	S-4	S-4	S-4	S-4	S-4	S-4	S-4	S-4	S-4	S-4	S-4	S-4	S-4	S-4
3000	S-4	S-4	S-4	S-4	S-4	S-5	S-5	S-5	S-5	S-5	S-5	S-5	S-5	S-5	S-5	S-5
4000	S-5	S-5	S-5	S-5	S-5	S-5	S-5	S-5	S-5	S-5	S-5	S-5	S-5	S-5	S-5	S-5
6000	S-6	S-6	S-6	S-6	S-6	S-6	S-6	S-6	S-6	S-6	S-6	S-6	S-6	S-6	S-6	S-6
8000	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8
10000	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8	S-8

Note: For higher capacity models, S-10 & S-12, consult factory.

Noise Reduction

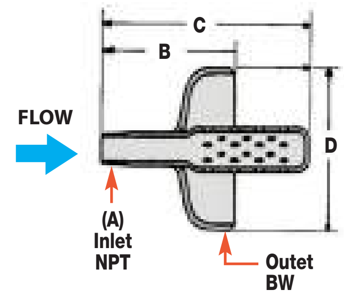
Series-S DIMENSIONS – *inches*

Model	Inlet (A)		Outlet	NPT x Weld Dimensions		
	NPT	FLG	FLG/BW	B	C	D
S-3	3/4		2	5 1/2	13 1/2	2 3/8
	1		2	5 1/2	13 1/2	2 3/8
S-4	3/4		4	6 1/2	13 1/2	4 1/2
	1		4	6 1/2	13 1/2	4 1/2
	1 1/4		4	6 1/2	13 1/2	4 1/2
	1 1/2		4	6 1/2	13 1/2	4 1/2
	2		4	6 1/2	13 1/2	4 1/2
S-5	3/4		4	6 1/2	16 1/2	4 1/2
	1		4	6 1/2	16 1/2	4 1/2
	1 1/4		4	6 1/2	16 1/2	4 1/2
	1 1/2		4	6 1/2	16 1/2	4 1/2
	2		4	6 1/2	16 1/2	4 1/2
	2 1/2	2 1/2	4	6 1/2	16 1/2	4 1/2
S-6	1 1/4		6	8	14	5 5/8
	1 1/2		6	8	14	5 5/8
	2		6	8	14	5 5/8
	2 1/2	2 1/2	6	8	14	5 5/8
	3	3	6	8	14	5 5/8
S-8	1 1/2		8	10	17	8 5/8
	2		8	10	17	8 5/8
	2 1/2	2 1/2	8	10	17	8 5/8
	3	3	8	10	17	8 5/8
	4	4	8	10	17	8 5/8
S-10	2		12	12	14	12 3/4
	2 1/2	2 1/2	12	12	14	12 3/4
	3	3	12	12	14	12 3/4
	4	4	12	12	14	12 3/4
	6	6	12	12	14	12 3/4
S-12	2 1/2	2 1/2	12	12	21	12 3/4
	3	3	12	12	21	12 3/4
	4	4	12	12	21	12 3/4
	6	6	12	12	21	12 3/4

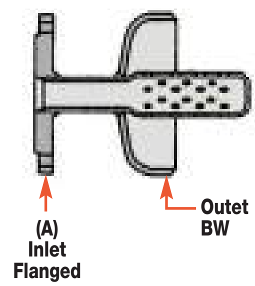
Notes: 1)150# & 300# flanged available.
2) Other sizes available; consult factory.

BW = Butt-weld

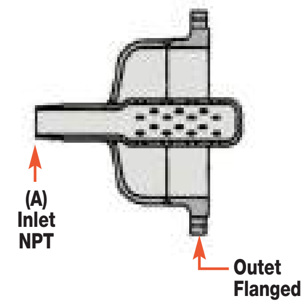
NPT x Butt-Weld



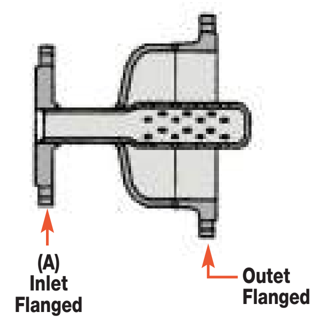
Flanged x Butt-Weld



NPT x Flanged



Flanged x Flanged



Pilot-Operated REGULATORS

Full Port

CAPACITIES – *Steam (lbs/hr)* FULL PORT

Inlet Pressure (PSIG)	Outlet Pressure (PSIG)	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"	6"
C_V Factors		3.8	6.7	11	15	21	37	55	71	113	241
5	0	85	150	250	350	500	800	1200	1600	2600	5500
	2	80	140	230	310	440	770	1100	1500	2400	5100
7	0	115	200	325	450	600	1100	1650	2100	3600	7800
	2	105	180	300	400	575	1000	1500	2000	3100	6700
	3	90	160	275	375	525	900	1300	1800	2800	6000
10	0	150	260	425	575	850	1500	2200	2800	4600	9900
	2	140	240	400	550	800	1400	2100	2700	4300	9100
	5	100	175	300	400	600	1000	1600	2000	3200	6900
12	0	160	280	475	600	900	1600	2400	3100	4900	10300
	4	140	240	400	550	800	1400	2100	2700	4300	9100
	7	125	200	375	500	700	1200	1900	2400	3800	8200
15	0-3	190	325	550	750	1000	1800	2700	3500	5600	12000
	5	175	300	500	700	900	1700	2500	3200	5200	11100
	8	140	250	400	500	800	1300	2000	2600	4200	8900
20	0-5	210	375	625	850	1200	2100	3100	4000	6400	13700
	10	190	325	550	750	1000	1800	2700	3500	5600	12000
	12	170	300	500	675	950	1600	2500	3200	5100	10800
25	0-7	250	450	775	1050	1500	2600	3800	5000	7900	16900
	10	225	425	700	975	1300	2400	3600	4600	7300	15600
	15	200	350	600	800	1100	2000	3000	3900	6200	13200
30	0-12	275	500	800	1100	1500	2700	4100	5200	8300	17800
	15	250	450	750	1000	1400	2500	3800	4900	7800	16600
	20	225	375	650	850	1200	2100	3200	4100	6500	14000
40	0-18	350	600	1000	1350	1900	3300	5000	6400	10300	21900
	25	300	500	850	1150	1600	2800	4200	5400	8700	18500
	30	250	425	700	1000	1400	2500	3700	4700	7600	16100
50	0-20	400	700	1200	1650	2300	4100	6000	7800	12400	26500
	30	350	650	1100	1500	2000	3600	5400	6900	11000	23600
	40	275	500	800	1100	1500	2700	4100	5200	8300	17800
60	0-30	475	850	1350	1900	2600	4600	6900	8900	14200	30300
	35	425	775	1250	1700	2400	4300	6400	8200	13100	27900
	50	300	525	850	1200	1600	2900	4300	5600	8900	19000
75	0-35	575	1000	1650	2300	3200	5600	8300	10800	17200	36600
	50	475	825	1350	1900	2600	4600	6900	8900	14100	30100
	60	400	700	1150	1600	2200	3900	5800	7400	11800	25200
90	0-45	675	1200	1950	2700	3700	6600	9800	12700	20200	43100
	60	575	1000	1700	2300	3200	5700	8500	10900	17400	37100
	75	425	750	1200	1700	2300	4100	6100	7900	12600	27000
100	0-50	750	1300	2100	3000	4100	7300	10800	14000	22200	47500
	60	700	1200	2000	2700	3800	6700	10000	12900	20500	43800
	80	500	875	1400	1900	2700	4800	7100	9200	14700	31300
125	0-60	925	1650	2700	3700	5200	9100	14000	17500	28000	59500
	75	825	1475	2400	3300	4600	8200	12200	15700	25000	53500
	100	625	1100	1800	2500	3500	6200	9200	11900	19000	40400
150	0-75	1100	1900	3100	4300	6000	10600	15800	20400	32400	69100
	100	925	1600	2700	3600	5100	9000	13400	17400	27700	59000
	125	650	1150	1900	2600	3600	6400	9500	12300	19600	41900
175	0-85	1275	2250	3700	5000	7100	12500	18600	24000	38200	81400
	125	1000	1800	2900	4000	5600	9900	14700	18900	30100	64300
	150	750	1300	2100	2900	4100	7300	10800	14000	22200	47500
200	0-100	1450	2500	4200	5700	8000	14100	21000	27100	43100	92000
	125	1300	2300	3700	5100	7100	12600	18700	24100	38400	81900
	150	1075	1900	3100	4300	6000	10600	15700	20300	32300	68900
225	0-120	1575	2800	4600	6200	8700	15400	22900	29500	47000	100200
	150	1450	2500	4200	5700	8000	14100	21000	27200	43300	92300
	175	1350	2400	3900	5300	7400	13100	19500	25200	40100	85500
250	0-130	1750	3100	5100	6900	9700	17100	25500	32900	53400	111800
	150	1650	2900	4700	6500	9100	16000	23800	30800	49000	104600
	200	1200	2100	3500	4800	6700	11900	17600	22800	36200	77300
300	0-160	2045	3605	5920	8075	11310	19220	29610	38230	60840	129750
	175	1945	3425	5625	7670	10740	18925	28130	36320	57800	123270
	200	1780	3140	5155	7030	9840	17340	25780	33275	52960	112950
400	0-200			7980		1480	22000		48800	78000	
	250			7550		13800	23800		46200	73950	
	300			6700		12100	21200		41000	65200	
450	0-225			8970		16000	22000		55000	87600	
	300			8500		15000	26900		52100	83200	
	350			7540		13300	23900		46200	73900	

Note: For inlet pressures in green shaded area, use low pressure main valve and low pressure temperature pilot.
For 400 & 450 PSIG inlet pressures, use HSP regulator only.

Pilot-Operated REGULATORS

HD & HSP Series

Reduced Port

CAPACITIES – *Steam (lbs/hr)* **REDUCED PORT**

Inlet Pressure (PSIG)	Outlet Pressure (PSIG)	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"	6"
C_V Factors		1.4	3.3	5.6	7.8	13.3	18.8	25.9	41.7	74	163
5	0	15	35	59	82	140	197	272	438	777	1712
	2	13	32	53	75	128	181	249	401	712	1569
7	0	21	48	82	115	195	276	381	613	1088	2396
	2	20	46	79	110	187	265	365	587	1042	2296
	3	19	44	74	104	177	250	344	554	983	2165
10	0	29	70	117	164	279	395	544	876	1554	3423
	2	28	68	115	160	274	387	533	858	1523	3354
	5	25	60	102	142	242	342	471	758	1346	2964
12	0	35	83	141	197	335	473	653	1051	1865	4108
	4	33	78	133	185	316	446	615	990	1758	3873
	7	29	68	115	160	272	385	530	854	1515	3336
15	0-3	43	102	173	241	410	580	800	1287	2284	5031
	5	41	98	166	232	395	558	769	1238	2198	4841
	8	37	88	149	208	354	500	690	1111	1972	4343
20	0-5	57	134	227	317	541	764	1053	1696	3009	6629
	10	51	120	204	284	483	684	942	1517	2692	5929
	12	47	111	188	262	447	632	870	1401	2486	5477
25	0-7	70	166	282	393	670	948	1305	2102	3730	8215
	10	67	158	269	375	640	905	1246	2006	3561	7843
	15	59	139	235	328	559	790	1088	1751	3108	6846
30	0-12	81	190	323	450	768	1085	1495	2408	4273	9411
	15	76	180	305	426	726	1025	1413	2275	4037	8892
	20	66	155	263	366	625	883	1216	1958	3475	7654
40	0-18	105	248	420	585	998	1410	1943	3128	5551	12227
	25	99	199	367	511	872	1232	1698	2734	4852	10688
	30	78	183	311	433	739	1044	1439	2317	4111	9056
50	0-20	135	318	539	751	1280	1809	2492	4013	7121	15686
	30	118	277	470	655	1117	1579	2175	3502	6216	13692
	40	88	208	353	491	838	1184	1632	2627	4662	10269
60	0-30	153	360	611	851	1451	2051	2826	4550	8074	17786
	35	143	338	573	798	1361	1924	2651	4268	7573	16682
	50	98	230	390	543	926	1309	1804	2904	5154	11353
75	0-35	195	460	780	1086	1853	2619	3608	5809	10308	22706
	50	164	387	657	916	1561	2207	3040	4895	8687	19135
	60	132	312	529	737	1257	1777	2448	3941	6993	15404
90	0-45	229	540	916	1277	2177	3077	4239	6825	12112	26680
	60	197	465	789	1100	1874	2648	3649	5874	10425	22962
	75	146	345	585	815	1389	1964	2705	4357	7731	17029
100	0-50	255	600	1018	1419	2419	3419	4710	7584	13458	29644
	60	235	554	940	1310	2234	3158	4351	7006	12432	27384
	80	176	416	706	983	1676	2367	3263	5254	9324	20538
125	0-60	322	760	1290	1796	3063	4329	5964	9603	17041	37536
	75	294	693	1176	1638	2793	3948	5439	8757	15540	34230
	100	221	518	882	1229	2095	2961	4079	6568	11655	25672
150	0-75	381	900	1527	2128	3628	5128	7065	11376	20187	44467
	100	329	775	1315	1831	3123	4414	6081	9791	17374	38270
	125	243	575	975	1385	2316	3274	4510	7261	12885	28382
175	0-85	449	1060	1800	2505	4272	6939	8320	13396	23771	52362
	125	360	849	1440	2006	3421	4835	6661	10725	19032	41923
	150	265	625	1060	1476	2518	3558	5606	7893	14008	30855
200	0-100	509	1200	2037	2837	4838	6838	9420	15168	26916	59288
	125	459	1082	1836	2557	4360	6164	8492	13672	24262	53442
	150	389	917	1556	2167	3695	5223	7195	11584	20557	45232
225	0-120	560	1319	2238	3117	5360	7514	10351	16667	29577	65150
	150	493	1162	1972	2747	4684	6621	9121	14686	26061	57405
	175	416	980	1663	2316	3950	5583	7692	12384	21976	48409
250	0-130	628	1480	2511	3498	5964	8431	11614	18700	33184	73095
	150	588	1386	2352	3276	5586	7896	10878	17514	31080	68460
	200	441	1040	1764	2457	4190	5922	8159	13136	23310	51345
300	0-160	755	1775	3015	4200	7160	10120	13945	22450	39840	87760
	175	715	1690	2865	3990	6800	9615	13250	21330	37850	83370
	200	655	1550	2625	3655	6235	8810	12140	19545	34680	76400
400	0-200			4070		9460	24500		29980	51450	
	250			3860		8970	12380		27460	48750	
	300			3430		7970	11010		24410	43330	
450	0-225			4580		10650	24500		32600	57890	
	300			4340		10090	13930		30890	54840	
	350			3860		8970	12380		27460	48750	

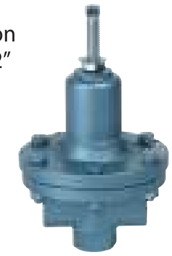
Note: For inlet pressures in green shaded area, use low pressure main valve and low pressure temperature pilot.
For 400 & 450 PSIG inlet pressures, use HSP regulator only.

Direct-Operated Pressure & Temperature Regulating Valves

Direct-Operated Regulators are used for controlling pressure or temperature in a variety of applications.

Pressure Regulating Valves	Page No.

Cast Iron
3/8" – 2"



O Series

246-249

Pressure Regulating Valve: Steam, Water, Oil, Air, other Liquids & Gases

The O-Series, with Cast Iron body and Hardened Stainless internals, is our most popular and economical solution for reducing pressure in STEAM systems. It is also suitable for Water, Oil, Air as well as other Liquids & Gases.

Bronze,
Cast Iron
1/2" – 4"

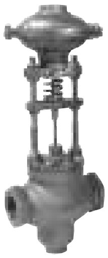
B Series

250-251

Pressure Regulating Valve: Water, Air, Oil, other Liquids & Gases,

The B-Series is primarily used for reducing pressure in WATER systems.
It is also suitable for Air, Oil, as well as other Liquids and Gases.
The B-Series offers higher capacity than the O-Series.

Bronze,
Cast Iron
1/2" – 4"



455 Series

252-253

Pressure Regulating Valve: Steam, Air, Other Gases

The 455 is ideally suited for reducing pressure in STEAM applications and requires only 5 PSIG minimum inlet pressure. Excellent for use in steam systems that contain large amounts of scale that may cause failure in pilot-operated regulators.

Ductile Iron
1/2" – 4"

403 Series

254-257

Pressure Regulating Valve: Steam, Air

The 403 are pilot-operated, piston-actuated, pressure regulators primarily used for reducing pressure in STEAM systems. This regulator is available with an optional internal sensing line which simplifies installation.

Direct-Operated Pressure & Temperature Regulating Valves

Back-Pressure Relief Valves

Page No.

Bronze
1/2" – 3"

R-Series & 10691-Series

258-260

Relief & Back Pressure Valves: Water, Liquids, Air

The R-Series & 10691 Series are economically-priced Back Pressure Relief Valves for Liquid service. Relief Valves (Back Pressure Valves) are used to maintain a specific back pressure or to protect systems from an over-pressure condition. 10691-Series is similar to the R-Series with the exception of a soft-elastomeric seat for bubble-tight shut-off.

Bronze,
Cast Iron
1/2" – 2"

3040-Series

261-263

Relief & Back Pressure Valves: Water, Liquids, Air

The 3040 Back Pressure Relief Valve offers a much higher capacity than the R-Series. Used for Liquid service. Relief Valves protect systems from over-pressurized conditions.

Temperature Regulating Valves

W91 & W94 Series

265-285

Self-Operating Temperature Regulating Valves:
Heating, Cooling, Mixing & Diverting

The W91/W94 Series Temperature Regulating Valves are used for controlling process temperature in industrial and HVAC applications.

Typical applications are: Heating different processes & devices with steam, Cooling equipment with chilled water, or Mixing & Diverting hot & cold liquids using 3-Way Valves.

What are Pressure Regulating Valves (PRVs) used for?

Steam, liquids and other gases are typically transported through piping systems at relatively higher pressure than ultimately needed and therefore need to be reduced to a lower pressure at the final point of use. The purpose of the Pressure Regulating Valve (PRV) is to reduce the pressure of steam, liquid or gas to a lower pressure appropriate for its final application. All pressure regulating valves are self-operated, which means they do not require any outside source of power such as air pressure or electric actuators to operate. In contrast, Control valves do require an outside source of power to actuate the valve. All pressure regulating valves are Self-Operated; however, they are categorized as either **Direct-Operated** or **Pilot-Operated**. The Pilot-Operated Regulators are either **Piston-Actuated** or **Diaphragm-Actuated**.

Direct-Operated

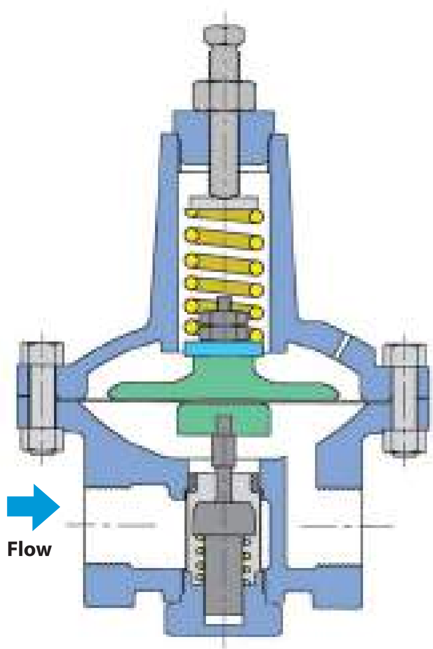
O-Series for Steam, Air & Water
455-Series for Steam
B-Series for Water & Liquids.

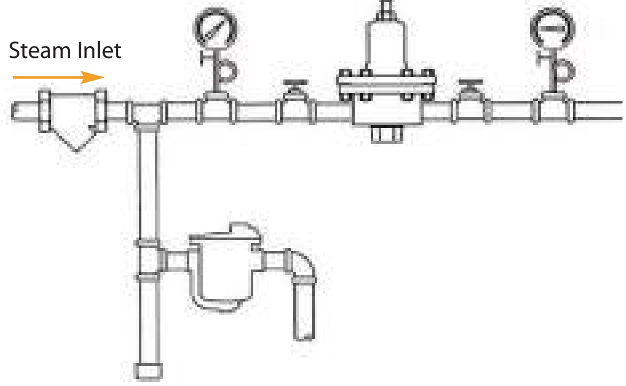
O-Series B-Series 455-Series

Direct-operated pressure regulating valves are the simplest in design and the most economical to purchase and therefore should be used whenever suitable. The downstream pressure of the steam or liquid being regulated is used to position the diaphragm and valve disc to control the amount of flow through the valve. Downstream pressure adjustment is easily made by turning the adjustment screw to increase or decrease compression on the control spring. The limitation of the direct-operated type regulator is a variation of up to 10% of initial set pressure depending on changes in flow through the valve. As flow requirements through the valve increase, the outlet set pressure will tend to decrease.

For example; Inlet pressure is 100 PSIG and downstream pressure is adjusted to maintain 50 PSIG while 250 lbs/hr of steam flows through the valve. If the steam flow rate happens to increase to 500 lbs/hr, then the outlet pressure would drop to 45 PSIG.

Direct-operated regulators are suitable for many less critical uses in the low-to-moderate flow range including small heaters, humidifiers, hospital equipment, tire molds, typical applications in food processing, as well as many other general uses.



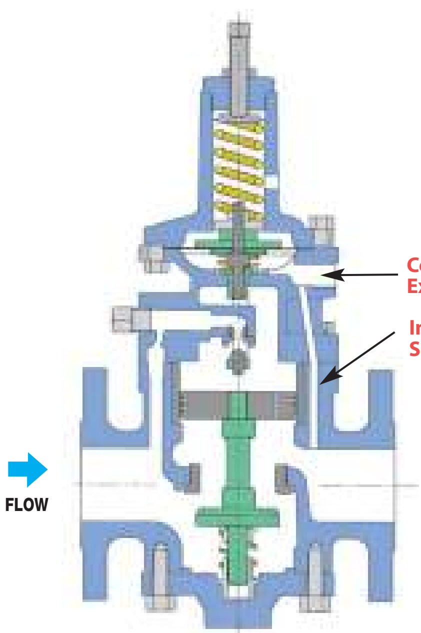


Pilot-Operated **Piston-Actuated**

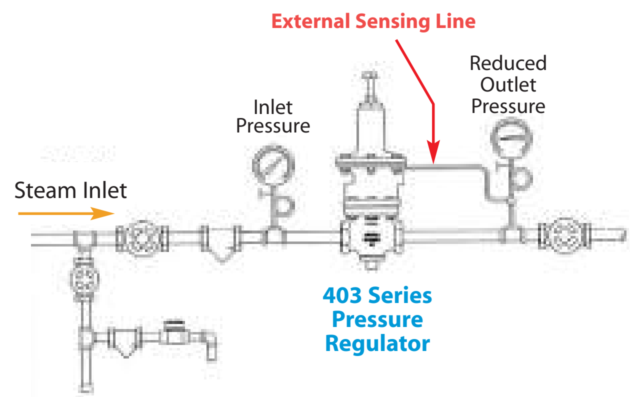
403-Series for Steam, Air & Gas Applications

Pilot-operated piston-actuated pressure regulating valves contain a separate pilot valve which is mounted on top of the main valve. The valve senses the downstream pressure (low pressure side) and precisely modulates a small amount of steam from the upstream side (high pressure side) to the top of the piston chamber, which in turn controls the opening of the main valve. When steam demand increases and downstream pressure starts to drop, the valve is opened further, allowing for additional flow. Pilot-operated piston-actuated regulators have increased accuracy and consistency of set pressure when compared to the Direct-operated type. Set pressure is more stable and will only vary a few percent over the full flow range. Downstream pressure sensing is either done internally (internally sensed) or by using an external pressure sensing line (externally sensed).

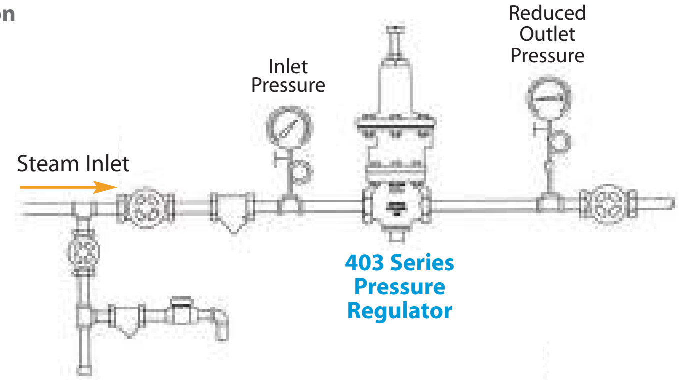
The piston-actuated valves are more compact than diaphragm-actuated valves; however, since the piston has more friction than a freely flexing diaphragm, they are not quite as accurate. These valves can be used for low-to-high flow applications or when larger flow rates or more accurate pressure control is required than can be achieved with direct-operated pressure regulators.



External Sensing (standard)
(requires sensing line)



Internal Sensing Option
(Specially drilled internal sensing path eliminates the need for an external sensing line)

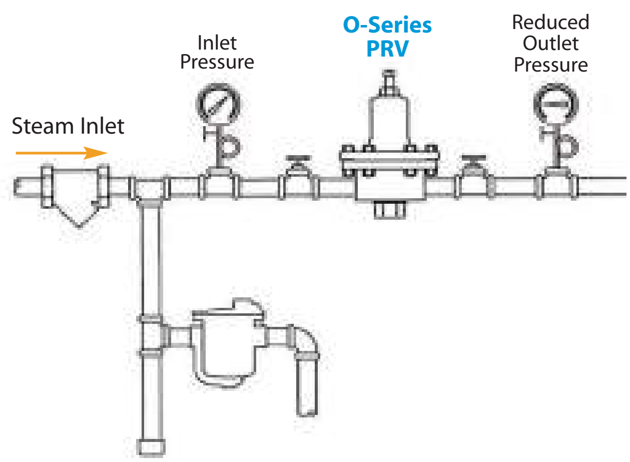


Pilot-Operated **Diaphragm-Actuated**

Pilot-Operated Diaphragm-Actuated PRVs contain a separate pilot valve mounted externally to the main valve. The pilot valve senses the downstream pressure (low pressure side) through an external sensing line which in turn controls the opening of the main valve. The sensitivity and frictionless motion of the diaphragm, in combination with using a control pilot, make this style of regulators the most accurate. Downstream pressure can often be controlled within 1-2 % of initial set-pressure. Refer to Watson HD-Series Regulators for steam applications.

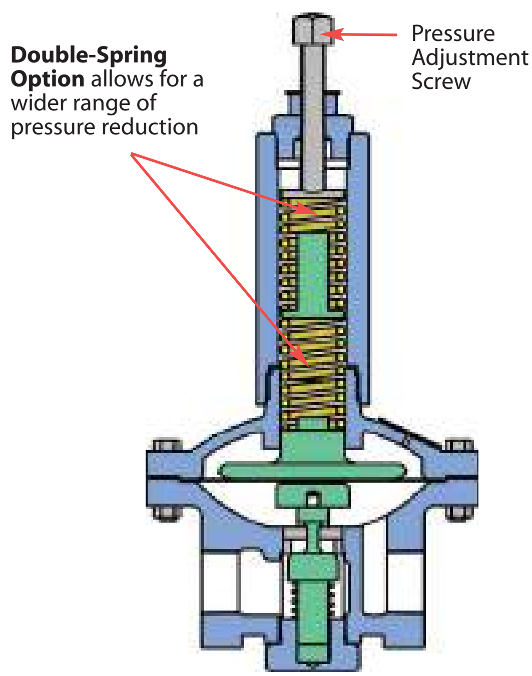
Model	**O-Series**
Service	**Steam, Air, Water & Other Liquids**
Sizes	**3/8", 1/2", 3/4", 1", 1 1/4", 1 1/2", 2"**
Connections	**NPT**
Body Material	**Cast Iron**
Seat & Disc	**Hardened 420 Stainless Steel**
Diaphragm (for Steam)	**Phosphor Bronze - Steam**
Diaphragm (for Liquid or Air)	**Viton - Water, Air & Oil (300˚F max)**
Max Inlet Pressure	**250 PSIG**
Min Inlet Pressure	**15 PSIG**
Max Differential Pressure	**125 PSI**
Min Differential Pressure	**15 PSI**

Design Pressure/Temperature Rating – PMA/TMA	
NPT	250 PSIG @ 450˚F



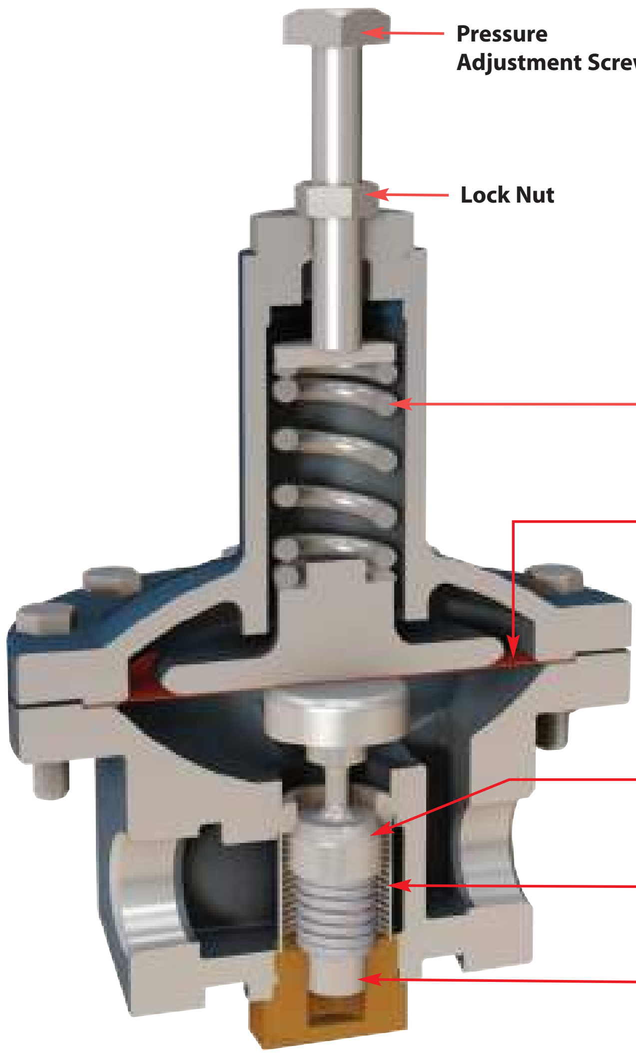
Typical Applications

The **O-Series** direct-operated pressure regulators with heavy duty cast iron bodies and internal strainer are suitable for a wide range of applications in the low-to-moderate flow range. Applications include small heaters, humidifiers, various hospital equipment, tire molds, as well as many other general uses. This style of regulator does not require an external sensing line. Set pressure is controlled by turning an adjustment screw with lock nut that increases or decreases spring force above the diaphragm. Several spring ranges are available, depending upon the downstream pressure that needs to be maintained. O-Series contains hardened stainless steel seat and disc for extended service life. Phosphor Bronze Diaphragm specifically designed for Steam service is considered a preferred choice over Stainless Steel diaphragms which are prone to work-hardening and potential cracking. Viton diaphragms are specifically designed for water, air, gases and other liquid service and have a working temperature range up to 300˚F.



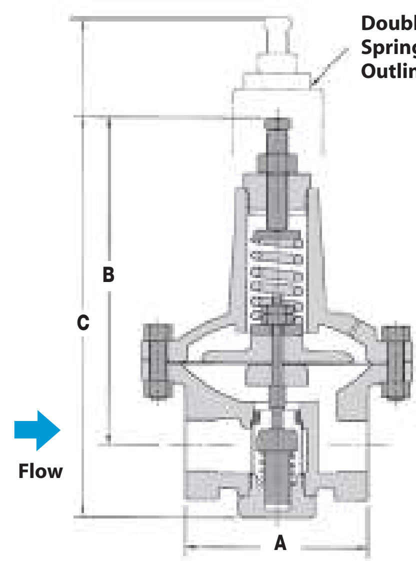
Features & Options

- Hardened stainless steel seat and disc for extended service life (55 Rc)
- Phosphor Bronze diaphragm for Steam Service
- Viton diaphragm for up to 300ºF for Water, Oil & Air Service
- Double spring available for extended outlet pressure range
- Integral stainless steel strainer on 3/4" HC, 1", 1 1/4", 1 1/2" & 2"



DIMENSIONS & WEIGHTS – *inches*

Size	A	B	C Single Spring	C Double Spring	Weight (lbs)
3/8"	4 1/4	6 1/2	8	-	8
1/2"	3 5/8	6 1/2	8	-	8
3/4"	3 5/8	6 1/2	8	-	8
3/4" HC	3 5/8	8	10	12 1/2	15
1"	4 1/2	8 1/2	10 1/2	13	18
1 1/4"	4 1/2	8 1/2	10 1/2	13	18
1 1/2"	6 1/2	8 3/4	12	14 1/2	40
2"	6 1/2	8 3/4	12	14 1/2	40



How to Size/Order

From the Capacity chart, find the inlet pressure and required regulator outlet pressure. Follow across chart to nearest capacity (steam, air, water) that meets or slightly exceeds demand requirements. Follow vertically up to determine appropriate size. When exact application values are not shown, interpolate between values. Select a model with the spring range that accommodates the required outlet set pressure.

Example:

Application: 200 lbs/hr of 100 PSIG Steam reduced to 30 PSIG
Model Code: **O-12-N-14-B** (1/2″ O-Series, 10-50 PSIG spring range, NPT with Bronze Diaphragm for Steam)

CAPACITIES – *Steam (lbs/hr); *Air (SCFM); *Water (GPM)* — Inlet/Outlet Pressures (PSIG)

		SINGLE Spring Only			Available with either **SINGLE** or **DOUBLE** Pressure Adjustment Spring(s)														
Inlet Press.	Outlet Press.	3/8″, 1/2″, 3/4″			3/4″ HC **			1″			1 1/4″			1 1/2″			2″		
		Steam	Air	Water	Steam	Air	Water	Steam	Air	Water	Steam	Air	Water	Steam	Air	Water	Steam	Air	Water
15	2	46	26	6	92	51	11	130	73	16	145	81	18	180	100	22	199	111	25
	5	38	21	4	75	42	9	106	59	13	119	66	14	147	82	18	163	91	19
20	5	65	36	8	130	72	15	184	102	22	205	114	25	254	141	30	281	156	34
	10	61	34	6	123	69	13	174	97	18	194	109	20	241	134	25	266	149	27
	15	45	25	4	90	51	9	128	72	13	143	80	14	177	99	18	196	109	19
30	5	83	46	10	167	93	20	236	131	28	264	147	32	327	181	39	362	201	43
	10	83	46	10	167	93	18	236	131	25	264	147	28	327	181	35	362	201	39
	20	71	40	6	142	79	13	201	112	18	225	126	20	278	155	25	308	172	27
50	5	121	67	13	242	134	27	342	190	38	382	212	42	473	263	53	523	291	58
	25	121	67	10	242	134	20	342	190	28	382	212	32	473	263	39	523	291	43
	40	87	49	6	174	97	13	247	138	18	276	154	20	341	191	25	377	211	27
100	30	214	119	17	428	238	33	607	337	47	678	376	53	839	466	66	928	515	73
	50	214	119	14	428	238	28	607	337	40	678	376	45	839	466	55	928	515	61
	70	195	109	11	275	154	18	390	218	25	436	244	28	540	301	35	597	333	39
125	30	261	145	19	522	290	39	739	410	55	826	458	62	1021	567	76	1130	627	84
	50	261	145	17	522	290	35	739	410	49	826	458	55	1021	567	68	1130	627	75
	70	261	145	15	522	290	30	739	410	42	826	458	47	1021	567	58	1130	627	64
	100	201	112	10	402	225	20	569	318	28	636	355	32	787	440	39	871	486	43
150	30	307	171	22	615	341	44	871	484	62	974	540	69	1204	668	86	1332	740	95
	50	307	171	20	615	341	40	871	484	57	974	540	63	1204	668	78	1332	740	87
	70	307	171	18	615	341	36	871	484	51	974	540	57	1204	668	70	1332	740	78
	100	298	166	14	596	333	28	844	471	40	943	527	45	1167	652	55	1291	721	61
	120	239	133	11	478	267	22	677	378	31	756	422	35	935	523	43	1035	578	47
200	30	401	222	26	802	445	52	1135	630	74	1269	705	83	1570	871	102	1737	964	113
	50	401	222	24	802	445	49	1135	630	69	1269	705	78	1570	871	96	1737	964	106
	70	401	222	23	802	445	46	1135	630	65	1269	705	72	1570	871	89	1737	964	99
	100	401	222	20	802	445	40	1135	630	57	1269	705	63	1570	871	78	1737	964	87
250	50	494	274	28	988	549	57	1400	777	80	1565	869	90	1935	1074	111	2141	1189	123
	70	494	274	27	988	549	54	1400	777	76	1565	869	85	1935	1074	105	2141	1189	116
	125	494	274	22	988	549	45	1400	777	63	1565	869	71	1935	1074	88	2141	1189	97

* *Air and water capacities are based on using elastomeric diaphragms.*
** *3/4″ HC is high-capacity version of standard 3/4″ valve.*
Note: *For capacities of other gases multiply the air capacities by the following factors:* ***Argon–0.85*** ***CO_2–0.81*** ***Helium–2.69*** ***Nitrogen–1.02***

Pressure Regulating Valves for

Steam: Phosphor Bronze Diaphragm

Water, Oil, Air: Viton Diaphragm

The **O-Series** with Cast Iron body and Hardened Stainless internals, is our most popular and economical solution for reducing pressure in STEAM systems. It is also suitable for Air, Water, Oil as well as other Liquids and Gases. When used on STEAM Applications, the valve must be specified with a Phosphor Bronze Diaphragm (Suffix Code **B**). When used on Air, Water & Oil or other Liquid Applications, the valve must be specified with a Viton Diaphragm (Suffix Code **V**).

Important Application Note:
- **Use Phosphor Bronze Diaphragms for Steam.**
- **Use Viton diaphragms for Water, Air and Oil Applications.**

Phosphor Bronze Diaphragms may fracture if used on Liquid Service. Use for Steam Only.

Diaphragm Code:

B - Phosphor Bronze for Steam Service
V - Viton (300 °F Max) for Air & Other Liquids

Example Model Codes:

1) O-13-N-14-B
(O-Series, 3/4" NPT, 10-50 PSI, Single Spring, **Phosphor Bronze Diaphragm**)

2) O-13-N-14-V
(O-Series, 3/4" NPT, 10-50 PSI, Single Spring, **Viton Diaphragm**)

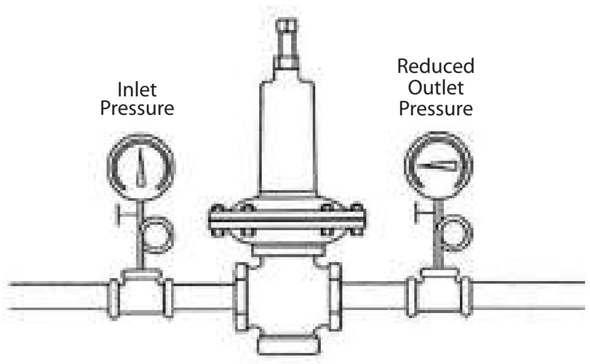
Size/ Connection NPT	Reduced Pressure Range (PSI)	STEAM Model Code	Water • Oil • Air Model Code	Weight lbs
SINGLE SPRING		**STEAM**	**Water • Oil • Air**	
3/8"	0-10	O-11-N-13-B	O-11-N-13-V	10
	10-50	O-11-N-14-B	O-11-N-14-V	10
	40-100	O-11-N-09-B	O-11-N-09-V	10
	100-200	O-11-N-10-B	O-11-N-10-V	10
1/2"	0-10	O-12-N-13-B	O-12-N-13-V	10
	10-50	O-12-N-14-B	O-12-N-14-V	10
	40-100	O-12-N-09-B	O-12-N-09-V	10
	100-200	O-12-N-10-B	O-12-N-10-V	10
3/4"	0-10	O-13-N-13-B	O-13-N-13-V	10
	10-50	O-13-N-14-B	O-13-N-14-V	10
	40-100	O-13-N-09-B	O-13-N-09-V	10
	100-200	O-13-N-10-B	O-13-N-10-V	10
SINGLE SPRING		**STEAM**	**Water • Oil • Air**	
3/4" HC	0-10	OHC-13-N-0003-B	OHC-13-N-0003-V	15
	10-30	OHC-13-N-0004-B	OHC-13-N-0004-V	15
	30-50	OHC-13-N-0005-B	OHC-13-N-0005-V	15
	40-85	OHC-13-N-0006-B	OHC-13-N-0006-V	15
1"	0-10	O-14-N-0007-B	O-14-N-0007-V	19
	10-30	O-14-N-0008-B	O-14-N-0008-V	19
	30-50	O-14-N-0009-B	O-14-N-0009-V	19
	40-85	O-14-N-0010-B	O-14-N-0010-V	19
1 1/4"	0-10	O-15-N-0007-B	O-15-N-0007-V	18
	10-30	O-15-N-0008-B	O-15-N-0008-V	18
	30-50	O-15-N-0009-B	O-15-N-0009-V	18
	40-85	O-15-N-0010-B	O-15-N-0010-V	18
1 1/2"	0-10	O-16-N-0008-B	O-16-N-0008-V	47
	10-30	O-16-N-0009-B	O-16-N-0009-V	47
	30-50	O-16-N-0010-B	O-16-N-0010-V	47
	40-85	O-16-N-0011-B	O-16-N-0011-V	47
2"	0-10	O-17-N-0008-B	O-17-N-0008-V	48
	10-30	O-17-N-0009-B	O-17-N-0009-V	48
	30-50	O-17-N-0010-B	O-17-N-0010-V	48
	40-85	O-17-N-0011-B	O-17-N-0011-V	48
DOUBLE SPRING		**STEAM**	**Water • Oil • Air**	
3/4" HC	0-75	OHC-13-N-0708-B	OHC-13-N-0708-V	19
	30-130	OHC-13-N-0809-B	OHC-13-N-0809-V	19
1"	0-75	O-14-N-0809-B	O-14-N-0809-V	22
	30-130	O-14-N-0910-B	O-14-N-0910-V	22
1 1/4"	0-75	O-15-N-0809-B	O-15-N-0809-V	22
	30-130	O-15-N-0910-B	O-15-N-0910-V	22
1 1/2"	0-75	O-16-N-0809-B	O-16-N-0809-V	48
	30-130	O-16-N-0910-B	O-16-N-0910-V	48
2"	0-75	O-17-N-0809-B	O-17-N-0809-V	48
	30-130	O-17-N-0910-B	O-17-N-0910-V	48

Model	**B-Series**
Service	**Water, Air, Oil, Other Gases & Liquids**
Sizes	**1/2", 3/4", 1", 1 1/4", 1 1/2", 2", 2 1/2", 3", 4"**
Connections	**NPT, 125# FLG, 250# FLG**
Body Material	**1/2"– 2 1/2" Bronze** **3"& 4" Cast Iron**
Disc & Diaphragm	**Viton - 300˚F max**
Max Inlet Pressure	**250 PSIG**
Min Inlet Pressure	**10 PSIG**
Max Differential Pressure	**125 PSI**
Min Differential Pressure	**20% of Inlet Pressure**

Design Pressure/Temperature Rating – PMA/TMA		
NPT	250 PSIG	@ 400˚F
125# FLG	125 PSIG	@ 450˚F
250# FLG	250 PSIG	@ 450˚F

Typical Applications

The **B-Series** direct-operated pressure regulators with balanced valve trim are used for reducing pressure in air and water systems. These regulators are commonly found in industrial plants, apartment buildings, water supply systems, schools and underground water distribution systems. The soft-seated elastomeric Viton disc has an operating temperature up to 300˚F and will produce a Class V shutoff. No external sensing line is required with this style of regulator.



Features & Options

- Diaphragm, disc and cup packing in Viton for 300ºF service
- Balanced pressure regulator allows accurate control even when incoming pressure fluctuates
- Valve has a Class V shut-off rating due to the "soft-seated" Viton disc

Note:
Flange selection may reduce pressure/temperature ratings.

Size/Connection		Model Code *	Body Material	Weight lbs
VITON Diaphragm & Disc (300˚F Max)				
1/2"	NPT	**B-12-N-X-V**	Bronze	8
3/4"	NPT	**B-13-N-X-V**	Bronze	8
1"	NPT	**B-14-N-X-V**	Bronze	9
1 1/4"	NPT	**B-15-N-X-V**	Bronze	13
1 1/2"	NPT	**B-16-N-X-V**	Bronze	15
2"	NPT	**B-17-N-X-V**	Bronze	21
2 1/2"	NPT	**B-18-N-X-V**	Bronze	27
3"	125# FLG	**B-19-F125-X-V**	Cast Iron	150
	250# FLG	**B-19-F250-X-V**	Cast Iron	160
4"	125# FLG	**B-20-F125-X-V**	Cast Iron	200
	250# FLG	**B-20-F250-X-V**	Cast Iron	210

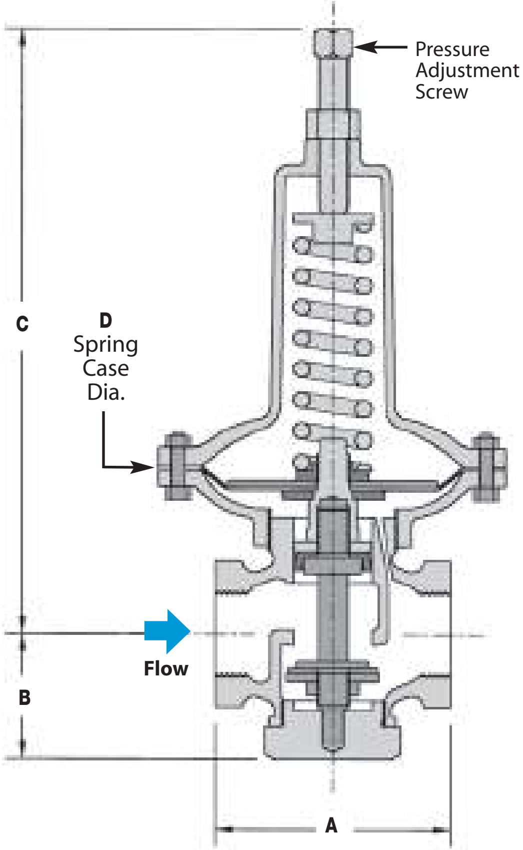
X=Spring Code (reference Spring Selection Table).

Example Model Code:
B-13-N-2-V (B-Series, 3/4" NPT, 20-70 PSI Spring Range)

B Series Spring Selection Table

Reduced Outlet Pressure (PSI)	Spring #	Code = X
1 - 12	#4	4
5 - 35	#3	3
20 - 70	#2	2
40 - 125	#1	1

Note: Reduced Outlet Pressure 1—12 PSI (Code 4) available in 1/2", 3/4", and 1" sizes only.



DIMENSIONS – *inches*

Size	Face-to-Face A: NPT Threaded	Face-to-Face A: 125# Flanged	Face-to-Face A: 250# Flanged	B	C	D Spring Case Dia. (in.)
1/2", 3/4"	3 3/8			1 7/8	9	5
1"	3 5/8			2 1/4	9 1/2	5
1 1/4"	4 1/4			2 3/8	10 1/2	6 3/4
1 1/2"	4 3/4			2 1/2	10 3/4	6 3/4
2"	5 7/8			3 3/8	11 5/8	6 3/4
2 1/2"	6 1/2			4 1/4	12 3/4	6 3/4
3"		10 1/4	11	4 1/2	21 1/2	9 1/4
4"		13	13 5/8	5 3/4	23	9 1/4

How to Size/Order

From the Capacity chart, find the inlet pressure and required regulator outlet pressure. Follow across chart to nearest capacity (water, air) that meets or slightly exceeds demand requirements. Follow vertically up to determine appropriate size. When exact application values are not shown, interpolate between values. From the spring range chart, select the spring range that accommodates the required outlet set pressure.

Example:
Application: 35 GPM of 70 PSIG Water reduced to 20 PSIG
Model Code: **B-14-N-3-V** (B-Series, 1″ NPT, 5-35 PSIG spring range)

PRESSURE Regulators

CAPACITIES – *Water (GPM); Air (SCFM)* Inlet/Outlet Pressures (PSIG)

Inlet Press.	Outlet Press.	1/2″ Water	1/2″ Air	3/4″ Water	3/4″ Air	1″ Water	1″ Air	1 1/4″ Water	1 1/4″ Air	1 1/2″ Water	1 1/2″ Air	2″ Water	2″ Air	2 1/2″ Water	2 1/2″ Air	3″ Water	3″ Air	4″ Water	4″ Air
10	5	5.5	25	10	45	13	60	22	100	33	150	55	250	88	400	132	600	176	800
20	5	9.8	48	18	86	23	114	39	190	59	285	98	475	156	760	234	1140	312	1520
	10	8.0	43	14	77	19	102	32	170	48	255	80	425	128	680	192	1020	256	1360
	15	5.5	30	10	54	13	72	22	120	33	180	55	300	88	480	132	720	176	960
30	5	12.5	68	23	122	30	162	50	270	75	405	125	675	200	1080	300	1620	400	2160
	10	11.3	63	20	113	27	150	45	250	68	375	113	625	180	1000	270	1500	360	2000
	20	8.0	48	14	86	19	114	32	190	48	285	80	475	128	760	192	1140	256	1520
50	5	16.8	98	30	176	40	234	67	390	101	585	168	975	268	1560	402	2340	536	3120
	25	12.5	88	23	158	30	210	50	350	75	525	125	875	200	1400	300	2100	400	2800
	40	8.0	63	14	113	19	150	32	250	48	375	80	625	128	1000	192	1500	256	2000
70	10	19.3	128	35	230	46	306	77	510	116	765	193	1275	308	2040	462	3060	616	4080
	30	15.8	125	28	225	38	300	63	500	95	750	158	1250	252	2000	378	3000	504	4000
	50	11.3	95	20	171	27	228	45	380	68	570	113	950	180	1520	270	2280	360	3040
100	30	21.0	175	38	315	50	420	84	700	126	1050	210	1750	336	2800	504	4200	672	5600
	50	17.5	165	32	297	42	396	70	660	105	990	175	1650	280	2640	420	3960	560	5280
	70	13.8	135	25	243	33	324	55	540	83	810	138	1350	220	2160	330	3240	440	4320
125	30	24.3	213	44	383	58	510	97	850	146	1275	243	2125	388	3400	582	5100	776	6800
	50	21.5	213	39	383	52	510	86	850	129	1275	215	2125	344	3400	516	5100	688	6800
	100	12.5	140	23	252	30	336	50	560	75	840	125	1400	200	2240	300	3360	400	4480
150	30	27.5	250	50	450	66	600	110	1000	165	1500	275	2500	440	4000	660	6000	880	8000
	50	25.0	250	45	450	60	600	100	1000	150	1500	250	2500	400	4000	600	6000	800	8000
	100	17.5	205	32	369	42	492	70	820	105	1230	175	2050	280	3280	420	4920	560	6560
	125	12.5	153	23	275	30	366	50	610	75	915	125	1525	200	2440	3000	3660	400	4880
200	70	28.5	325	51	585	68	780	114	1300	171	1950	285	3250	456	5200	684	7800	912	10400
	100	25.0	263	45	473	60	630	100	1050	150	1575	250	2625	400	4200	600	6300	800	8400
	125	21.5	223	39	401	52	534	86	890	129	1335	215	2225	344	3560	516	5340	688	7120
250	100	30.8	403	55	725	74	966	123	1610	185	2415	308	4025	492	6440	738	9660	984	12880
	125	28.0	393	50	707	67	942	101	1570	168	2355	280	3925	448	6280	672	9420	896	12560

Note: *For capacities of other gases multiply the air capacities by the following factors:* ***Argon–0.85*** ***CO_2–0.81*** ***Helium–2.69*** ***Nitrogen–1.0***

Pressure Regulating Valve

455 Series

Direct-Operated

Model	**455 Series**
Service	**Steam, Air & Other Gases**
Sizes	**1/2", 3/4", 1", 1 1/4", 1 1/2", 2", 2 1/2", 3", 4"**
Connections	**NPT, 125# FLG, 250# FLG**
Body Material	**1/2"– 1 1/2" SS Body/Brass Stuffing Box** **2"– 4" Cast Iron**
Seat & Disc	**Stainless Steel**
Diaphragm	**Neoprene/Nylon**
Max Inlet Pressure	**250 PSIG**
Min Inlet Pressure	**5 PSIG**
Max Differential Pressure	**125 PSI**
Min Differential Pressure	**20% of Inlet Pressure**

Design Pressure/Temperature Rating – PMA/TMA

NPT	250 PSIG	@ 400˚F
125# FLG	125 PSIG	@ 450˚F
250# FLG	250 PSIG	@ 450˚F

Typical Applications

The **455 Series** direct-operated pressure regulatoring valves are used for pressure reduction applications on steam, air and other gases. Balanced seat and disc design allows these valves to be used in applications with low inlet pressure; down to 5 PSIG. Unlike pilot-operated valves, the 455 does not contain any small pilot orifices and are therefore less susceptible to issues caused by dirt and pipe scale. The 455-Series is installed using an external sensing line which is connected several feet downstream of the valve. Placing the pressure sensing location out of range of valve discharge turbulence makes it more accurate in controlling downstream pressure.

Features

- Operates with minimum inlet pressure of 5 PSIG
- Stainless steel internals
- Excellent for use in steam systems that contain excessive amounts of pipe scale and other contaminants
- Pressure balanced valve & seat for more precise control of downstream pressure

Note:
Flange selection may reduce pressure/temperature ratings.

Size/Connection		Model Code *	Body Material	Weight lbs
STEAM Applications - 455				
1/2"	NPT	**455-12-N-X**	Bronze	15
3/4"	NPT	**455-13-N-X**	Bronze	15
1"	NPT	**455-14-N-X**	Bronze	15
1 1/4"	NPT	**455-15-N-X**	Bronze	18
1 1/2"	NPT	**455-16-N-X**	Bronze	18
2"	NPT	**455-17-N-X**	Cast Iron	75
	125# FLG	**455-17-F125-X**	Cast Iron	75
	250# FLG	**455-17-F250-X**	Cast Iron	75
2 1/2"	125# FLG	**455-18-F125-X**	Cast Iron	105
	250# FLG	**455-18-F250-X**	Cast Iron	105
3"	125# FLG	**455-19-F125-X**	Cast Iron	125
	250# FLG	**455-19-F250-X**	Cast Iron	125
4"	125# FLG	**455-20-F125-X**	Cast Iron	175
	250# FLG	**455-20-F250-X**	Cast Iron	175

X=Spring Code (reference Spring Selection Table).

455 Spring Selection Table

Size	Reduced Outlet Pressure (PSI)	Spring Case Dia. (in.)	Spring #	Code = X
1/2" – 1 1/2"	1 - 6	6	#5	**65**
	5 - 20	6	#3	**63**
	15 - 45	6	#2	**62**
	40 - 70	6	#1	**61**
	60 - 125	5	#1	**51**
2" – 4"	1 - 6	13	#4	**134**
	5 - 20	9	#4	**94**
	15 - 45	9	#3	**93**
	40 - 70	7	#3	**73**
	60 - 125	7	#2	**72**

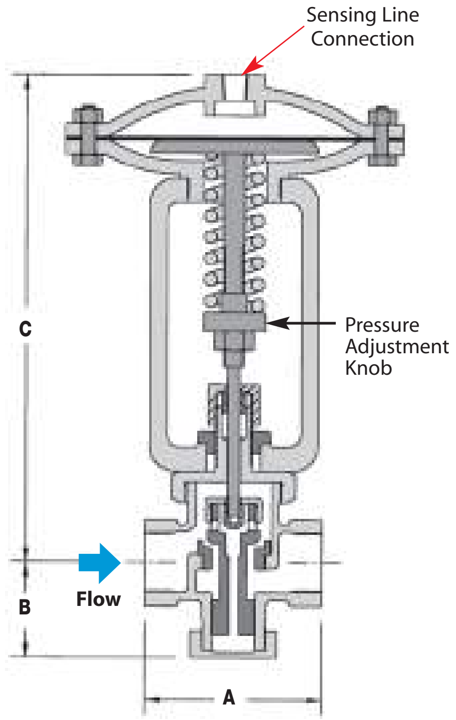
Options & Notes:

Must Specify Spring Code when Ordering:
Use the **455 Spring Selection Table** to specify the proper spring(s) based on valve size and reduced pressure range by Replacing the "**X**" with Spring Code from chart.

Example Model Codes:

1) **455-15-N-65**
(455 Series, 1 1/4" NPT, 1-6 PSIG outlet pressure)

2) **455-18-F125-73**
(455 Series, 2 1/2" 125# Flanged, 40-70 PSIG outlet pressure)



DIMENSIONS – *inches*

Size	Face-to-Face A			B	C	Sensing Line Connection NPT
	NPT Threaded	125# Flanged	250# Flanged			
1/2"	4 1/4			2 3/8	10 1/4	1/4"
3/4"	4 1/4			2 3/8	10 1/4	1/4"
1"	4 1/8			2 3/8	10 1/4	1/4"
1 1/4"	5			3 1/8	10 3/4	1/4"
1 1/2"	5 1/4			3 3/8	11	1/4"
2"	9 1/2	10 3/8	10 7/8	5 3/4	18 1/2	3/8"
2 1/2"		10 5/8	11 1/4	6 1/4	18 3/4	3/8"
3"		10 7/8	11 5/8	7 1/8	19 1/4	3/8"
4"		12 1/2	13 1/8	8 1/4	20	3/8"

How to Size/Order

From the Capacity chart, find the inlet pressure and required regulator outlet pressure. Follow across chart to nearest capacity (steam) that meets or slightly exceeds demand requirements. Follow vertically up to determine appropriate size. When exact application values are not shown, interpolate between values. From the spring range chart, select the spring range that accommodates the required outlet set pressure.

Example:

Application: 1000 lbs/hr of 20 PSIG Steam reduced to 5 PSIG
Model Code: **455-16-N-65** (455-Series, 1 1/2" NPT, 1-6 PSIG spring range)

CAPACITIES – *Steam (lbs/hr); Water (GPM)* Inlet/Outlet Pressures (PSIG)

Inlet Press.	Outlet Press.	1/2" Steam	1/2" Water	3/4" Steam	3/4" Water	1" Steam	1" Water	1 1/4" Steam	1 1/4" Water	1 1/2" Steam	1 1/2" Water	2" Steam	2" Water	2 1/2" Steam	2 1/2" Water	3" Steam	3" Water	4" Steam	4" Water
5	2	53	4.3	95	7.8	191	15.6	276	22.5	403	33.0	572	47.0	890	73.0	1166	95.0	1484	121
10	2	95	7.1	171	12.7	342	25.0	494	37.0	722	54.0	1026	76.0	1596	119	2090	156	2660	198
	5	73	5.6	131	10.1	263	20.0	380	29.0	555	42.0	788	60.0	1226	94.0	1606	123	2044	157
20	0-5	157	9.7	283	17.4	565	35.0	816	50.0	1193	75.0	1696	105	2638	163	3454	213	4396	271
	10	125	7.9	225	14.2	450	28.0	650	41.0	950	60.0	1350	85.0	2100	133	2750	174	3500	221
30	0-10	200	11.2	360	20.1	720	40.0	1040	58.0	1520	85.0	2160	121	3360	188	4400	246	5600	313
	20	145	7.9	261	14.2	522	28.0	754	41.0	1102	60.0	1566	85.0	2436	133	3190	174	4060	221
	25	107	5.6	193	10.1	385	20.0	556	29.0	813	42.0	1156	60.0	1798	94.0	2354	123	2996	157
50	0-20	295	13.7	531	24.6	1062	49.0	1534	71.0	2242	104	3186	148	4956	230	6490	301	8260	383
	30	245	11.2	441	20.1	882	40.0	1274	58.0	1862	85.0	2646	121	4116	188	5390	247	6860	313
	40	185	7.9	333	14.2	666	28.0	962	41.0	1406	60.0	1998	85.0	3108	133	4070	174	5180	221
75	0-30	402	16.8	724	30.2	1447	60.0	2090	87.0	3055	127	4342	181	6754	282	8844	369	11256	470
	50	327	12.5	589	22.5	1177	45.0	1700	65.0	2485	95.0	3532	135	5494	210	7194	275	9156	350
	60	255	9.7	459	17.4	918	35.0	1326	50.0	1938	74.0	2754	105	4284	163	5610	213	7140	271
100	0-50	522	17.7	940	31.8	1879	64.0	2714	92.0	3967	134	5638	191	8770	297	11484	389	14616	495
	60	455	15.8	819	28.5	1638	57.0	2366	82.0	3458	120	4914	171	7644	266	10010	348	12740	443
	80	325	11.2	585	20.1	1170	40.0	1690	58.0	2470	85.0	3510	121	5460	188	7150	246	9100	313
125	0-60	635	20.2	1143	36.3	2286	73.0	3302	105	4826	153	6858	218	10668	339	13970	443	17780	564
	70	575	18.5	1035	33.4	2070	67.0	2990	96.0	4370	141	6210	200	9660	311	12650	408	16100	519
	100	420	12.5	756	22.5	1512	45.0	2184	65.0	3192	95.0	4536	135	7056	210	9240	275	11760	350
150	0-70	750	22.4	1350	40.2	2700	80.0	3900	116	5700	170	8100	241	12600	376	16500	492	21000	626
	100	612	17.7	1102	31.8	2203	64.0	3182	92.0	4651	134	6610	191	10282	297	13464	389	17136	495
	125	435	12.5	783	22.5	1566	45.0	2262	65.0	3306	95	4698	135	7308	210	9570	275	12180	350
200	0-100	977	25.0	1759	45.0	3517	90.0	5080	130	7425	190	10552	270	16414	420	21494	550	27356	700
	125	850	21.7	1530	39.0	3060	78.0	4420	113	6460	165	9180	234	14280	364	18700	476	23800	606
250	0-125	1180	28.0	2124	50.3	4248	101	6136	145	8968	212	12744	302	19824	470	25960	615	33040	783

Note: *Air in SCFM (Standard Cubic Feet per Minute) = Steam (lbs/hr) x 0.36*

403 Series
Pilot-Operated

Model	**403 Series**
Service	**Steam & Air**
Sizes	**1/2" – 4"**
Connections	**NPT, 150# FLG, 300# FLG**
Body Material	**Ductile Iron**
Seat & Disc	**Hardened 420 Stainless Steel (55 Rc)**
Max Inlet Pressure	**450 PSIG**
Min Inlet Pressure	**20 PSIG**
Max Differential Pressure	**250 PSI**
Min Differential Pressure	**15% of Inlet Pressure (10 PSI min)**

Design Pressure/Temperature Rating – PMA/TMA	
NPT	450 PSIG @ 650˚F
150# FLG	150 PSIG @ 566˚F
300# FLG	450 PSIG @ 650˚F

Typical Applications

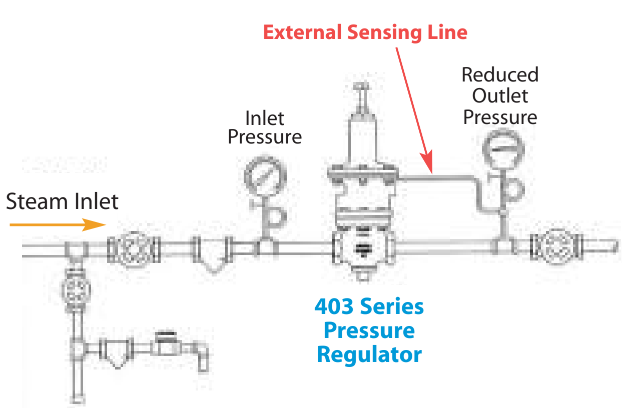
The **403 Series** pilot-operated (piston-actuated) pressure regulating valves are used for pressure reduction on steam mains and other process equipment. Pilot-operated regulators will maintain a constant and accurate downstream pressure regardless of fluctuations in supply pressure or usage. These regulators can be supplied with an optional internal sensing line which simplifies installation. Piston-actuated regulators are more compact than Diaphragm-actuated regulators. The 403 Series contains all stainless steel internals for high-pressure applications up to 450 PSIG. The Double-Spring option is available for a wider range of reduced pressures.

Features & Options

- Pilot-operated regulators minimize outlet pressure fluctuations even when load varies
- Internal Sensing option (If requested, the regulator can be modified to internally sense pressure, eliminating the need for an external sensing line)
- Ductile Iron body to handle increased pressure and temperature
- Hardened stainless steel seat and disc (55 Rc)

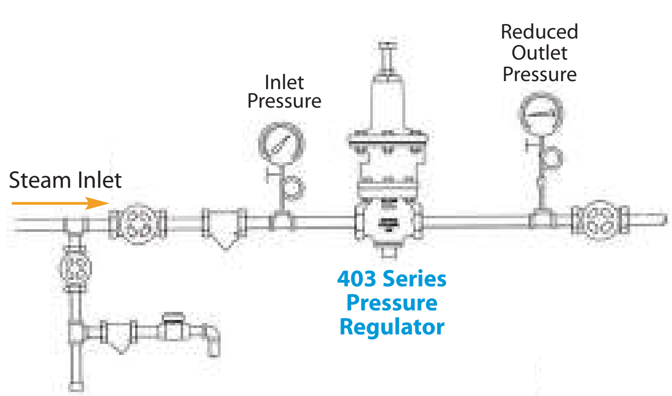
Pressure Reducing Station with External Sensing Line

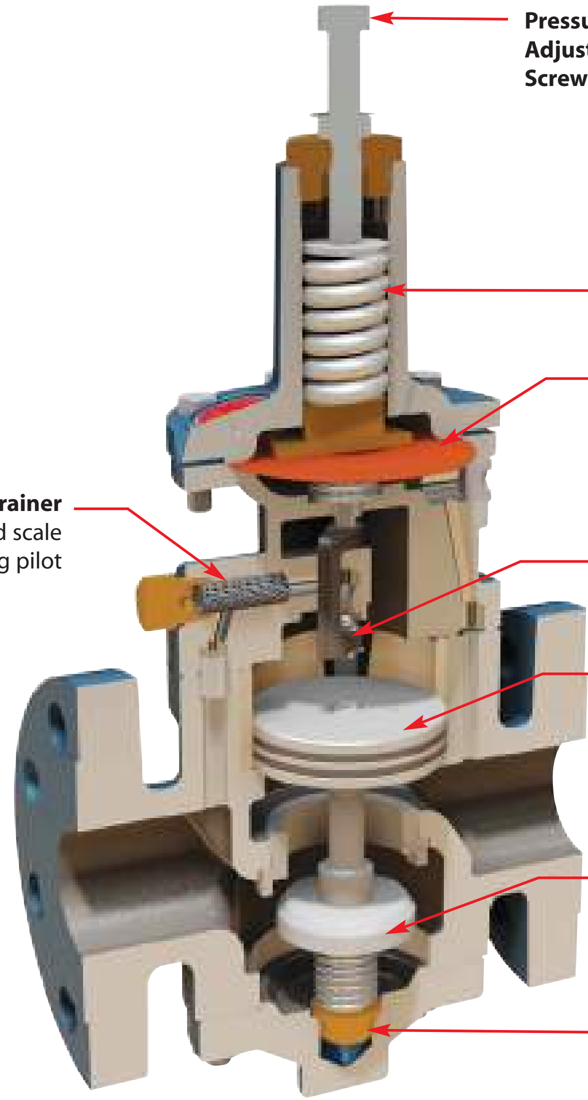
External Sensing (standard)
(requires sensing line)

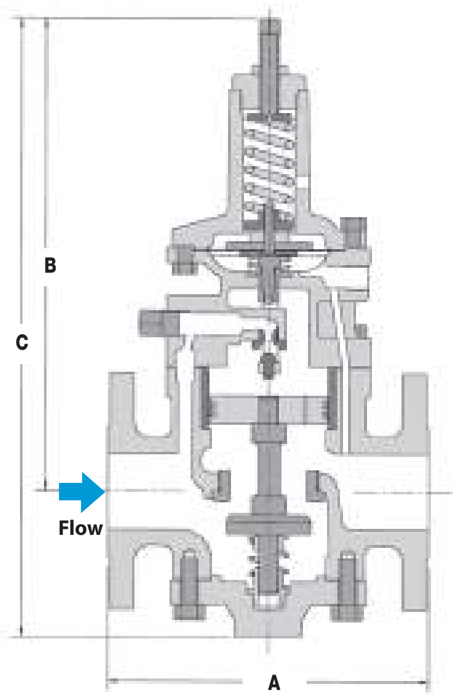


Pressure Reducing Station with Internal Sensing Line

Internal Sensing Option
(Specially drilled internal sensing path eliminates the need for an external sensing line)







DIMENSIONS – *inches*

Size	Face-to-Face A			Centerline to Top B		Overall Height C	
	NPT Threaded	150# Flanged	300# Flanged	Single Spring	Double Spring	Single Spring	Double Spring
1/2"	4 1/2			12	14 3/8	14 3/8	16 3/4
3/4"	4 1/2			12	14 3/8	14 3/8	16 3/4
1"	4 1/2			12	14 3/8	14 3/8	16 3/4
1 1/4"	8 3/16			12 3/4	15 1/8	16 1/8	18 1/2
1 1/2"	8 3/16			12 3/4	15 1/8	16 1/8	18 1/2
2"	8 3/4	8 1/4	8 3/4	13	15 3/8	17 1/8	19 1/2
2 1/2"		9 1/8	9 3/4	13 3/4	16 1/8	18 1/4	20 5/8
3"		9 3/4	10 1/2	14 3/4	16 1/8	19 3/4	22 1/8
4"		13 1/2	14	16	18 3/8	24	26 3/8

How to Size/Order

From the Capacity chart, find the inlet pressure and required regulator outlet pressure. Follow across chart to nearest capacity (steam, air) that meets or slightly exceeds demand requirements. Follow vertically up to determine appropriate size. When exact application values are not shown, interpolate between values. From the spring range chart, select the spring range that accommodates the required outlet set pressure. Specify Internal or External (remote) Pressure sensing.

Example:
Application: 12,500 lbs/hr of 300 PSIG Steam reduced to 125 PSIG
Model Code: **403-17-N-0010-R** (2″ 403 Series Valve, 100-200 PSIG spring range, with external sensing

Note: Flange selection may reduce pressure/temperature ratings.

Size/Connection		Model Code *	Weight lbs
REMOTE Pressure Sensing - Requires External Sensing Line			
1/2″	NPT	**403-12-N-X-R**	20
3/4″	NPT	**403-13-N-X-R**	20
1″	NPT	**403-14-N-X-R**	20
1 1/4″	NPT	**403-15-N-X-R**	37
1 1/2″	NPT	**403-16-N-X-R**	38
2″	NPT	**403-17-N-X-R**	54
	150# FLG	**403-17-F150-X-R**	54
	300# FLG	**403-17-F300-X-R**	56
2 1/2″	150# FLG	**403-18-F150-X-R**	66
	300# FLG	**403-18-F300-X-R**	69
3″	150# FLG	**403-19-F150-X-R**	88
	300# FLG	**403-19-F300-X-R**	96
4″	150# FLG	**403-20-F150-X-R**	174
	300# FLG	**403-20-F300-X-R**	182
INTERNAL Pressure Sensing - No Sensing Line Required			
1/2″	NPT	**403-12-N-X-I**	20
3/4″	NPT	**403-13-N-X-I**	20
1″	NPT	**403-14-N-X-I**	20
1 1/4″	NPT	**403-15-N-X-I**	37
1 1/2″	NPT	**403-16-N-X-I**	38
2″	NPT	**403-17-N-X-I**	54
	150# FLG	**403-17-F150-X-I**	54
	300# FLG	**403-17-F300-X-I**	56
2 1/2″	150# FLG	**403-18-F150-X-I**	66
	300# FLG	**403-18-F300-X-I**	69
3″	150# FLG	**403-19-F150-X-I**	88
	300# FLG	**403-19-F300-X-I**	96
4″	150# FLG	**403-20-F150-X-I**	174
	300# FLG	**403-20-F300-X-I**	182

X = Spring Code (reference Spring Selection Table).

403 Spring Selection Table

Reduced Outlet Pressure PSI	Spring #	Code = X	Color
SINGLE Spring Ranges			
0 to 10	#13	**0013**	Blue & yellow
10 to 50	#14	**0014**	Black & yellow
40 to 100	#9	**0009**	Red & yellow
100 to 200	#10	**0010**	Green & blue
DOUBLE Spring Ranges			
30 to 125	#14 & #9	**1409**	Red & yellow Black & yellow
50 to 200	#9 & #10	**0910**	Red & yellow Green & blue

Note: For 200 - 280 PSI use Bellville washers (Code = 0015)

Notes:

Must Specify Spring Code when Ordering:
Use the **403 Spring Selection Table** to specify the proper spring(s) based on reduced pressure range by Replacing the "**X**" with Spring Code from chart.

Internal Sensing (not available with 0-10 PSI range)

Pressure Sensing Codes:
Code **R - Remote** Pressure Sensing
Code **I - Internal** Pressure Sensing

Example Model Code:
1) **403-15-N-0014-R**
(403 Series, 1 1/4″ NPT, 10-50 PSI, Remote Pressure Sensing)

CAPACITIES – *Steam (lbs/hr); Air (SCFM)* Inlet/Outlet Pressures (PSIG)

Inlet Press.	Outlet Press.	1/2", 3/4" Steam	1/2", 3/4" Air	1" Steam	1" Air	1 1/4" Steam	1 1/4" Air	1 1/2" Steam	1 1/2" Air	2" Steam	2" Air	2 1/2" Steam	2 1/2" Air	3" Steam	3" Air	4" Steam	4" Air
20	0-10	175	60	425	145	600	204	850	289	1300	442	2750	935	3850	1309	4900	1666
30	0-10	270	88	655	213	924	300	1309	425	2002	650	4235	1375	5929	1925	7546	2450
	20	203	67	493	162	696	228	986	323	1508	494	3190	1045	4466	1463	5684	1862
50	0-20	385	130	935	315	1320	444	1870	629	2860	962	6050	2035	8470	2849	10780	3626
	30	343	116	833	281	1176	396	1666	561	2548	858	5390	1815	7546	2541	9604	3234
100	0-50	690	231	1675	561	2364	792	3349	1122	5122	1716	10835	3630	15169	5082	19306	6468
	60	637	214	1547	519	2184	732	3094	1037	4732	1586	10010	3355	14014	4697	17836	5978
	80	455	151	1105	366	1560	516	2210	731	3380	1118	7150	2365	10010	3311	12740	4214
125	0-60	865	287	2100	697	2964	984	4199	1394	6422	2132	13585	4510	19019	6314	24206	8036
	70	805	270	1955	655	2760	924	3910	1309	5980	2002	12650	4235	17710	5929	22540	7546
	100	588	196	1428	476	2016	672	2856	952	4368	1456	9240	3080	12936	4312	16464	5488
150	0-70	1019	343	2474	833	3492	1176	4947	1666	7566	2548	16005	5390	22407	7546	28518	9604
	100	858	287	2083	697	2940	984	4165	1394	6370	2132	13475	4510	18865	6314	24010	8036
	125	609	214	1479	519	2088	732	2958	1037	4524	1586	9570	3355	13398	4697	17052	5978
200	0-100	1337	445	3247	1080	4584	1524	6494	2159	9932	3302	21010	6985	29414	9779	37436	12446
	150	1001	333	2431	808	3432	1140	4862	1615	7436	2470	15730	5225	22022	7315	28028	9310
	175	739	245	1794	595	2532	840	3587	1190	5486	1820	11605	3850	16247	5390	20678	6860
250	0-125	1652	550	4012	1335	5664	1884	8024	2669	12272	4082	25960	8635	36344	12089	46256	15386
	175	1358	452	3298	1097	4656	1548	6596	2193	10088	3354	21340	7095	29876	9933	38024	12642
	200	1138	378	2763	918	3900	1296	5525	1836	8450	2808	17875	5940	25025	8316	31850	10584
300	0-150	2016	665	4896	1615	6912	2280	9792	3230	14976	4940	31680	10450	44352	14630	56448	18620
	200	2016	665	4896	1615	6912	2280	9792	3230	14976	4940	31680	10450	44352	14630	56448	18620
	250	1250	417	3035	1012	4284	1428	6069	2023	9282	3094	19635	6545	27489	9163	34986	11662
400	0-200	2657	875	6452	2125	9108	3000	12903	4250	19734	6500	41745	13750	58443	19250	74382	24500
	280	2146	711	5211	1726	7356	2436	10421	3451	15938	5278	33715	11165	47201	15631	60074	19894
450	0-225	2975	984	7225	2389	10200	3372	14450	4777	22100	7306	46750	15455	65450	21637	83300	27538
	280	2975	984	7225	2389	10200	3372	14450	4777	22100	7306	46750	15455	65450	21637	83300	27538

Note: *For capacities of other gases multiply the air capacities by the following factors:* ***Argon–0.85*** ***CO_2–0.81*** ***Helium–2.69*** ***Nitrogen–1.02***

Model	R Series	10691 Series*
Service	Liquids	Liquids
Sizes	1/2" – 3"	1/2", 3/4", 1"
Connections	NPT	NPT
Body	Bronze	Bronze
Seat Material	Bronze	Bronze
Disc Material	Stainless Steel (1/2" – 1 1/2") Bronze (2" – 3")	EPDM* Optional Viton or Teflon
Max Inlet Pressure	**300 PSIG**	**300 PSIG**

* **10691-Series** Relief Valves use a soft elastomeric disc for tight shut-off. Available in 1/2", 3/4" & 1" sizes only.

Design Pressure/Temperature Rating – PMA/TMA	
NPT	300 PSIG @ 180˚F

Description

The **R-Series** & the **10691-Series** Back Pressure & Relief Valves relieve upstream pressure in a variety of processes. **R-Series** has a stainless steel disc and the **10691-Series** has a soft elastomeric disc for tight shut-off. These valves automatically maintain desired maximum pressure in a vessel or system by relieving excess pressure into lower pressure return line or to atmosphere. Ideally suited for use as pump bypass control valve by maintaining constant pump discharge pressures. Used as a continuously operating valve or for protection against intermittent overpressure conditions.

NOT TO BE USED ON STEAM.

Typical Applications

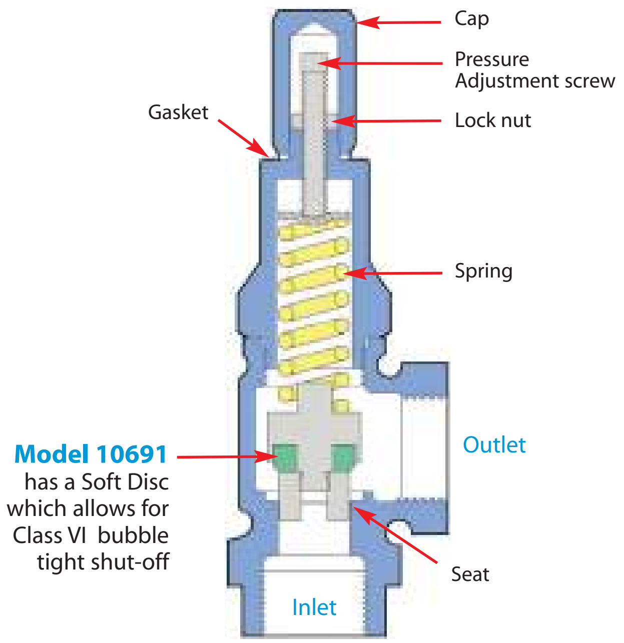
The **R-Series** & **10691 Series** Back Pressure Relief Valves are used in the following applications:

- Water pump bypass for irrigation, sprinkler systems on golf courses, fountains and fire protection systems
- Fuel oil pump bypass on commercial systems or large residential systems

Note: Not to be used as a safety relief valve on steam systems.

Features & Options

- Four Springs – easily interchanged to cover pressures from 1 to 300 PSIG
- Heavy-duty bronze valve body
- 10691 Series has EPDM Seat for tight shut-off (1/2" - 1")

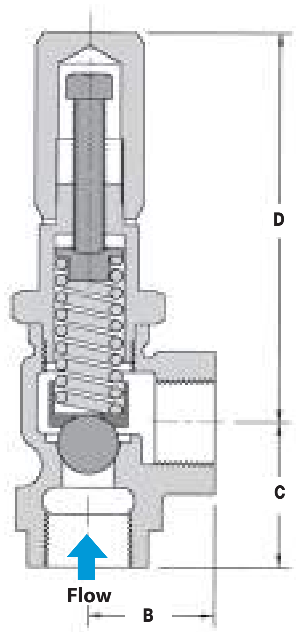


1/2" – 1"
10691-Series

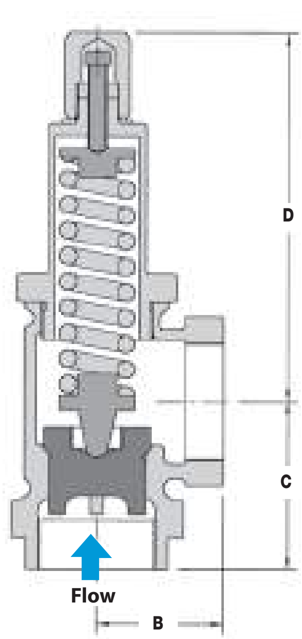
Pressure Adjustments

To adjust set pressure of valve, remove top cap, loosen lock nut and adjust pressure by rotating adjustment screw. Rotating the screw clockwise increases the compression on the spring thereby increasing the set pressure. Rotating the screw counter-clockwise lowers the set pressure. Tighten the lock nut and replace top cap and gasket.

R & 10691 Series



1/2" – 1 1/2"
R-Series



2" & 3"
R-Series

DIMENSIONS & WEIGHTS – *inches*

Size	B	C	D	Weight (lbs)
1/2"	1 1/8	1 1/2	3 5/8	1.5
3/4"	1 3/8	1 3/4	5 1/2	2
1"	1 5/8	2 1/4	6	3
1 1/4"	1 7/8	2 1/2	5 9/16	6
1 1/2"	2 3/16	2 3/4	6 5/8	8
2"	2 1/2	3 5/16	7 3/8	10
3"	3 1/2	4 3/4	9 7/8	25

Note: Model 10691 available only in sizes 1/2" thru 1".

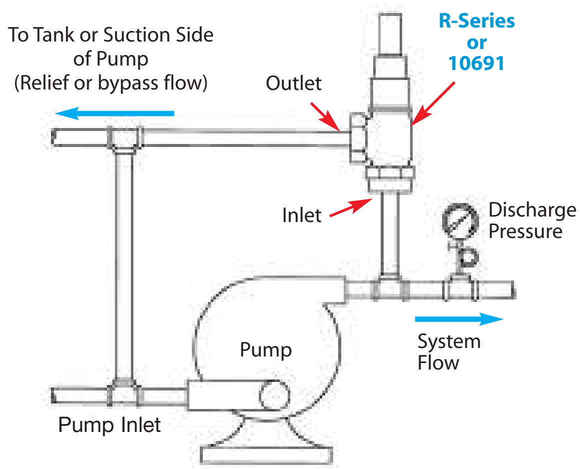
Spring Selection Table

Relief Pressure (PSI)	Spring #	Spring Color
1 - 6	#4*	yellow
5 - 35	#3	silver
25 - 100	#2	blue
75 - 300	#1	red

* 1/2" – 1 1/2" R-Series type only.
Not available on 2" & 3" models.

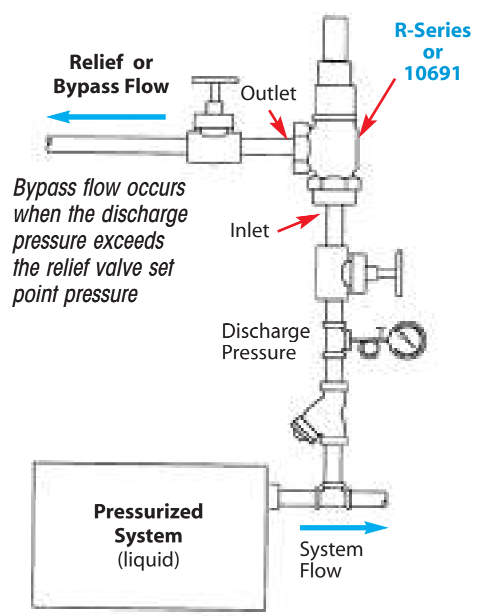
How it Works

The Relief Valve is actuated by the system pressure on the inlet side of the valve. Valve loading is provided by a spring. The adjustment is done by removing the cap and rotating the screw clockwise or counter-clockwise. Spring load balances against the opening force of the upstream (or relief) pressure. Valve will open at the slightest increase in pressure above the spring set point, and will close when the excess pressure has been relieved. The higher the system pressure is above the relief set point pressure, the more flow the valve will pass. It is therefore typical to specify the maximum capacity of a back pressure relief valve at 10% and 20% over set pressure.



A Relief Valve allows water to recirculate through the pump even when the discharge valve on the pump is completely closed. As a rule, a minimum of 20% of the pump capacity must recirculate to prevent overheating of the pumped liquid.

Protection Against Over-pressure Condition



Water, Oil & Other Liquids

Options & Notes:

Factory Setting of Relief Pressure Option:
Specify Set-Pressure when ordering. Add desired factory set pressure to the end of the model code.
See Example below:

R-Series Example Model Code with Set-Pressure Option:
R-12-N-2, *Set at 50 PSI*
(R Series, 1/2" NPT, 25-100 PSIG Spring Range, with a Factory Set Relief Pressure of 50 PSIG)

10691 Example Model Code with Set-Pressure Option:
10691-14-N-2-E, *Set at 75 PSI*
(10691 Series, 1" NPT, 25-100 PSIG Spring Range, EPDM disc, with a Factory Set Relief Pressure of 75 PSIG)

10691-Series
Disc Material: standard in EPDM (Sufffix Code **E**)
Also available in: Teflon (Sufffix Code **T**)
& Viton (Sufffix Code **V**)

Size/ Connection NPT	Model **Code** R-Series	Model **Code** 10691 Series EPDM Disc	Relief Pressure Range (**PSI**)	Weight lbs
1/2"	**R-12-N-4**	NA	1-6	1.5
	R-12-N-3	**10691-12-N-3-E**	5-35	1.5
	R-12-N-2	**10691-12-N-2-E**	25-100	1.5
	R-12-N-1	**10691-12-N-1-E**	75-300	1.5
3/4"	**R-13-N-4**	NA	1-6	2.5
	R-13-N-3	**10691-13-N-3-E**	5-35	2.5
	R-13-N-2	**10691-13-N-2-E**	25-100	2.5
	R-13-N-1	**10691-13-N-1-E**	75-300	2.5
1"	**R-14-N-4**	NA	1-6	3.3
	R-14-N-3	**10691-14-N-3-E**	5-35	3.3
	R-14-N-2	**10691-14-N-2-E**	25-100	3.3
	R-14-N-1	**10691-14-N-1-E**	75-300	3.3
1 1/4"	**R-15-N-4**		1-6	4.5
	R-15-N-3		5-35	4.5
	R-15-N-2		25-100	4.5
	R-15-N-1		75-300	4.5
1 1/2"	**R-16-N-4**		1-6	6.3
	R-16-N-3		5-35	6.3
	R-16-N-2		25-100	6.3
	R-16-N-1		75-300	6.3
2"	**R-17-N-3**		5-35	10.3
	R-17-N-2		25-100	10.3
	R-17-N-1		75-300	10.3
3"	**R-19-N-3**		5-35	25.0
	R-19-N-2		25-100	25.0
	R-19-N-1		75-300	25.0

The Relief Valve remains closed until the **Set-Pressure** is reached. When the Set-Pressue is met or exceeded, the spring will compress, allowing the valve to open and flow to occur. It is standard practice to publish flow values at 10% and 20% over the **Set-Pressure**.

Example: A 1" valve set at 50 PSIG will pass 3.1 GPM if the system pressure exceeds the set point by 20%.

The **R Series & 10691** Relief Valve water capacities at inlet pressures of 10% and 20% over **Set-Pressure:**

CAPACITIES – *Water (GPM)*

Spring Range	Set Pressure (PSIG)	1/2" (PSIG)	3/4"	1"	1 1/4"	1 1/2"	2"	3"
At 10% Over Set Pressure								
1-6	**3**	1.2	2.2	3.2	4.3	5.4	-	-
5-35	**10**	0.3	0.4	0.4	0.5	0.5	0.6	0.7
5-35	**20**	0.6	0.7	0.8	1.0	1.1	1.3	1.6
25-100	**50**	1.0	1.3	1.6	1.8	2.2	2.6	3.2
25-100	**75**	1.4	1.9	2.3	2.8	3.4	4.0	5.0
75-300	**100**	1.9	2.5	3.2	3.8	4.6	5.4	6.9
75-300	**200**	3.4	4.4	5.8	6.9	8.2	9.7	12.3
At 20% Over Set Pressure								
1-6	**3**	2.2	3.4	4.6	5.8	7.1	-	-
5-35	**10**	0.6	0.8	1.1	1.3	1.4	1.8	2.2
5-35	**20**	1.4	1.9	2.4	3.0	3.4	4.1	4.8
25-100	**50**	1.8	2.0	3.1	3.8	4.4	5.4	6.4
25-100	**75**	2.3	3.2	4.0	4.8	5.6	6.9	8.1
75-300	**100**	3.6	4.2	5.0	6.3	7.0	7.3	8.9
75-300	**200**	6.5	7.6	9.0	11.2	12.4	13.1	16.0

3040 Series

Water, Air, Oil & Other Liquids

Model	**3040 Series**
Service	**Water, Oil, other Liquids, Air**
Sizes	1/2", 3/4", 1", 1 1/4", 1 1/2", 2"
Connections	NPT, 125# FLG, 250# FLG
Body Material	• 1/2"– 1 1/2" NPT, SS Body, Bronze Diaphragm Chamber
	• 2" NPT, Cast Iron Body
	• 2" FLG, Cast Iron Body
Seat Material	Stainless Steel
Disc Material	Viton - 300°F max
Diaphragm	Viton - 300°F max
Max Inlet Pressure	**250 PSIG**

Design Pressure/Temperature Rating – PMA/TMA

NPT	300 PSIG	@ 200˚F
125# FLG	125 PSIG	@ 200˚F
250# FLG	250 PSIG	@ 200˚F

Typical Applications

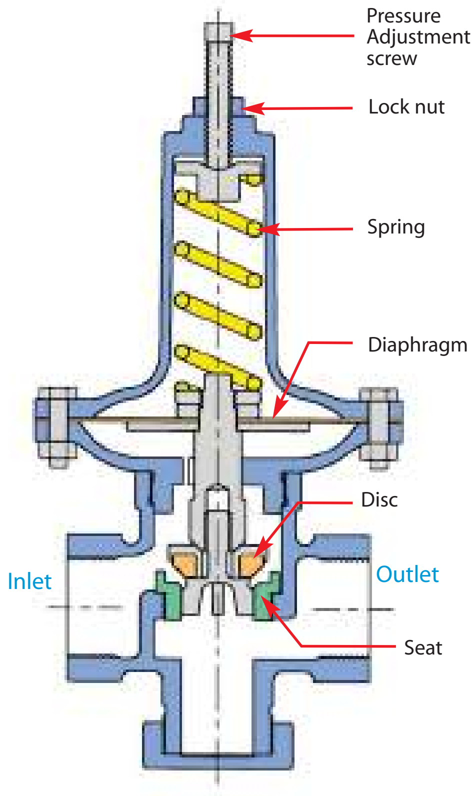
The **3040 Series** Back Pressure Valves relieve upstream pressure in a variety of processes. Automatically maintains desired maximum pressure in a vessel or system by relieving excess pressure into lower pressure return line or to atmosphere. Ideally suited for use as pump bypass control valve by maintaining constant pump discharge pressures. Used as a continuously operating valve or for intermittent protection against over-pressure conditions.

Features & Options

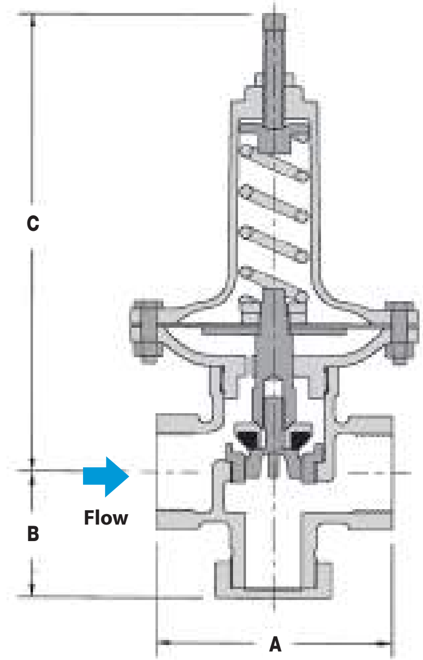
- Fast response
- Viton Trim for 300˚F service
- Soft "Seat" for tight shut-off

Pressure Adjustments

Rotating the adjustment screw clockwise increases the compression on the spring, thereby increasing the set-pressure. Rotating the adjustment screw counter-clockwise lowers the set-pressure. Tighten the locknut after adjustment.



Water, Air, Oil & Other Liquids

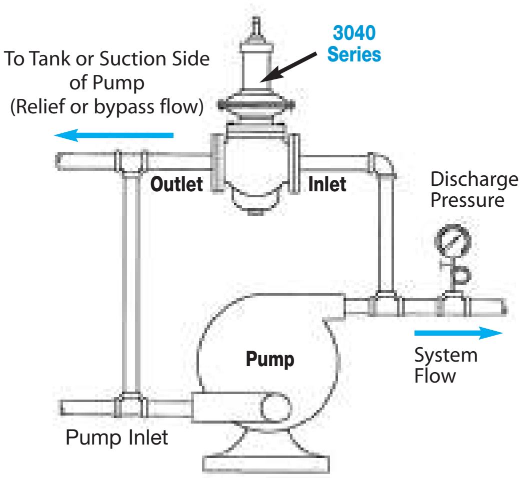


DIMENSIONS – *inches*					
Size	Face-to-Face A			B	C
Threaded	NPT Flanged	125# Flanged	250#		
1/2"	4 1/8	–	–	2 5/16	9
3/4"	4 1/8	–	–	2 5/16	9
1"	4 1/8	–	–	2 5/16	9
1 1/4"	4 13/16	–	–	3 1/4	12 3/4
1 1/2"	5 3/16	–	–	3 1/2	13 1/4
2"	9 1/2	10 3/8	10 7/8	5 1/2	16 3/4

How it Works

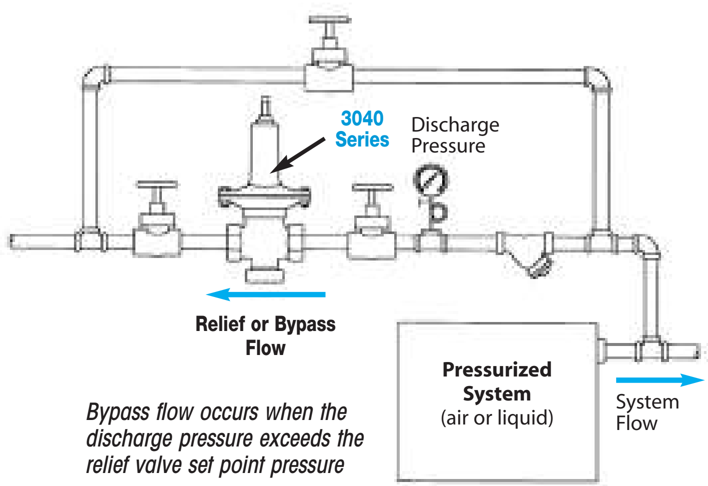
The **3040 Series** Back Pressure Valve senses upstream pressure acting on the underside of the diaphragm through a port in the bottom diaphragm case. An increase in the upstream pressure above the set point will compress the spring and allow the valve to open. The spring will close the valve as the upstream pressure decreases to the set-point.

The higher the system pressurizes above the relief set-point pressure, the more flow the valve will pass. It is therefore typical to specify the maximum capacity of a back pressure relief valve at 10% & 20% over set-pressure.



A Relief Valve allows water to recirculate through the pump even when the discharge valve on the pump is completely closed. As a rule, a minimum of 20% of the pump capacity must recirculate to prevent overheating of the pumped liquid.

Protection Against Over-Pressure Condition



Bypass flow occurs when the discharge pressure exceeds the relief valve set point pressure

Relief & Back Pressure Regulating Valve

3040 Series

Water, Air, Oil & Other Liquids

3040 Series Spring Selection Table

Relief Pressure (PSI)	Spring #	Code = X
1 - 12	#4	4
5 - 35	#3	3
20 - 70	#2	2
40 - 125	#1	1

Note: Relief Pressure 1-12 PSI (Code 4) available in 1/2", 3/4", and 1" sizes only.

Size/Connection		Model Code *	Body Material	Weight lbs
Viton Diaphragm & Disc (300˚F Max)				
1/2"	NPT	**3040-12-N-X-V**	Bronze	8
3/4"	NPT	**3040-13-N-X-V**	Bronze	8
1"	NPT	**3040-14-N-X-V**	Bronze	9
1 1/4"	NPT	**3040-15-N-X-V**	Bronze	15
1 1/2"	NPT	**3040-16-N-X-V**	Bronze	16
2"	NPT	**3040-17-N-X-V**	Cast Iron	48
2"	125# FLG	**3040-17-F125-X-V**	Cast Iron	53
2"	250# FLG	**3040-17-F250-X-V**	Cast Iron	56

X=Spring Code. (reference Spring Selection Table)

Example Model Code:

1) **3040-15-N-3-V**
(3040 Series, 1 1/4" NPT, 5-35 PSIG Relief Pressure)

Note: The Relief Valve remains closed until the **Set-Pressure** is reached. When the Set-Pressure is met or exceeded, the spring will compress, allowing the valve to open and flow to occur. It is standard practice to publish flow values at 10% and 20% over the **Set-Pressure**.

Example: A 1" valve set at 50 PSIG will pass 35.6 GPM of water or 409 SCFM of air if the system pressure exceeds the set-point by 20%.

The **3040 Series** Relief Valve water and air capacities at inlet pressures of 10% and 20% over **Set-Pressure:**

CAPACITIES – *Water (GPM)*

Spring Range (PSIG)	Set Pressure (PSIG)	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"
At 10% Over Set Pressure							
1-12	5	4.0	8.0	10.0	–	–	–
5-35	10	5.7	11.4	14.3	29	43	71
5-35	20	8.1	16.2	20.3	41	61	101
20-70	50	12.7	25.4	31.8	64	95	159
40-125	75	15.6	31.2	39.0	78	117	195
40-125	100	18.0	36.0	45.0	90	135	225
40-125	125	20	40	50	100	150	250
At 20% Over Set Pressure							
1-12	5	4.4	8.8	11.2	–	–	–
5-35	10	6.3	12.5	16.0	32	47	79
5-35	20	8.9	17.8	22.7	45	67	113
20-70	50	14.0	27.0	35.6	71	105	177
40-125	75	17.2	34.3	43.7	87	129	217
40-125	100	19.8	39.6	50.4	101	149	250
40-125	125	22	44	56	112	166	278

CAPACITIES – *Air (SCFM)*

1/2"	3/4"	1"	1 1/4"	1 1/2"	2"
At 10% Over Set Pressure					
31	55	111	–	–	–
39	70	141	203	297	422
56	100	201	290	424	603
106	191	381	551	805	1144
148	266	532	768	1123	1596
190	341	682	986	1441	2047
231	416	833	1203	1758	2499
At 20% Over Set Pressure					
32	57	113	–	–	–
41	73	146	211	308	438
59	106	212	306	447	635
114	204	409	591	863	1226
159	287	573	828	1210	1719
205	369	737	1065	1556	2212
250	451	901	1302	1903	2704

Temperature Regulators

W91 • **Non-Indicating**
W94 • **Indicating - Dial Thermometer**

For Heating with Steam
for Cooling with Water
Mixing/Diverting for Liquids

Description & Selection

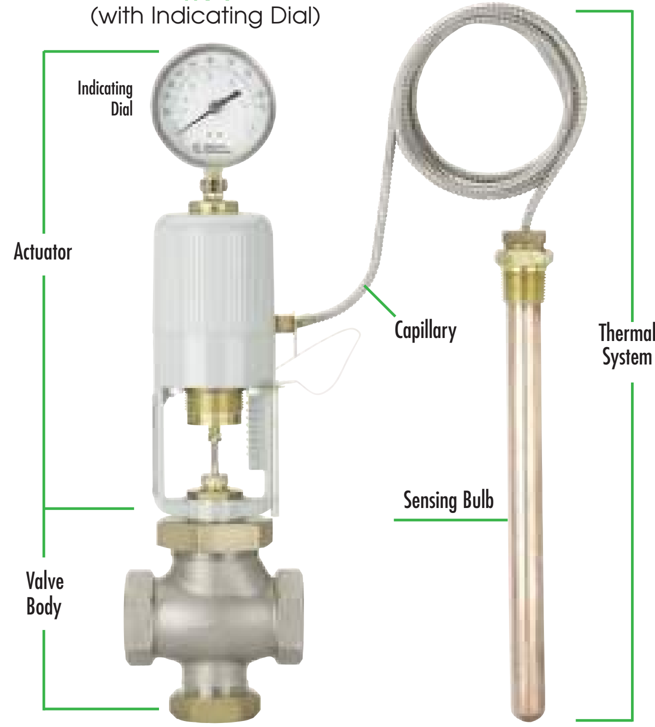
The **W91/W94** Self-Operating Temperature Regulator is a mechanically operated device designed to regulate system temperature by modulating the flow of a heating or cooling fluid in response to temperature changes; requires no external power source. They are recommended for controlling temperature on relatively stable systems, where small valve stroke modulations will correct temperature drift. Where sudden or large load changes, or rapid temperature changes occur, a pneumatically-actuated Control Valve should be considered. Please consult the Control Valve Section of this catalog.

Principle of Operation

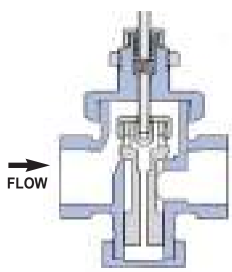
The **W91/W94** Temperature Regulator is a fully self-contained unit requiring no external power source (i.e., compressed air or electricity). Regulation takes place when the sensing element (bulb) of the thermal system is exposed to changes in temperature. The thermal system is charged with a predetermined amount of vapor fill, which, when heated, will cause the bellows within the unit's actuator housing to expand.

The valve action is either **In-To-Close for Heating** or **In-To-Open for Cooling**.

W94
(with Indicating Dial)



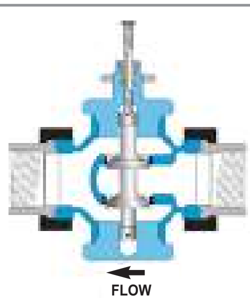
HEATING
Normally Open
(**in-to-close**)



Normally Open Valves are used for **HEATING**, so the valve stem closes (**in-to-close**) as the control signal (temperature) increases.

Single-Seated Balanced Valves are used for Heating Applications (normally steam) where tighter shut-off is required. Leakage rate is approximately 0.01% of the maximum capacity (Class IV shut-off).

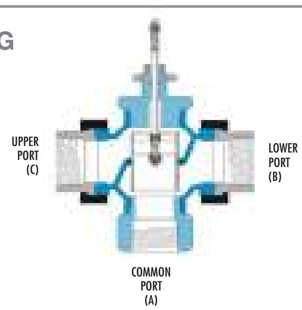
COOLING
Normally Closed
(**in-to-open**)



Normally Closed Valves are used for **COOLING**, so the valve stem opens (**in-to-open**) as the control signal (temperature) increases.

Double-Seated Balanced Valves are used for Cooling Applications where larger flow rates of water are frequently required, and a small leakage rate through the valve is normally acceptable. Leakage rate can be up to 0.5% of the maximum valve capacity (Class II shut-off).

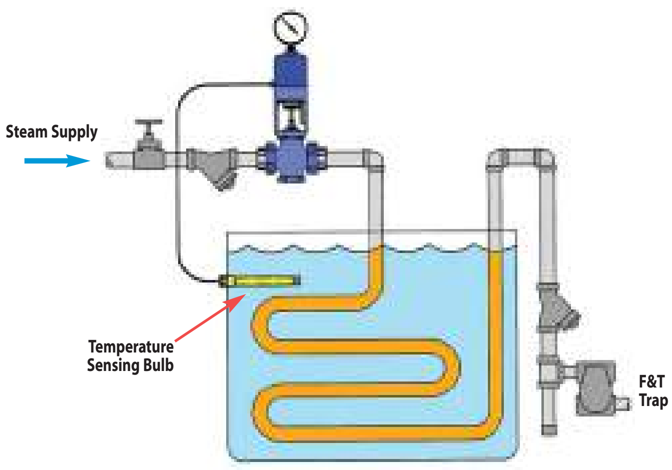
MIXING & DIVERTING
3-Way Valves



3-Way Valves are used for mixing two flows together, or for diverting a flow to or around a device (bypass). In order to produce consistent flow quantity for stable operation, the pressure drop across both flow paths (inlet to outlet) must be nearly equal. The Sleeve-Type (common port on the bottom) is most commonly used for diverting applications; however, due to its design, it can also be used for mixing applications (NOT for steam use). It is also suitable for water or glycol type service, up to a maximum temperature of 300˚F. A higher temperature O-ring for use with other fluids, such as oil, or for temperatures up to 410˚F, is available. Consult factory.

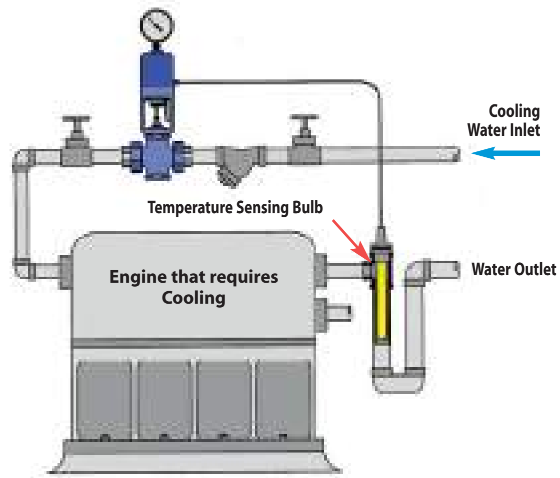
HEATING

Regulating Temperature of a Plating or Finishing Tank
Valve Body determines the action of the Regulator
For Heating: use **Normally Open** Valve Body (**in-to-close**)



COOLING

Using Water to Cool Engine
Valve Body determines the action of the Regulator
For Cooling: use **Normally Closed** Valve Body (**in-to-open**)



Components of a Self-Operated Temperature Regulator

Model W91 Actuator
is Non-indicating (without temperature indicating dial).

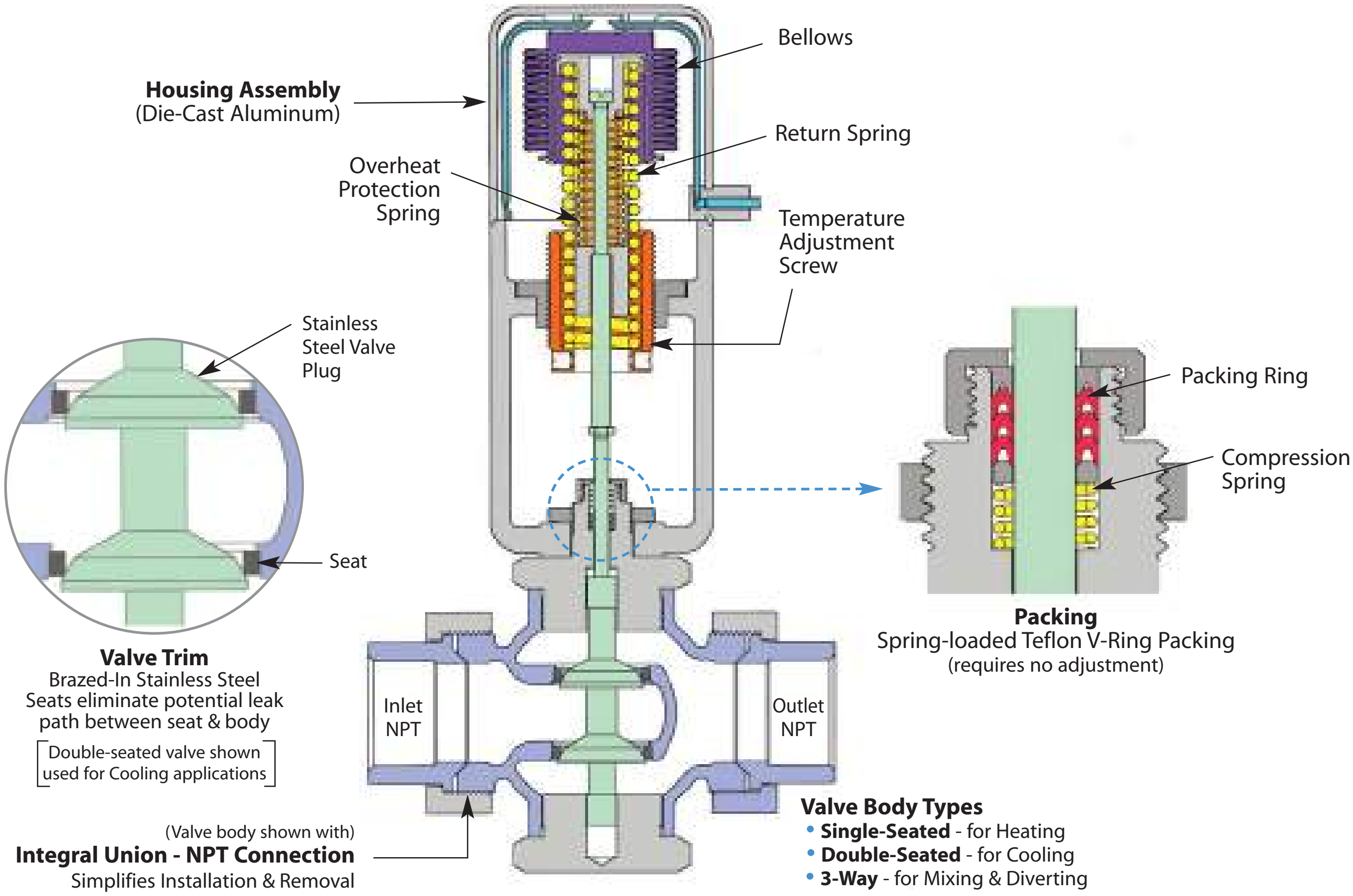
Model W94 Actuator is equipped with an integral dial thermometer to indicate sensing bulb temperature. The W94 displays the temperature at the sensing bulb. This allows for easy adjustment of the temperature set-point, as well as continuous monitoring of the application, without the installation of an additional thermometer.

The thermometer has a $3^1/_2$" diameter dial face and can be rotated and tilted for maximum readability.

The **Sensing Bulb and Capillary** are available in either Copper (for best heat transfer) or Stainless Steel (for corrosive applications). The capillary tubing is protected by stainless steel flexible armor to resist damage during handling and installation. The sensing bulb is also available with an optional Teflon or Kynar coating; used for special corrosive applications such as plating tanks where stainless steel may not be acceptable.

Capillary lengths up to 24 feet are considered standard; non-standard lengths up to 52 feet are available. Longer capillary lengths require longer bulb length to contain the additional actuating fluid required (see selection chart).

Valve Body
Single-seated balanced valves are used on heating applications (most commonly steam) where tight shut-off is required. Double-seated valves are used on cooling applications because of the high flow rates often required. The balanced double-seated design also allows the temperature actuator to operate with higher differential pressures than would be possible using single-seated non-balanced valves. 3-way valves are used for mixing and diverting applications.



Actuator Housing Assembly

The housing consists of a cap and yoke constructed from precision die cast aluminum. This assembly ensures permanent alignment with the valve body, while protecting the bellows assembly. The yoke includes a set-point scale used to reference the setting of the temperature adjustment screw. The entire housing is finished in a corrosion resistant, baked grey epoxy.

Actuator Bellows & Spring Return Assembly

The accordion type bellows is corrosion resistant to provide accurate response for the life of the regulator. An adjusting bar is provided to turn the brass temperature adjustment screw, which compresses or expands the range adjustment spring, thereby setting the control-point of the unit.

Valve Body & Connection Type

W91/W94 Temperature Regulators available with NPT connection, Integral Union (with NPT connection) and Flanged.

Valve Trim

Valve Trim is composed of the plug and seat(s). Single and double-seated valves employ a stainless steel, tapered plug for enhanced modulation. The valve plug is both top and bottom guided to ensure positive seating alignment. 3-Way valves use a stainless steel sleeve and brass seating surface to change flow direction within the body.

Packing

Valves feature a self-energizing (spring-loaded) Teflon V-Ring packing, which reduces leakage around the valve stem. V-Ring packing is spring loaded to maintain proper compression and does not require manual adjustment.

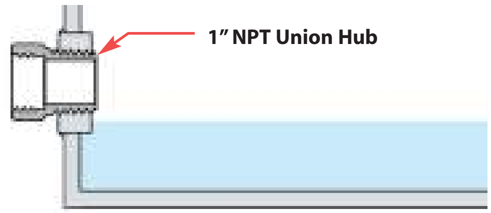
Sensing Bulb & Thermowells

Sensing Bulb

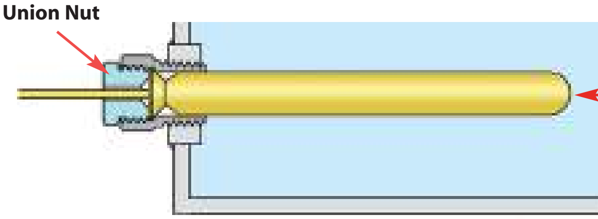
Sensing Bulb Installation

Care must be taken to ensure that the entire length of the sensing bulb is immersed into the medium at the sensing location. Partial immersion of sensing bulb in the process fluid can result in faulty control.

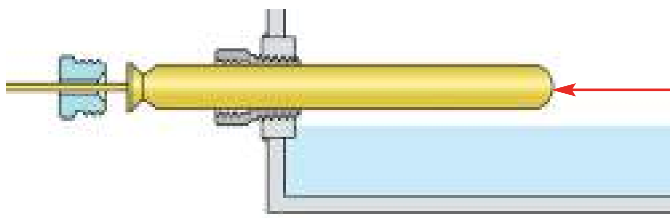
The sensing bulb is designed to be installed in either a horizontal or vertical orientation (with the tip down). If the tip must be installed upwards, please specify when ordering, as a special bulb construction is required. The sensing bulb material is available in either copper (best heat transfer) or stainless steel (corrosion resistant) and must be compatible with the process fluid, or an optional thermowell can be used for complete isolation of the sensing bulb from the process fluid.



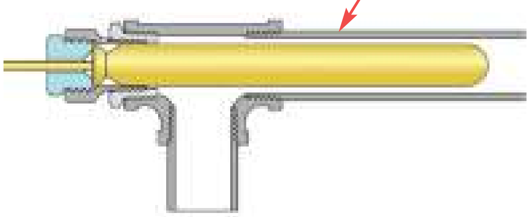
First insert threaded Union Hub into side of tank (or pipe) & fully tighten.



Sensing Bulb is inserted through union hub and is in direct contact with fluid.



Liquid level must be lowered below sensing bulb insertion point for installation or removal.



Installed in Pipe Line:
Drawing shows Sensing Bulb installed in a 1" NPT pipe fitting. 1 1/4" is minimum pipe size for adequate clearance around sensing bulb.

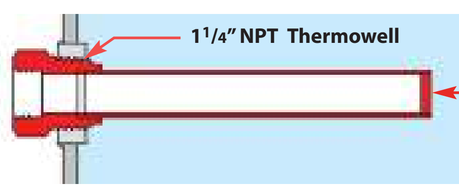
Sensing Bulb with Thermowell

Thermowell (isolates sensing bulb from process fluid)

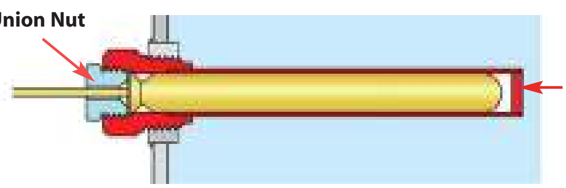
Thermowells isolate the sensing bulb from the process fluid. For applications in which the process media may be corrosive or contained under excessive pressure, the use of a thermowell is required to prevent damage to the sensing bulb. A thermowell also allows the removal of the sensing bulb without having to drain liquid from the system. Thermowells are available in either brass (best heat transfer) or stainless steel (for corrosive applications). The 1 1/4" NPT hub of the thermowell can be installed into the side of a tank or female pipe connection, depending on the application. Three different length thermowells are available to match sensing bulb lengths.

To ensure minimum response time, Heat Transfer Paste (supplied with thermowell) should be applied to the sensing bulb prior to installation.

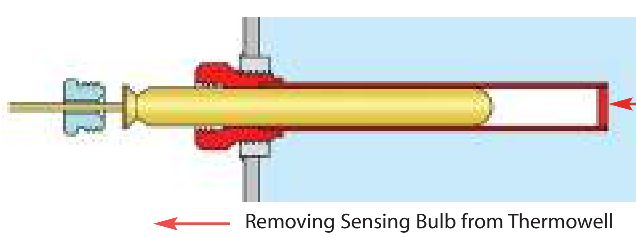
Thermowell remains installed into tank or pipeline; therefore, liquid does not require draining when replacing sensing bulb.



Thermowell threaded into tank wall



Sensing Bulb Inserted into Thermowell



Removing Sensing Bulb from Thermowell

Typical Applications for Temperature Regulators for Heating & Cooling

Temperature Range

Nominal ranges from 20°F (-10°C) through 440°F (225°C) are available. The nominal range defines the entire temperature range of the unit. The service conditions and choice of valve style and action will determine the actual operating range (recommended working span) of the unit. Using the valve in the recommended working span improves temperature response time of the system. The nominal range should be selected so that the set-point falls within the recommended working span for the specified valve style and action. They include an over-range protection spring, which allows the sensing bulb to be heated 100°F above the upper limit of the unit's nominal range for system cleaning or temporary situations.

Accuracy

The W91/W94 Temperature Regulator is a "set-and-forget" regulating device. Once the proper control-point setting has been achieved, the unit requires virtually no adjustments and very little maintenance. Control-point accuracy is dependent upon the sensing bulb location, load change size and speed, and valve size. The sensing bulb must be installed in an area within the process that is most representative of overall process conditions. Care should be taken not to locate the bulb in close proximity to the valve, as the regulator might respond to temperature changes before the process has had time to reach the control-point. Where sudden or large load changes occur, a pneumatically or electrically-powered Control Valve should be specified. Consult the Control Valves section of this catalog.

Valve sizing also plays a major part in regulator performance. A valve that is too small will not be able to provide the desired capacity during peak load conditions, while a valve that is too large may overshoot the control-point and operate with the valve plug too close to the seat, resulting in undue wear of the plug and seat. As part of a well-designed system, a properly sized valve (operating in the 60-90% open position) can control to within 2 to 5 °F.

Size

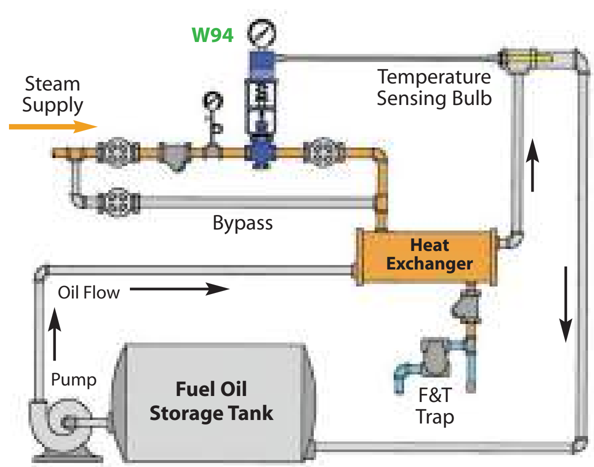
The proper sizing of a regulating valve is one of the most important factors in its selection. A valve that is too small will not be able to provide the desired capacity during peak load conditions, while a valve that is too large may overshoot the control-point and operate with the valve plug too close to the seat, resulting in premature wear of the plug and seat. The valve coefficient (Cv) is used to determine the maximum capacity of a valve. From this value, a valve body with the appropriate port size can be selected. Port sizes from 1/8" through 4" and connection sizes from 1/2" through 4" are available. Consult the Valve Selection section of this catalog.

Close-Off

Temperature Regulators are not considered shut-off valves. A pressure surge may force a single-seated valve plug open. The W91/W94 Temperature Regulator is a balanced equilibrium system and may not provide the force necessary to tightly seat the valve plug. A separate power-driven or hand-actuated valve is required to ensure tight shut-off when necessary.

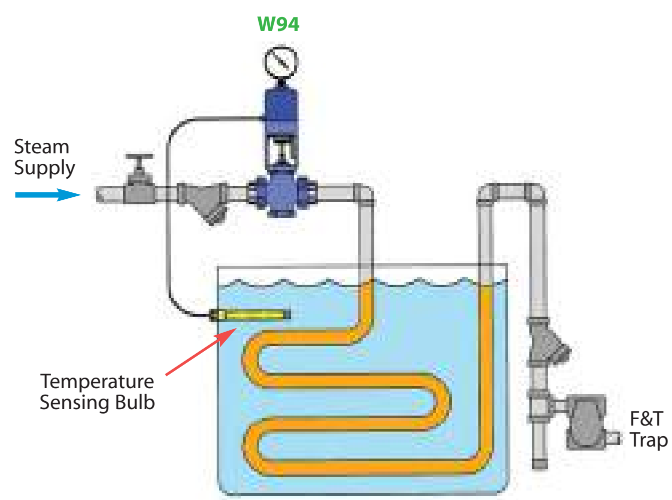
W94 Heating Fuel Oil to Proper Temperature

When the Sensing Bulb is mounted remotely from the actual point of heating (as shown) the Circulation Pump MUST continue to run so that the sensing bulb can sample the product temperature in the heat exchanger. Without product circulation, the temperature control valve will never shut off and the oil will be overheated



W94 Elevating Temperature of a Plating or Finishing Tank

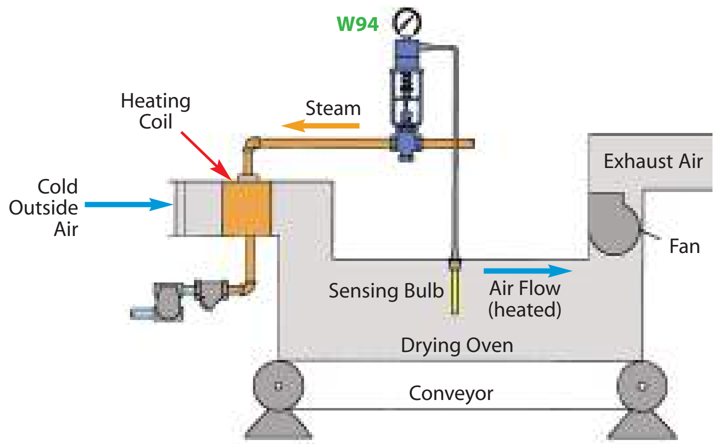
Sensing bulb should be properly placed inside tank for best temperature consistency. An optional Thermowell (Stainless Steel or Brass) may slightly reduce temperature sensitivity. However, it will isolate sensing bulb and allow for its removal without draining the tank.



Introduction

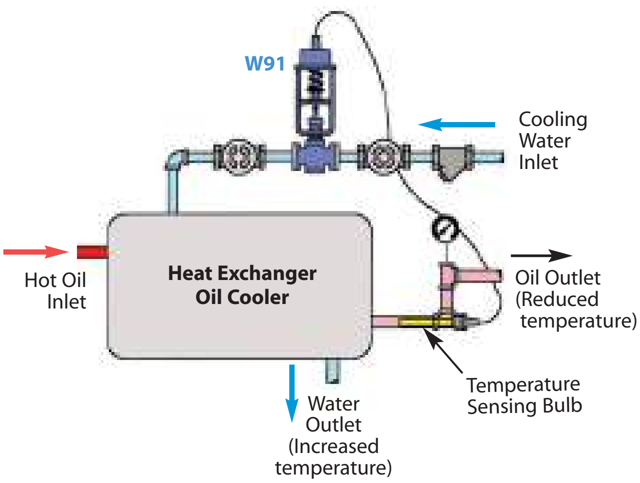
Typical Applications for Temperature Regulators for Heating & Cooling

W94 Used in a Drying Oven Application



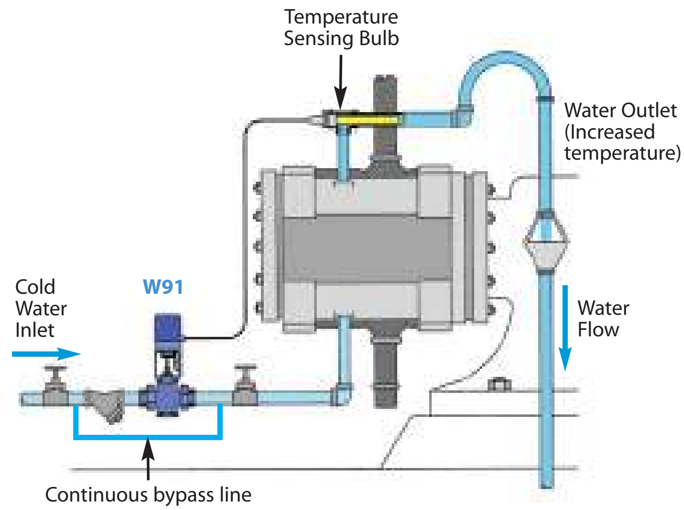
W94 Valve used to regulate the temperature of the air flow through an air heating duct. The sensing bulb is installed toward the end of the heating duct and will sense the temperature of the air flowing past the heating coils. When air temperature is below the set point, the valve will open to allow more steam through to the coils to heat the air passing through the duct. Once the desired air temperature is achieved, the valve will begin to modulate closed to maintain the air temperature.

W91 Used to Reduce Oil Temperature In a Heat Exchanger



W91 Cooling valve controlling the flow of water through a heat exchanger to maintain the temperature of oil that is gaining heat by some process. The valve automatically shuts off when not required, greatly reducing cooling water usage. The source of the cooling water may be a well or city water supply and it can be circulated or dumped to drain. A 3-way valve may be used on cold water chiller systems so flow can be diverted from going through the heat exchanger when not required.

W91 Used to Control Water Flow to Air Compressor for Cooling Purposes



When the Sensing Bulb is mounted remotely from the actual point of Cooling (as shown), the water MUST continue to flow so that the sensing bulb can sample the product temperature of the unit being cooled. Without continuous water flow, the temperature control valve will never turn on, causing the unit to overheat. The bypass line provides a minimum continuous flow when temperature set point is achieved and the valve is closed.

For Heating & Cooling

Model	**W91 (No Indicating Dial)** **W94 (Temperature Indicating Dial)**
Service	**Water, Steam, Other Liquids**
Sizes	**1/2"– 4"**
Connections	**Threaded, Union Ends, 125# FLG** **250# FLG (optional)**
Body Material	**1/2" – 1 1/2"** **Bronze/Stainless Steel** **2"** **Cast Iron** (Direct-acting) **2"** **Bronze** (Reverse-acting) **2 1/2" – 4"** **Cast Iron**
Seat Material	**Stainless Steel**
Max Inlet Pressure	**250 PSIG**

Typical Applications

The **W91** & **W94** Self-Operating Temperature Regulators are the preferred choice of original equipment manufacturers, mechanical contractors and specifying engineers. They require no external power source and are ideal for regulating the temperature of tanks, process streams and various types of industrial equipment. The Actuator is noted for its rugged die-cast aluminum housing, fully-enclosed bellows assembly and internal over-temperature range protection.

Model W91
Non-Indicating (without indicating dial) features a lower profile and should be specified where space constraints may be an issue.

Model W94
Temperature Indicating (with indicating dial) will allow the operator to verify the process temperature and to aid in temperature adjustment.

Features

- Self-Operating (no external power source required)
- Temperature Indicating & Non-Indicating models available
- Heavy Duty Die-Cast Aluminum Housing
- 1/2" thru 4" Valve Sizes
- Fully Enclosed Bellows
- Temperature Over-range protection spring to protect thermal system

Specifications

Dial Thermometer:	3 1/2" dial, stainless steel case, swivel and angle adjustment (Model W94 only)
Housing:	Die-cast aluminum, epoxy powder coated grey finish
Bellows:	High-pressure brass, corrosion resistant, tin plated finish
Temperature Over-range Protection:	Protects Thermal System from damage up to 100°F over high limit of range

Temperature Regulator Valve Action

Application	Stem Action	Normal (Fail) Position
Heating	In-To-Close	Normally Open
Cooling	In-To-Open	Normally Closed

How to write proper model number:

Explanation of Model Number:	**W91**	**06**	**08**	**S15**	**H13N**
	Model	Temp. Range	Cap. Length	Bulb Type	Valve Body
Model Number:	**W91-06-08-S15-H13N**				

Model Code Configuration

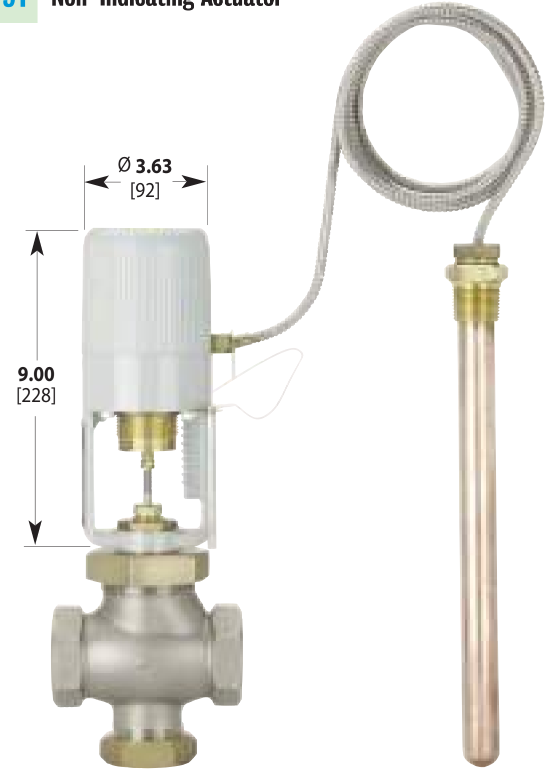
Models		Temperature Range		Capillary Length		Sensing Bulb		Valve Body Selection
W91	Non-Indicating	**01 – 14**	Refer to Temperature Range Chart	**08**	8 Feet (standard)	**S15**	Brass bulb (standard)	Refer to Valve Body Section
W94	Indicating Dial			**12**	12 Feet			
				16	16 Feet	**S16**	Stainless bulb	*(Omit this selection if purchasing Actuator only)*
				20	20 Feet			
				24	24 Feet			

Note: Thermowells are ordered separately. See Thermowell & Bulb Connections page.

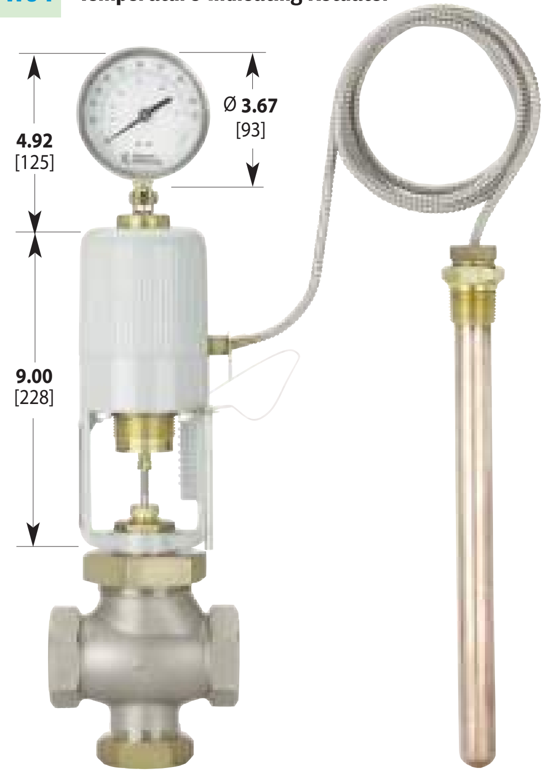
Temperature Range Selection

For Heating & Cooling

W91 Non-Indicating Actuator



W94 Temperature Indicating Actuator



Dimensions: inches [mm]
Actuator Weight: 6 lbs.

Description of Working Span

The recommended working span typically falls within the upper third of the nominal range. Single-Seat In-To-Close, all Double-Seat, and all 3-Way valves have a recommended working span in this part of the nominal range. Using the valve in the recommended working span improves temperature response time of the system.

Temperature Range Chart

W91 & W94 Actuators				
Range Code	Nominal Range		Recommended Working Span *	
01	20 to 70 °F	-10 to 20 °C	40 to 65 °F	5 to 20 °C
02	40 to 90 °F	5 to 30 °C	65 to 85 °F	20 to 30 °C
03	30 to 115 °F	0 to 45 °C	85 to 110 °F	30 to 45 °C
04	50 to 140 °F	10 to 60 °C	110 to 135 °F	45 to 60 °C
05	75 to 165 °F	25 to 70 °C	135 to 160 °F	60 to 70 °C
06	105 to 195 °F	40 to 90 °C	160 to 190 °F	70 to 90 °C
07	125 to 215 °F	55 to 100 °C	190 to 210 °F	90 to 100 °C
09	155 to 250 °F	70 to 120 °C	210 to 245 °F	100 to 120 °C
10	200 to 280 °F	95 to 135 °C	245 to 275 °F	120 to 135 °C
11	225 to 315 °F	110 to 155 °C	275 to 310 °F	135 to 155 °C
12	255 to 370 °F	125 to 185 °C	305 to 365 °F	155 to 185 °C
13	295 to 420 °F	145 to 215 °C	365 to 415 °F	185 to 215 °C
14	310 to 440 °F	155 to 225 °C	415 to 435 °F	215 to 225 °C

*Note: The recommended working span typically falls within the upper third of the nominal range.

SENSING BULB & CAPILLARY Selection

Sensing Bulb Selection & Installation:

The sensing bulb and capillary are available in Copper (best heat transfer properties) or Stainless Steel (for corrosive applications). Copper has better heat transfer properties than stainless steel and should always be chosen for better temperature control unless used in corrosive service. The length of the sensing bulb is dependent upon the capillary length required (see chart). Longer capillary lengths require a longer length sensing bulb to operate the regulator. For installation, the Union Hub is threaded into a tank or piping system. The bulb slides through the Union Hub and is held in place by the Union Nut which spins freely around the armored capillary and threads into the Union Hub. The angled surface of the sensing bulb forms a metal-to-metal seal on the inner edge of the Union Hub to prevent leakage of the process fluid.

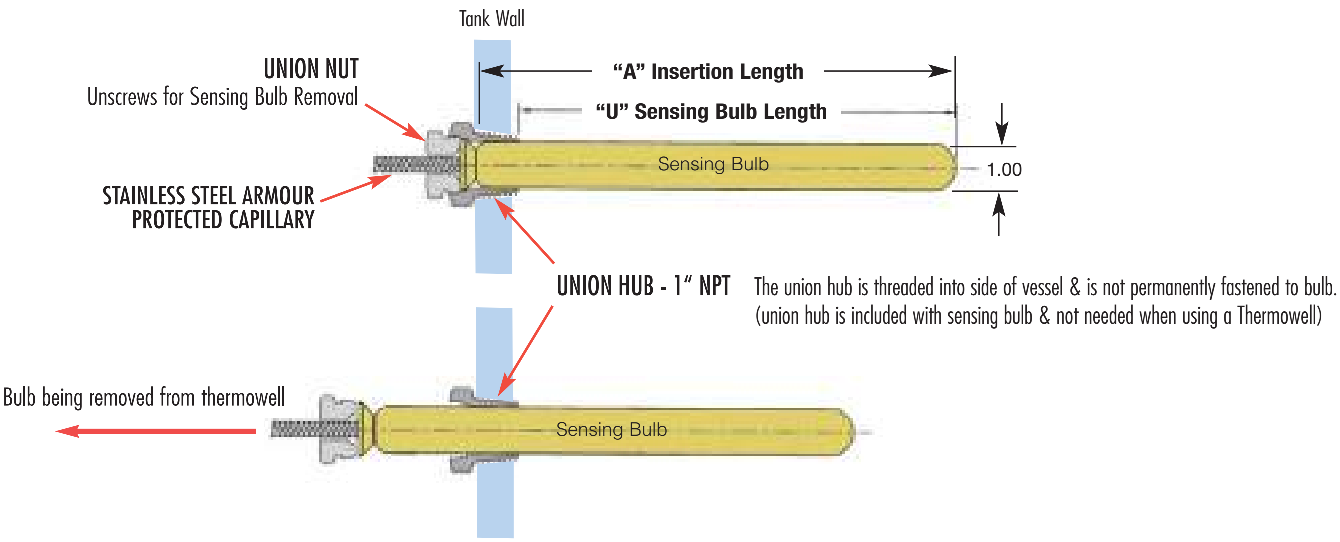
Thermowell Option **(ordered separately)**

A thermowell isolates the sensing bulb from the process fluid. It can be used to remove the sensing bulb while the system is filled with fluid or to protect the sensing bulb from corrosive liquids or excessive system pressures (see following page).

Sensing Bulb & Capillary

ORDER CODE	Sensing Bulb Material	Capillary Tubing Material	Capillary Length in Ft.			
				8, 12, 16	20	24
S15	**Copper** (Brass Union Hub)	**Copper** with Stainless Steel Spiral Armour	A	13”	16”	20”
			U	12.25”	15.25”	19.25”
S16	**Stainless Steel** (Stainless Steel Union Hub)	**Stainless Steel** with Stainless Steel Spiral Armour	A	13”	16”	20”
			U	12.25”	15.25”	19.25”

Other Options available. Consult Factory.



SENSING BULB inside OPTIONAL THERMOWELL

Thermowell Option (ordered separately)

Thermowells isolate and protect the sensing bulb from the process fluid, and are available in either Brass (best heat transfer) or Stainless Steel (for corrosive applications). Thermowells allow for sensing bulb removal and replacement without having to drain liquid from the system. To maintain the best temperature control, always use a Copper Sensing bulb as opposed to a Stainless Steel sensing bulb. For corrosive applications, Stainless Steel thermowells (with a copper sensing bulb) can be used. Thermowells are also recommended for applications with excessive system pressures or extremely turbulent flow to protect the sensing bulb from damage.

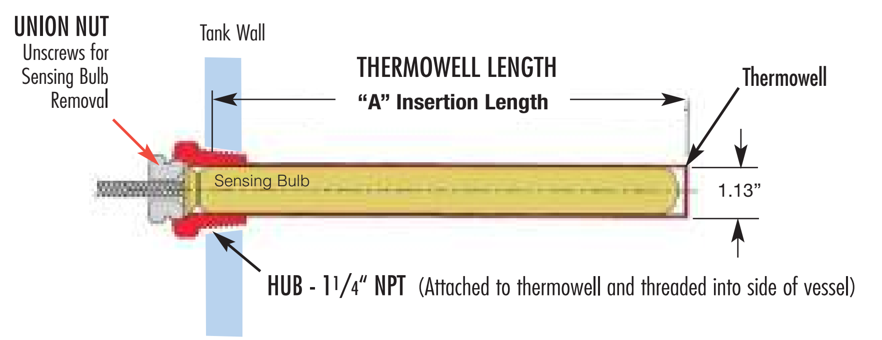
Thermowell Length must be selected based on the length of the sensing bulb. The sensing bulb length is based on the length of the Capillary used in the Thermal System. Longer capillary lengths require a longer sensing bulb to hold the additional actuator fluid inside the sensing bulb. Reference Sensing Bulb Chart for sensing bulb length.

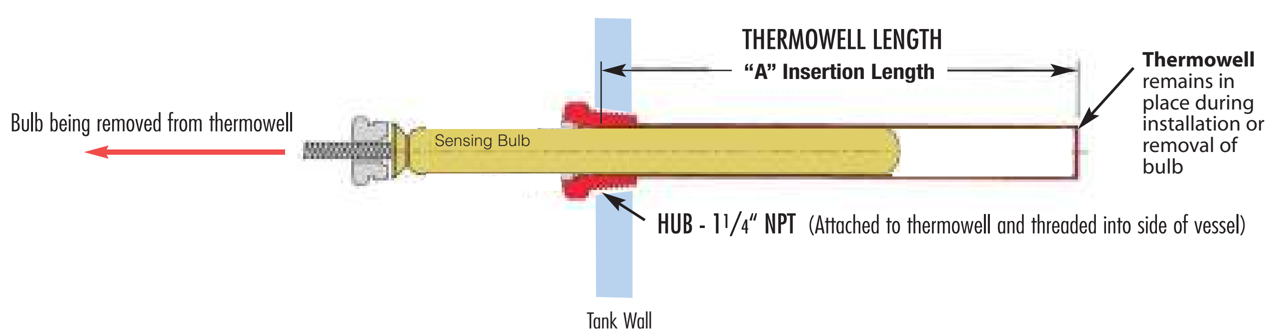
THERMOWELLS - Model Numbers & Lengths

Brass Model Code	**Stainless Steel** Model Code	**Nominal Length**	**"A" INSERTION LENGTH (in.)**		**Capillary Length** (Ft.)
			BULB	**THERMOWELL**	
536-S2	**536-S6**	13"	12.25	13.00	8, 12 or 16
536-SE2	**536-SE6**	16"	15.25	16.00	20
536-WE2	**536-WE6**	20"	19.25	20.00	24

Notes: 1) Other connections and lengths may be available, consult factory.
2) External pressure rating on Copper is 500 PSI max.
3) External pressure rating on 316 SS is 1000 PSI max.

The Thermowell isolates the sensing bulb from the process liquid and allows for easy and safe removal of the sensing bulb. For applications in which the process media may be corrosive or contained under pressure, the use of a thermowell is required to prevent damage to the sensing bulb. For corrosive applications, use a stainless steel thermowell & copper sensing bulb. To ensure minimum response time, Heat Transfer Paste should be applied to the sensing bulb prior to installation into the thermowell.





HEATING

Model Codes in Chart are for complete Temperature Regulators.
This includes the Valve Body and Thermal Actuator with standard copper bulb and 8 ft. capillary.

Connection		**W91** Non-Indicating Type Actuator with valve body X = Temperature Range 08 = Capillary Length 8ft. S15 = Copper Bulb	PMO (PSI)	**W94** Indicating Type Actuator with valve body X = Temperature Range 08 = Capillary Length 8ft. S15 = Copper Bulb	PMO (PSI)	Weight (lbs)
1/2" NPT	Standard Body	**W91-X-08S15-H12N**	250	**W94-X-08S15-H12N**	250	21
	with Integral Union	**W91-X-08S15-H12U**	250	**W94-X-08S15-H12U**	250	21
3/4" NPT	Standard Body	**W91-X-08S15-H13N**	250	**W94-X-08S15-H13N**	250	21
	with Integral Union	**W91-X-08S15-H13U**	250	**W94-X-08S15-H13U**	250	21
1" NPT	Standard Body	**W91-X-08S15-H14N**	200	**W94-X-08S15-H14N**	200	21
	with Integral Union	**W91-X-08S15-H14U**	200	**W94-X-08S15-H14U**	200	21
1 1/4" NPT	Standard Body	**W91-X-08S15-H15N**	200	**W94-X-08S15-H15N**	200	24
	with Integral Union	**W91-X-08S15-H15U**	200	**W94-X-08S15-H15U**	200	24
1 1/2" NPT	Standard Body	**W91-X-08S15-H16N**	200	**W94-X-08S15-H16N**	200	25
	with Integral Union	**W91-X-08S15-H16U**	200	**W94-X-08S15-H16U**	200	25
2" NPT	Standard Body	**W91-X-08S15-H17N**	150	**W94-X-08S15-H17N**	150	57
2"	*Flanged with Standard Actuator	**W91-X-08S15-H17F125**	150	**W94-X-08S15-H17F125**	150	57
2 1/2"		**W91-X-08S15-H18F125**	65	**W94-X-08S15-H18F125**	65	65
3"		**W91-X-08S15-H19F125**	50	**W94-X-08S15-H19F125**	50	80
4"		**W91-X-08S15-H20F125**	40	**W94-X-08S15-H20F125**	40	105
2 1/2"	*Flanged with High-Force Actuator	**W91H-X-08S15-H18F125**	150	N/A	-	96
3"		**W91H-X-08S15-H19F125**	150	N/A	-	118
4"		**W91H-X-08S15-H20F125**	150	N/A	-	60

* 250# Flange available. Consult Factory. The Special High-Force Actuator will allow the valve to be operated at a higher operating pressure.

Model Configuration Chart

Note: Thermowells for Models W91/W94 are ordered separately.

Models	Temperature Range = X	Capillary Length	Sensing Bulb	Valve Body Selection
W91 Non-Indicating **W94** Indicating Dial **W91H** High-Force	**01 – 14** (Refer to Temperature Range Chart)	**08** 8 Feet (std) **12** 12 Feet **16** 16 Feet **20** 20 Feet **24** 24 Feet	**S15** Copper Bulb (std) (with Brass Union Hub) **S16** Stainless Steel Bulb (with SS Union Hub)	Included in Model Code in above chart.
W91	**05** (75 - 165°F)	**12**	**S15**	**H15N** (1 1/4" NPT)

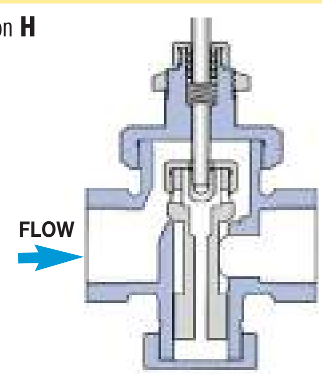
Range Code	Nominal Temperature Range *	
01	20 - 70°F	10 - 20°C
02	40 - 90°F	5 - 30°C
03	30 - 115°F	0 - 45°C
04	50 - 140°F	10 - 60°C
05	75 - 165°F	25 - 70°C
06	105 - 195°F	40 - 90°C
07	125 - 215°F	55 - 100°C
09	155 - 250°F	70 - 120°C
10	200 - 280°F	95 - 135°C
11	225 - 315°F	110 - 155°C
12	255 - 370°F	125 - 185°C
13	295 - 420°F	145 - 215°C
14	310 - 440°F	155 - 225°C

* The recommended working span falls within the upper third of the nominal range.

Example Model Code configured: W91-05-12-S15-H15N
(W91, 75-165 °F Temp. Range, 12 ft. capillary, Std. Copper Sensing Bulb, 1 1/4" NPT Valve Body)

Valve bodies used for HEATING have designation **H**
(Example: **H15N**)

Normally Open
(IN-TO-CLOSE)
Single-seated Balanced Valve with Class IV shut-off



HEATING

W91/W94 Series

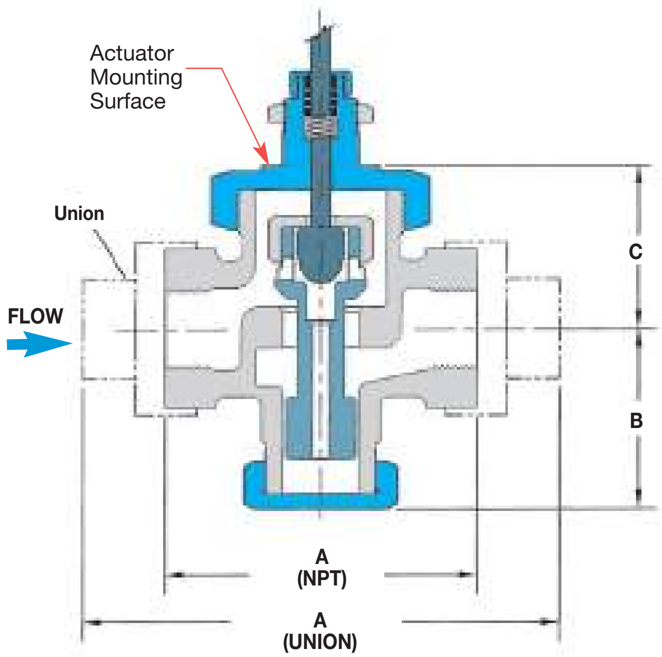
Single Seat • 1/2" – 4"

HEATING

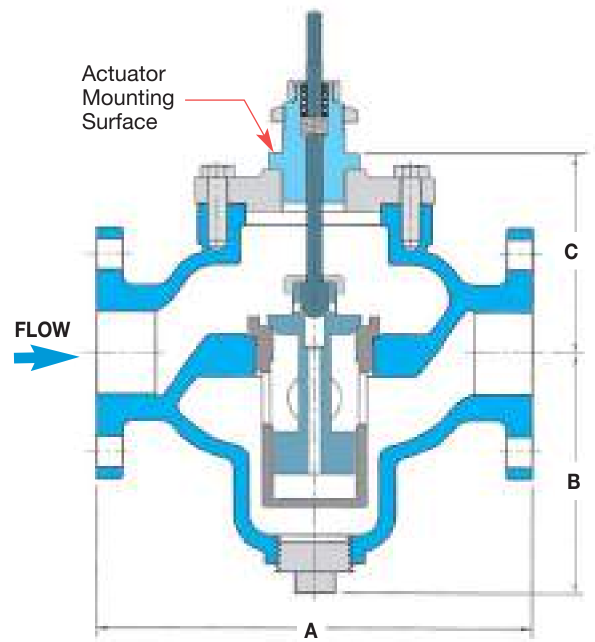
NORMALLY OPEN

Stem In-To-Close for HEATING

Dimensions in inches



THREADED & UNION



FLANGED

Valve Body Specifications

Body Material	Trim Material	Connection	Pressure & Temperature Rating
1/2"- 1 1/2" Stainless/Bronze	Stainless Steel	Threaded or Malleable Iron Union Ends	250 PSI @ 410°F
2" Cast Iron	Stainless Steel	Threaded	250 PSI @ 450°F
2" - 4" Cast Iron	Stainless Steel	125# Flanged	125 PSI @ 450°F
		250# Flanged	250 PSI @ 450°F

Valve Body Selection

Valve Body Number (In-To-Close Heating) NPT	Union	Size Connection NPT	Capacity Cv	Maximum Close-Off Pressure (PSI△P)		Dimensions A Threaded	A 125# FLG	A 250# FLG	A Union	B	C	Approx. Ship. Wt. (lbs) [kg]
H12N	H12U	1/2"	3.2	250		4.125	x	x	6.50	2.375	2.12	14 [6.35]
H13N	H13U	3/4"	6.3	250		4.125	x	x	6.50	2.375	2.12	14 [6.35]
H14N	H14U	1"	10.8	200		4.125	x	x	7.00	2.375	2.12	14 [6.35]
H15N	H15U	1 1/4"	15.9	200		4.810	x	x	7.50	3.250	2.50	17 [7.7]
H16N	H16U	1 1/2"	22.4	200		5.190	x	x	8.00	3.500	2.69	18 [8.2]
H17N	–	2"	33.1	150		9.500	x	x	x	5.750	4.75	50 [22.7]
FLANGED 125#	250#			Valve Type: Standard	Special*							
H17F125	H17F250	2"	33.1	150	–	x	10.375	10.875	x	5.75	4.75	80 [36.3]
H18F125	H18F250	2 1/2"	47.5	65	150	x	10.625	11.250	x	7.00	5.00	96 [43.6]
H19F125	H19F250	3"	68.2	50	150	x	10.875	11.625	x	8.00	5.75	110 [49.9]
H20F125	H20F250	4"	109.5	40	150	x	10.500	13.125	x	8.75	6.50	160 [72.6]

Notes: For 2 1/2" - 4" sizes, consult factory for proper actuators.

* With High-Force Actuator, which allows the valve to operate at a higher differential pressure.

HEATING

CAPACITIES – Steam (lbs/hr) SINGLE-SEATED VALVES

Inlet Pressure (PSIG)	Size & Valve Body Number 1/2" H12	3/4" H13	1" H14	$1^1/4$" H15	$1^1/2$" H16	2" H17	$2^1/2$" H18	3" H19	4" H20
1	91	180	309	454	640	946	1357	1949	3129
3	103	203	348	512	722	1066	1530	2197	3527
5	115	226	387	570	803	1187	1703	2445	3926
10	144	283	486	715	1007	1488	2135	3066	4922
15	173	341	584	859	1211	1789	2568	3686	5919
20	202	398	682	1004	1415	2090	3000	4307	6915
25	231	455	780	1149	1618	2392	3432	4928	7912
30	260	513	879	1294	1822	2693	3864	5548	8908
40	319	627	1075	1583	2230	3295	4729	6790	10,901
50	377	742	1272	1872	2638	3898	5593	8031	12,894
60	435	857	1468	2162	3045	4500	6458	9272	14,887
70	493	971	1665	2451	3453	5102	7322	10,513	16,880
80	552	1086	1861	2740	3861	5705	8187	11,755	18,873
90	610	1200	2058	3030	4268	6307	9051	12,996	20,866
100	668	1315	2255	3319	4676	6910	9916	14,237	22,859
125	814	1602	2746	4043	5695	8416	12,077	17,340	27,841
150	959	1888	3237	4766	6714	9922	14,238	20,443	32,823
175	1105	2175	3729	5490	7734				
200	1250	2462	4220	6213	8753				
250	1542	3035							

Notes: 1) For reduced-port 1/2″ valves, consult factory. 2) All steam capacities based on Critical Drop (Choked Flow).

Note:
Verify that Maximum Close-Off Pressure for 2″ - 4″ models does not exceed max rating for selected Valve Body Number and Type (refer to Valve Body Number in chart).

CAPACITIES – Water (GPM) SINGLE-SEATED VALVES

Pressure (PSI△P)	Size & Valve Body Number 1/2″ HW12	3/4″ HW13	1″ HW14	$1^1/4$″ HW15	$1^1/2$″ HW16	2″ HW17	$2^1/2$″ HW18	3″ HW19	4″ HW20
1	3.2	6.3	11	16	22	33	48	68	110
3	5.5	11	19	28	39	57	82	118	190
5	7.2	14	24	36	50	74	106	152	245
10	10	20	34	50	71	105	150	216	346
15	12	24	42	62	87	128	184	264	424
20	14	28	48	71	100	148	212	305	490
25	16	32	54	80	112	166	238	341	548
30	18	35	59	87	123	181	260	374	600
40	20	40	68	101	142	209	300	431	693
50	23	45	76	112	158	234	336	482	774
60	25	49	84	123	174	256	368	528	848
70	27	53	90	133	187	277	397	571	916
80	29	56	97	142	200	296	425	610	979
90	30	60	102	151	213	314	451	647	1039
100	32	63	108	159	224	331	475	682	1095
125	36	70	121	178	250	370	531	762	1224
150	39	77	132	195	274	405	582	835	1341
175	42	83	143	210	296				
200	45	89	153	225	317				
250	51	100							

Note: When used with water, add **W** to the Valve Body Number.

Example:
H17N becomes **HW17N**

Note: Verify that Maximum Close-Off Pressure for 2″ - 4″ models does not exceed max rating for selected Valve Body Number and Type (refer to Valve Body Number chart on previous page)

HEATING

Steam Required for Heating Water

Steam flow required through a temperature regulator (lbs/hr) to heat a specified number of gallons of water per hour (gal/hr)

TABLE 1- Steam Flow Required in Pounds Per Hour (lbs/hr)

Temp Increase (˚F)	Gallons of Water per Hour To Be Heated												Temp Increase (˚F)
	25	50	100	200	300	500	700	1000	2000	4000	10,000	20,000	
5°	1	2	4	8	12	21	29	41	83	166	415	830	5°
10°	2	4	8	16	25	41	58	83	166	332	830	1660	10°
15°	3	6	12	25	37	62	87	124	249	498	1245	2490	15°
20°	4	8	17	33	50	83	116	166	332	664	1660	3320	20°
25°	5	10	20	42	62	104	145	207	415	830	2075	4150	25°
30°	6	12	25	50	75	124	174	249	498	996	2490	4980	30°
40°	8	16	33	66	100	166	232	332	664	1328	3320	6640	40°
50°	10	21	42	83	124	207	290	415	830	1660	4150	8300	50°
60°	12	25	50	100	149	249	348	498	996	1992	4980	9960	60°
70°	15	29	58	116	174	290	407	581	1162	2324	5810	11,620	70°
80°	17	33	67	133	199	332	465	664	1328	2656	6640	13,280	80°
90°	19	38	75	149	224	373	523	747	1494	2988	7470	14,940	90°
100°	21	42	83	166	249	415	581	830	1660	3320	8300	16,600	100°
115°	24	48	95	191	286	477	668	955	1909	3818	9544	19,088	115°
130°	27	54	108	216	324	539	755	1079	2158	4316	10,790	21,580	130°
145°	30	60	120	241	361	601	842	1200	2400	4812	12,030	24,060	145°
160°	33	66	133	266	398	664	929	1328	2656	5312	13,280	26,560	160°
175°	36	72	145	290	436	726	1017	1452	2900	5810	14,524	29,048	175°
200°	41	83	166	332	498	830	1162	1660	3320	6640	16,600	33,200	200°
225°	47	94	187	374	560	934	1307	1867	3735	7470	18,680	37,360	225°
250°	52	104	207	415	622	1037	1452	2075	4150	8300	20,750	41,500	250°

HEATING WATER: The amount of steam required to heat water can be found using chart above.
Example: **To heat 1000 gallons per hour of water from 40˚F to 140˚F (Temp. increase 100˚F) requires 830 lbs/hr of steam.**

HEATING FUEL OIL: The amount of steam required to heat fuel oil is half of that to heat water. Use half the value found in chart above.
Example: **To heat 1000 gallons per hour of fuel oil from 40˚F to 140˚F (Temp. increase 100˚F) requires 415 lbs/hr of steam.**

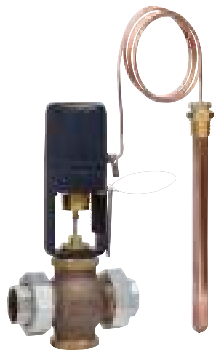
Capacity Formulas for Steam Loads

When Heat Load or Heat Transfer Rate (E) is Known	**Capacity of steam required (lbs/hr)**	= $\frac{E}{1000}$ (Btu/hr)
When Square Feet Equivalent Direct Radiation (EDR) is Known	**Capacity of steam required (lbs/hr)**	= $\frac{\text{Sq. ft. of EDR}}{4}$
When Heating Water with Steam	**Capacity of steam required (lbs/hr)**	= $\frac{\text{GPM}}{2}$ x Temp Rise (°F)
When Heating Fuel Oil with Steam	**Capacity of steam required (lbs/hr)**	= $\frac{\text{GPM}}{4}$ x Temp Rise (°F)
When Heating Air with Steam Coils	**Capacity of steam required (lbs/hr)**	= $\frac{\text{CFM}}{900}$ x Temp Rise (°F)

Note: Above formulas based on steam containing approximately 1000 Btu's of Latent Heat per pound.

COOLING

Model Codes in Chart are for complete Temperature Regulators.
This includes the Valve Body and Thermal Actuator with standard copper bulb and 8 ft. capillary.



W91 Non-Indicating Type Actuator with valve body — X = Temperature Range; 08 = Capillary Length 8 ft.; S15 = Copper Bulb

W94 Indicating Type Actuator with valve body — X = Temperature Range; 08 = Capillary Length 8 ft.; S15 = Copper Bulb

Connection		W91	PMO (PSI)	W94	PMO (PSI)	Weight
3/4″ NPT	with Integral Union	W91-X-08S15-C13U	250	W94-X-08S15-C13U	250	12
1″ NPT	with Integral Union	W91-X-08S15-C14U	250	W94-X-08S15-C14U	250	13
1 1/4″ NPT	with Integral Union	W91-X-08S15-C15U	250	W94-X-08S15-C15U	250	17
1 1/2″ NPT	with Integral Union	W91-X-08S15-C16U	250	W94-X-08S15-C16U	250	18
2″ NPT	with Integral Union	W91-X-08S15-C17U	250	W94-X-08S15-C17U	250	24
2 1/2″	125# FLG	W91-X-08S15-C18F125	65	W94-X-08S15-C18F125	65	55
3″	125# FLG	W91-X-08S15-C19F125	50	W94-X-08S15-C19F125	50	80
4″	125# FLG	W91-X-08S15-C20F125	40	W94-X-08S15-C20F125	40	105

Model Configuration Chart

Note: Thermowells for Models W91/W94 are ordered separately.

Models	Temperature Range = X	Capillary Length	Sensing Bulb	Valve Body Selection
W91 Non-Indicating **W94** Indicating Dial	01 – 14 (Refer to Temperature Range Chart)	**08** 8 Feet (std) **12** 12 Feet **16** 16 Feet **20** 20 Feet **24** 24 Feet	**S15** Copper Bulb (std) (with Brass Union Hub) **S16** Stainless Steel Bulb (with SS Union Hub)	Included in Model Code in above chart.
W91	**05** (75 - 165°F)	**12**	**S15**	**C15U** (1 1/4″ NPT)

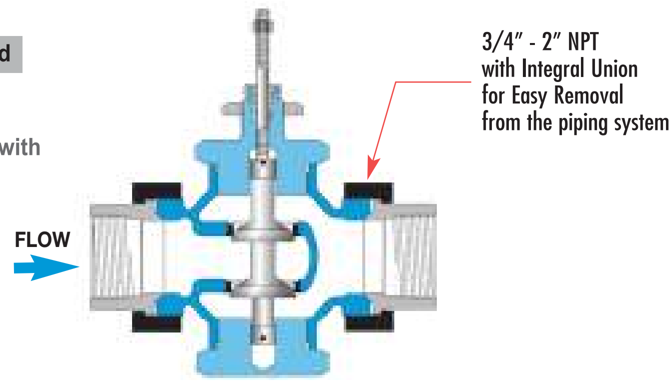
Example Model Code configured: **W91-05-12-S15-C15U**
(W91, 75-165 °F Temp. Range, 12 ft. Capillary, Copper Sensing Bulb, 1 1/4″ NPT Valve Body)

Range Code	Nominal Temperature Range *	
01	20 - 70°F	10 - 20°C
02	40 - 90°F	5 - 30°C
03	30 - 115°F	0 - 45°C
04	50 - 140°F	10 - 60°C
05	75 - 165°F	25 - 70°C
06	105 - 195°F	40 - 90°C
07	125 - 215°F	55 - 100°C
09	155 - 250°F	70 - 120°C
10	200 - 280°F	95 - 135°C
11	225 - 315°F	110 - 155°C
12	255 - 370°F	125 - 185°C
13	295 - 420°F	145 - 215°C
14	310 - 440°F	155 - 225°C

* The recommended working span typically falls within the upper third of the nominal range.

Valve bodies used for COOLING have designation **C**
(Example: **C15U**)

Normally Closed
(IN-TO-OPEN)
Double-seated Balanced Valve with Class II shut-off



COOLING

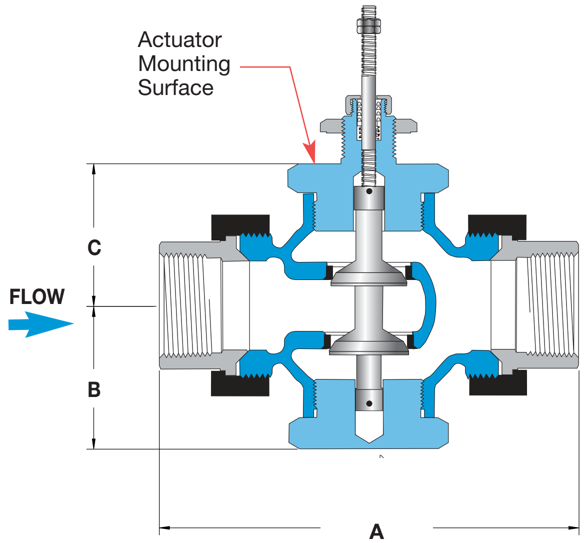
Double Seat • 3/4" – 4"

COOLING

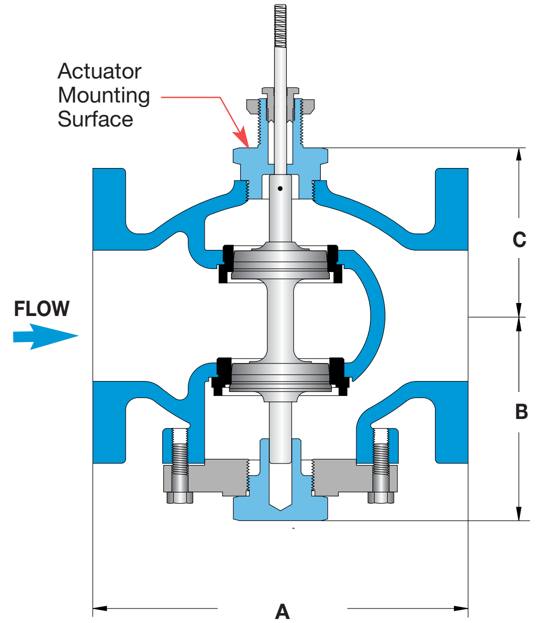
Dimensions in inches [mm]

NORMALLY CLOSED

Stem In-To-Open for Cooling



3/4" – 2"
NPT



2 1/2" – 4"
Flanged

Valve Body Specifications

Body Material	Trim Material	Connection	Pressure & Temperature Rating
3/4" - 2" Bronze	Stainless Steel	Threaded with Malleable Iron Union Ends	250 PSI @ 410°F (210°C)
2 1/2" - 4" Cast Iron	Stainless Steel	125# Flanged	125 PSI @ 350°F (149°C)

Valve Body Selection – Threaded

Valve Body Number (In-To-Open Cooling)	Size Connection (NPT)	Size Nominal Port	Capacity C_V	Maximum Close-Off Pressure (PSI△P)	Dimensions A	Dimensions B	Dimensions C	Approximate Shipping Wt. (lbs) [kg]
C13U	3/4	3/4"	8	250	5.6 [142]	2.3 [58]	2.3 [58]	5.0 lbs [2.25 kg]
C14U	1	1"	12	250	6.0 [152]	2.3 [58]	2.3 [58]	6.1 lbs [2.75 kg]
C15U	1 1/4	1 1/4"	21	250	7.2 [183]	2.6 [66]	2.6 [66]	10.1 lbs [4.55 kg]
C16U	1 1/2	1 1/2"	30	250	7.7 [196]	2.6 [66]	2.6 [66]	11.1 lbs [5.00 kg]
C17U	2	2"	47	250	8.6 [218]	3.1 [79]	3.1 [79]	17.0 lbs [7.65 kg]

Valve Body Selection – Flanged

Valve Body Number (In-To-Open Cooling)	Size Connection	Size Nominal Port	Capacity C_V	Maximum Close-Off Pressure (PSI△P)	Dimensions A	Dimensions B	Dimensions C	Approximate Shipping Wt. (lbs) [kg]
C18F125	2 1/2"	2 1/2"	69	65	7.8 [198]	4.8 [122]	5.4 [137]	45 lbs [20 kg]
C19F125	3"	3"	90	50	9.0 [229]	5.0 [127]	5.6 [142]	70 lbs [32 kg]
C20F125	4"	4"	196	40	11.4 [290]	6.3 [160]	6.5 [165]	100 lbs [45 kg]

W91/W94 Series

MIXING & DIVERTING

Model Codes in Chart are for complete Temperature Regulators.
This includes the Valve Body and Thermal Actuator with standard copper bulb and 8 ft. capillary.

W91: Non-Indicating Type Actuator with valve body
W94: Indicating Type Actuator with valve body

X = Temperature Range
08 = Capillary Length 8 ft.
S15 = Copper Bulb

Connection		W91	PMO (PSI)	W94	PMO (PSI)	Weight
1/2″ NPT	with Integral Union	W91-X-08-S15-A18	250	W94-X-08-S15-A18	250	10
3/4″ NPT	with Integral Union	W91-X-08-S15-A25	250	W94-X-08-S15-A25	250	12
1″ NPT	with Integral Union	W91-X-08-S15-A34	250	W94-X-08-S15-A34	250	13
1-1/4″ NPT	with Integral Union	W91-X-08-S15-A45	250	W94-X-08-S15-A45	250	17
1-1/2″ NPT	with Integral Union	W91-X-08-S15-A56	250	W94-X-08-S15-A56	250	18
2″ NPT	with Integral Union	W91-X-08-S15-A67	250	W94-X-08-S15-A67	250	24
2-1/2″	125# FLG	W91-X-08-S15-B75	125	W94-X-08-S15-B75	125	55
3″	125# FLG	W91-X-08-S15-B80	125	W94-X-08-S15-B80	125	80
4″	125# FLG	W91-X-08-S15-B85	125	W94-X-08-S15-B85	125	105

Model Configuration Chart

Note: Thermowells for Models W91/W94 are ordered separately.

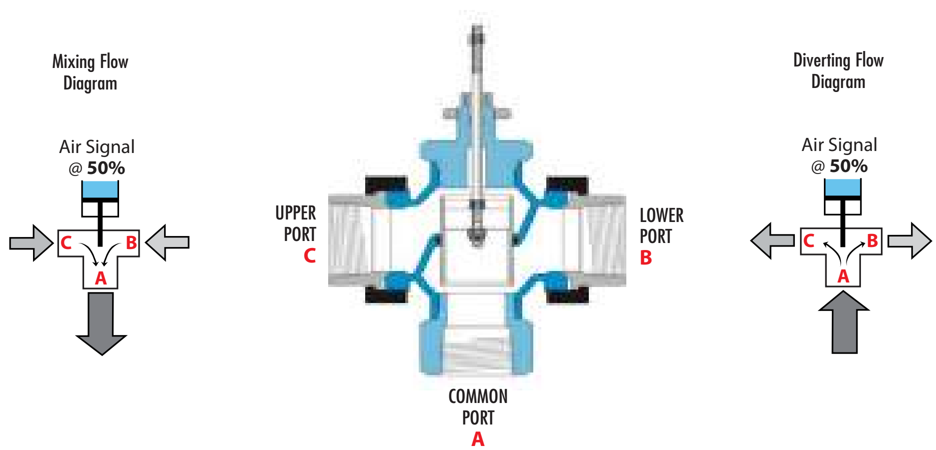
Models	Temperature Range = X	Capillary Length	Bulb	Valve Body Selection
W91 Non-Indicating **W94** Indicating Dial	01 – 14 (Refer to Temperature Range Chart on next page)	**08** 8 Feet (standard) **12** 12 Feet **16** 16 Feet **20** 20 Feet **24** 24 Feet	**S15** Copper Bulb (with Brass Union Hub) **S16** Stainless Steel Bulb (with SS Union Hub)	Included in Model Code in above chart.
W91	**05** (75 - 165°F)	**12**	**S15**	**A45** (1-1/4″ NPT)

Example Model Code configured: **W91-05-12-S15-A45**
(W91, 75-165 °F Temp. Range, 12 ft. Capillary, Copper Sensing Bulb, 1-1/4″ NPT Valve Body)

Range Code	Nominal Temperature Range *	
01	20 - 70°F	10 - 20°C
02	40 - 90°F	5 - 30°C
03	30 - 115°F	0 - 45°C
04	50 - 140°F	10 - 60°C
05	75 - 165°F	25 - 70°C
06	105 - 195°F	40 - 90°C
07	125 - 215°F	55 - 100°C
09	155 - 250°F	70 - 120°C
10	200 - 280°F	95 - 135°C
11	225 - 315°F	110 - 155°C
12	255 - 370°F	125 - 185°C
13	295 - 420°F	145 - 215°C
14	310 - 440°F	155 - 225°C

* The recommended working span typically falls within the upper third of the nominal range.

Valve Body for MIXING & DIVERTING



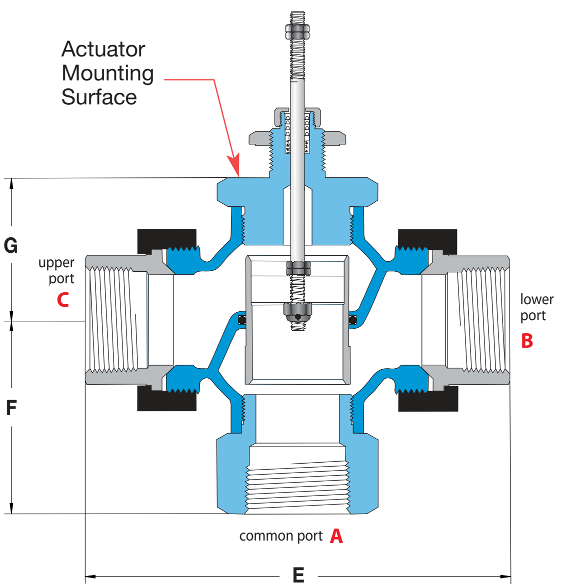
CAUTION: 3-Way Valves are not designed for use in steam applications.
To properly control the mixing of two flows, inlet pressures at ports B and C should be as equal as possible.

W91/W94 Series

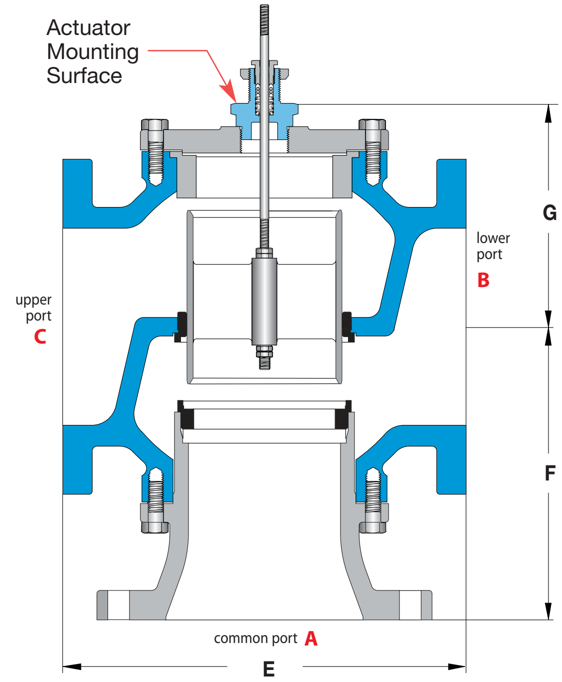
3-Way • 1/2" – 4"

Dimensions in inches [mm]

for Mixing or Diverting



1/2" – 2"
NPT



$2^1/_2$" – 4"
Flanged

TEMPERATURE Regulators

CAUTION: Watson McDaniel 3-Way Valves are not designed for use in steam applications.
To properly control the mixing of two flows, inlet pressures at ports B and C should be as equal as possible.

Valve Body Specifications

Body Material	Trim Material	Connection	Pressure & Temperature Rating
1/2" - 2" Bronze	Bronze	Threaded with Malleable Iron Union Ends	250 PSI @ 300°F (149°C)
$2^1/_2$" - 4" Cast Iron	Bronze	125# Flanged	125 PSI @ 300°F (149°C)

Valve Body Selection

Valve Body Number	Size		Capacity	Maximum Close-Off Pressure	Dimensions			Approximate Shipping Wt.
	Connection (NPT)	Nominal Port	C_V	(PSI△P)	E	F	G	
A18	1/2"	1/2"	2.8	250	4.8 [122]	1.8 [46]	1.8 [46]	2.9 lbs [1.31 kg]
A25	3/4"	3/4"	5.6	250	5.6 [142]	2.3 [58]	2.3 [58]	4.7 lbs [2.12 kg]
A34	1"	1"	8.4	250	6.0 [152]	2.3 [58]	2.3 [58]	5.7 lbs [2.57 kg]
A45	$1^1/_4$"	$1^1/_4$"	15	250	7.2 [183]	2.8 [71]	2.6 [66]	9.5 lbs [4.28 kg]
A56	$1^1/_2$"	$1^1/_2$"	21	250	7.7 [196]	3.5 [89]	2.6 [66]	11.1 lbs [5.00 kg]
A67	2"	2"	33	250	8.6 [218]	4.1 [104]	3.1 [79]	16.7 lbs [7.55 kg]

Valve Body Selection

Valve Body Number	Size		Capacity	Maximum Close-Off Pressure	Dimensions			Approximate Shipping Wt.
	Connection	Nominal Port	C_V	(PSI△P)	E	F	G	
B75	$2^1/_2$"	$2^1/_2$"	58	125	9.0 [229]	7.1 [180]	5.2 [132]	62 lbs [28 kg]
B80	3"	3"	72	125	10.0 [254]	8.0 [203]	6.0 [152]	80 lbs [36 kg]
B85	4"	4"	102	125	13.0 [330]	10.0 [254]	6.9 [175]	140 lbs [64 kg]

COOLING Double-Seated Valve Bodies

CAPACITIES – Water (GPM) **DOUBLE-SEATED VALVES**

Pressure Drop (PSI△P)	Size, Valve Body Number & Coefficient (Cv)							
	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"
	C13U Cv = 8	C14U Cv = 12	C15U Cv = 21	C16U Cv = 30	C17U Cv = 47	C18F125 Cv = 69	C19F125 Cv = 90	C20F125 Cv = 196
1	8	12	21	30	47	69	90	196
3	14	21	36	52	81	120	156	339
5	18	27	47	67	105	154	201	438
10	25	38	66	95	149	218	285	620
15	31	46	81	116	182	267	349	759
20	36	54	94	134	210	309	402	877
25	40	60	105	150	235	345	450	980
30	44	66	115	164	257	378	493	1074
40	51	76	133	190	297	436	569	1240
50	57	85	148	212	332	488	636	
60	62	93	163	232	364			
70	67	100	176	251	393			
80	72	107	188	268	420			
90	76	114	199	285	446			
100	80	120	210	300	470			
125	89	134	235	335	525			
150	98	147	257	367	576			
175	106	159	278	397	622			
200	113	170	297	424	665			
225	120	180	315	450	705			
250	126	190	332	474	743			

Note: Double-seated valves have In-to-Open (**ITO**) stem action for cooling applications.

MIXING & DIVERTING 3-Way Valve Bodies

CAPACITIES – Water (GPM) **3-WAY VALVES**

Pressure Drop (PSI△P)	Size, Valve Body Number & Coefficient (Cv)								
	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"
	A18 Cv = 2.8	A25 Cv = 5.6	A34 Cv = 8.4	A45 Cv = 15	A56 Cv = 21	A67 Cv = 33	B75 Cv = 58	B80 Cv = 72	B85 Cv = 102
1	2.8	5.6	8.4	15	21	33	58	72	102
3	4.8	10	15	26	36	57	100	125	177
5	6.3	13	19	34	47	74	130	161	228
10	8.9	18	27	47	66	104	183	228	323
15	11	22	33	58	81	128	225	279	395
20	13	25	38	67	94	148	259	322	456
25	14	28	42	75	105	165	290	360	510
30	15	31	46	82	115	181	318	394	559
40	18	35	53	95	133	209	367	455	645
50	20	40	59	106	148	233	410	509	721
60	22	43	65	116	163	256	449	558	790
70	23	47	70	125	176	276	485	602	853
80	25	50	75	134	188	295	519	644	912
90	27	53	80	142	199	313	550	683	968
100	28	56	84	150	210	330	580	720	1020
125	31	63	94	168	235	369	648	805	1140
150	34	69	103	184	257	404			
175	37	74	111	198	278	437			
200	40	79	119	212	297	467			
225	42	84	126	225	315	495			
250	44	89	133	237	332	522			

Note: Oil service or high temperature service requires special O-ring.

W91/W94 Series

Replacement Actuators

W91
Non-indicating
Replacement Actuator

W94
Indicating
Replacement Actuator

Note: Thermowells for Models W91/W94 are ordered separately.

Example Model Code configured: W91-05-12-S15

Replacement Actuator Model Configuration

Models	Temperature Range = X	Capillary Length	Bulb
W91 **W94**	01 – 14 (Refer to Temperature Range Chart)	**08** 8 Feet (std) **12** 12 Feet **16** 16 Feet **20** 20 Feet **24** 24 Feet	**S15** Copper Bulb (with Brass Union Hub) **S16** Stainless Steel Bulb (with SS Union Hub)
W91	05 (75 - 165°F)	**12**	**S15**

Thermowells for W91 & W94 Series Self-Operated Temperature Regulators

Capillary Length (ft.)	Bulb Length Required	Thermowell Length (in.)	Connection Size NPT	Brass Model #	Stainless Steel Model #
8', 12' or 16'	12.25"	13.0"	1 1/4"	**536S2**	**536S6**
20'	15.25"	16.0"	1 1/4"	**536SE2**	**536SE6**
24'	19.25"	20.0"	1 1/4"	**536WE2**	**536WE6**

Note: Thermowell Length chosen is based on the Length of the Capillary used in the Thermal System. (See chart above)

Control Valves

HB Series
Control Valve
(with Pneumatic Actuator)

HB Series Control Valve
(with Electric Actuator)

The **HB Control Valve** with Electric Actuator is a robust user-friendly alternative to pneumatic actuators. Actuator is ideal for installations where pneumatic lines are not present.

Fail-safe Mode: Super capacitors are used to drive the valve fully-closed or open in the event of power loss to the actuator. This replaces common back-ups such as springs with limited thrust or batteries with a limited life span.

Fast Response Time: Fully-open or close in approximately 6 seconds making them ideal for instantaneous and semi-instantaneous water heaters.

Integral Positioner: accepts 4-20 mA or 0-10 VDC control signal.

HEAT MISER
Watson McDaniel's Instantaneous Hot Water Heating Systems
(shown with HB Control Valve)

CONTROL VALVES

Watson McDaniel

Control Valves

Control Valves & Control Loop Components

A Control Valve is one component of a control loop and relies upon other components for proper function of operation (i.e. controller, sensor, transducer, etc.).

The failure mode of the valve should be considered if the air signal controlling the actuator becomes interrupted. For example: For heating applications with steam, a **Normally-Closed/Air-To Open (ATO)** Valve should be selected. If the air signal to the actuator is interrupted, the valve will close in a fail-safe position. For cooling applications with water, a **Normally-Open/Air-To Close (ATC)** should be selected.

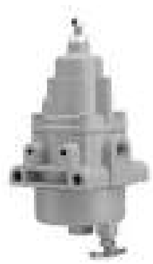
Ensure the maximum Close-off Pressure of the valve exceeds the inlet pressure. This is necessary to guarantee the valve assembly will overcome the forces generated in the valve body from the fluid pressure, allowing the valve to open and close properly and completely.

The **Pneumatic Actuator** accepts an industry-standard air pressure range of 3–15 PSIG, which allows the valve to fully open and fully close and modulate in between.

The **Electric Actuator** features a 6-8 second actuator time (fully-open to fully-closed), super capacitors which allow Fail-Safe operation in the event of a power loss, and an integral positioner which accepts 4-20 mA or 0-10 VDC control signal. Ideal for instantaneous water heaters.

CA2000 Valve Positioner

TA901 I/P Transducer



TA987 Air Filter/ Regulator

TR890 Electronic PID Controller

Electronic Temperature Sensor

Control Valves

HB Series Control Valve with Pneumatic Actuator

Models	HB Series
Service	Steam, Air, Water
Sizes	1/2", 3/4", 1", 1$^1/_2$", 2"
Connections	NPT, 150# FLG, 300# FLG
Body Material	316 Stainless Steel
Plug and Seat Material	Stainless Steel
PMA Max. Operating Pressure	720 PSIG @ 100˚F
TMA Max. Operating Temperature	450˚F @ 497 PSIG
Min Operating Temperature	-20˚F
Max Air Supply Pressure	40 PSIG
Max Ambient Temperature	280˚F
Min Ambient Temperature	-20˚F

DESIGN PRESSURE/TEMPERATURE RATING – PMA/TMA		
NPT	300 PSIG	@ 450˚F
150# FLG	150 PSIG	@ 450˚F
300# FLG	300 PSIG	@ 450˚F

These Control Valve feature all 316 Stainless Steel bodies and trim for use with Steam, Water, Glycol and other chemically compatible fluids.

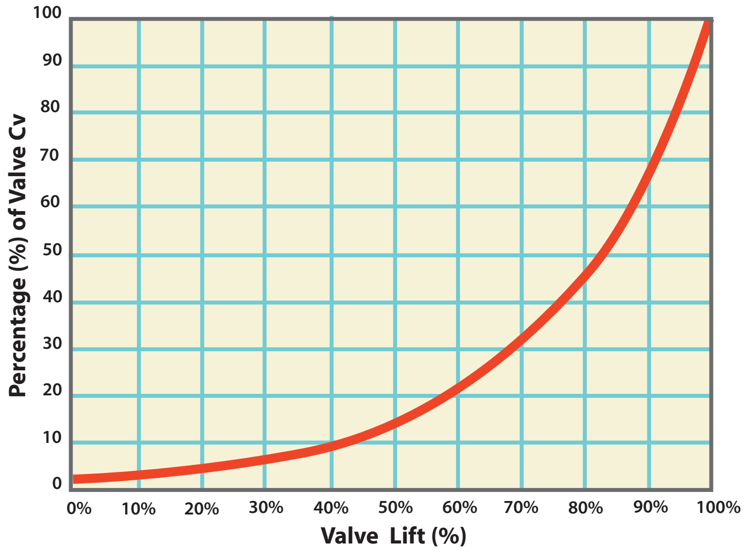
The **HB Series** is a high performance, general service control valve designed using Computational Fluid Dynamics (CFD) for high control accuracy, optimized flow characteristics and extended service life. These control valves, with stainless steel bodies, are equipped with a contoured plug design to withstand the rigorous nature of steam service and are compatible with many fluids and environments. Modern manufacturing techniques and modular construction allows these stainless steel valves to be extremely cost-effective in comparison to valves with bronze, cast iron or cast steel bodies. The standard configuration has an equal percentage flow characteristic with metal-to-metal seating, spring-loaded Teflon V-ring stem packing and pneumatic actuator. The HB Series is available with both pneumatic or electric actuation.

Description & Operation

A control valve is a device capable of modulating flow at varying degrees between minimal flow and full capacity in response to a signal from an external control device. The valve modulates flow through movement of a valve plug in relation to the port(s) located within the valve body. The valve plug is attached to a valve stem, which, in turn, is connected to the actuator. The actuator, which can be pneumatically or electrically operated, directs the movement of the stem as dictated by the external control device.

Options & Associated Control Loop Accessories

- Electric Actuators
- Positioner: Pneumatic, Electro-Pneumatic or Explosion-Proof
- PID Electronic Controllers (TR890 Series)
- I/P converters (Model TA901)
- Air Filter Regulators (Air Sets-Model TA987)
- Thermocouples
- RTD's
- Pressure Transmitters



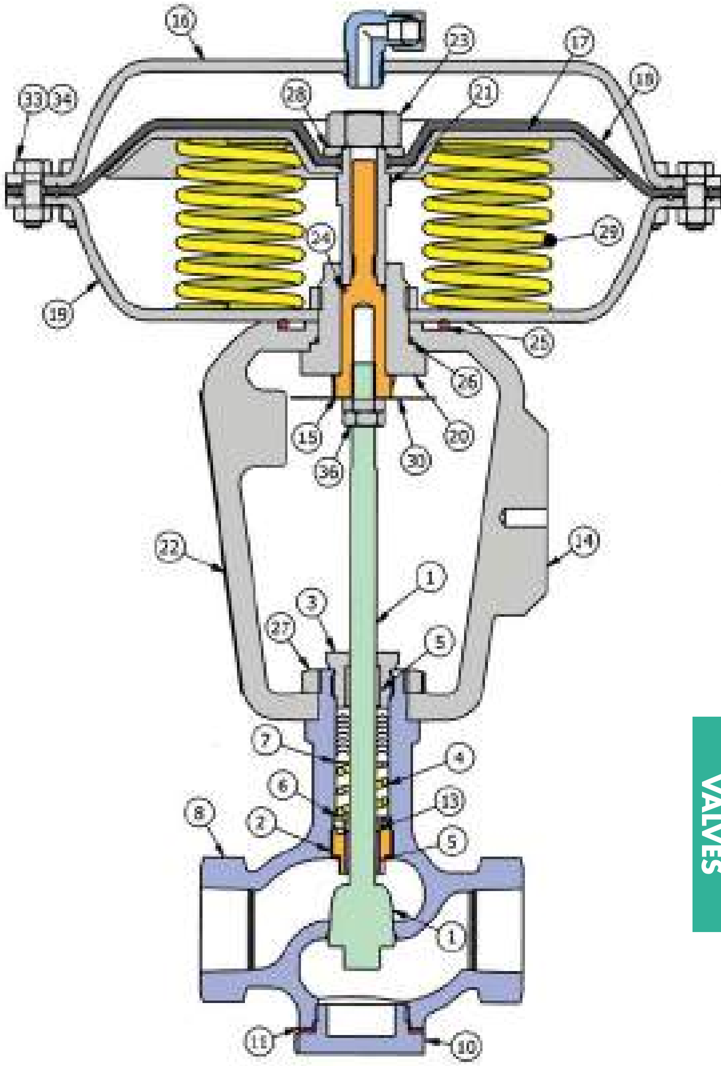
HB Series Control Valve with Pneumatic Actuator

MATERIALS • Pneumatic Actuator		
14	Yoke	Stainless steel
15	Lower actuator stem	Stainless steel
16	Upper diaphragm case	Epoxy painted steel
17	Diaphragm plate	Nickel plated steel
18	Diaphragm*	Nylon reinforced Neoprene
19	Lower diaphragm case	Epoxy painted steel
20	Upper guide bush	SS/Bronze Impregnated
21	Upper actuator stem	Stainless steel
22	Nameplate	Stainless steel
23	Hex nut	Stainless steel
24	Stem O-ring*	Viton
25	Yoke O-ring*	Viton
26	Upper guide O-ring*	Viton
27	Ring nut*	Stainless steel
28	Diaphragm washer	Stainless steel
29	Springs†	Stainless steel
30	Position indicator disc	Stainless steel
33/34	Hex bolt & nut	Grade 5 steel zinc plated

† **Air-To-Open Actuator**: 6 Actuator Springs
† **Air-To-Close Actuator**: 3 Actuator Springs
Diaphragm Area = 47 in^2

MATERIALS • Valve Body		
1	Stem & Plug Assembly*	Stem: 316 SS, Plug: 303 SS
2	Lower Seal Bushing	303 Stainless Steel
3	Gland Nut	303 Stainless Steel
4	Stem Seal Spring*	302 Stainless Steel
5	Guide Bushing*	Rulon 641
6	Washer	303 Stainless Steel
7	V-ring Stem Seals*	PTFE
8	Body	316 Stainless Steel
10	Body Plug	316 Stainless Steel
11	Body Gasket*	303 Stainless Steel
13	Packing O-Ring	PTFE

* Available as part of a spares kit.

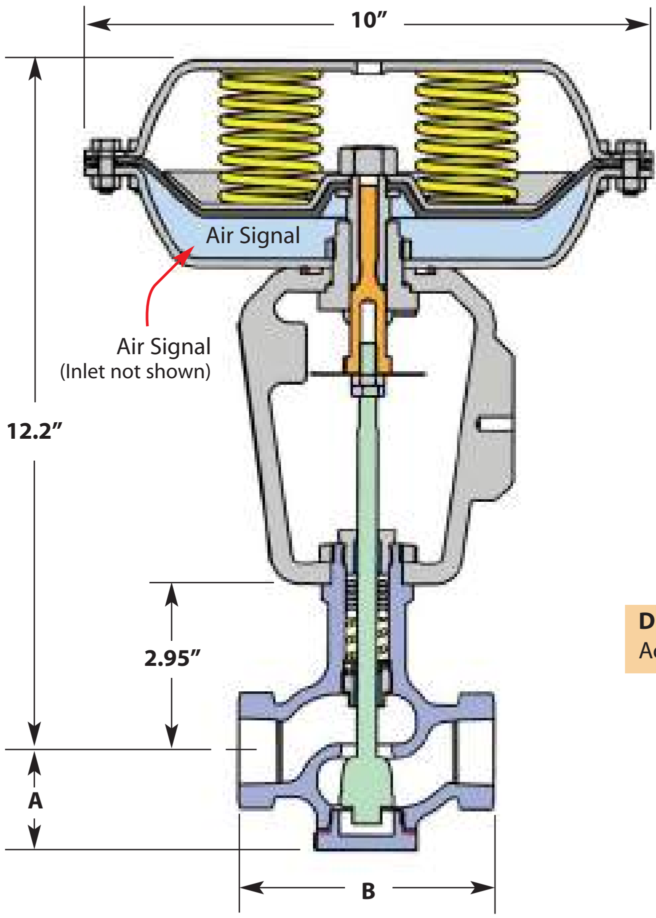


150# FLG or 300# FLG Available

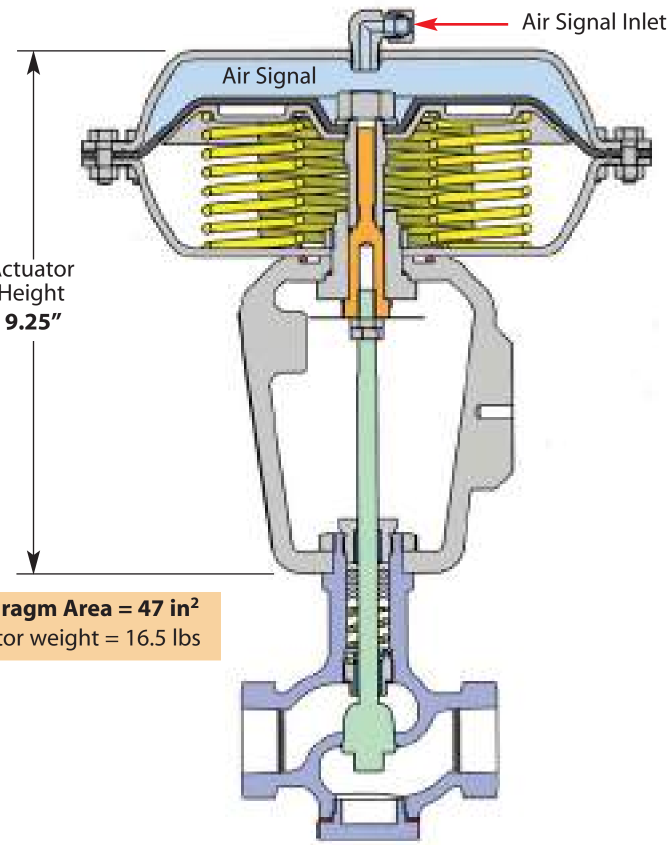
Technical Information	
Plug Design	Contoured
Flow Characteristics	Equal Percentage
Leakage Rating	ANSI/FCI 70-2 Class IV
Rangeability	50:1
Travel	3/4"
Actuator Area	47 sq. in.
Body Design Rating	Class 300
Primary Stem Seals	PTFE Live-Loaded V-Ring
Diaphragm Design	Semi-Rolling
Design	Multi-Spring Diaphragm
Action (field-reversible)	Air-to-Open Air-to-Close
Positioner Mounting	IEC 60534-6-1 (NAMUR)
Stem Wiper	O-Ring

HB Series Control Valve with Pneumatic Actuator

Air-to-Close
(Normally Open)



Air-to-Open
(Normally Closed)



Diaphragm Area = 47 in²
Actuator weight = 16.5 lbs

HB Control Valve Selection

Model HB	Size Connection (NPT)	C_V Full Port	C_V Reduced Port	Close-Off Pressure (PSI△P) No Positioner	Close-Off Pressure (PSI△P) Positioner	A	NPT B	FLG #150 B	FLG #300 B	Approximate Weight
Air-To-CLOSE (Normally OPEN)										
HB-12-N-ATC	1/2"	5.0	3.5	300	300	1.76	4.5	7.25	7.75	22 lbs [10 kg]
HB-13-N-ATC	3/4"	6.5	3.5	300	300	1.76	4.5	7.25	7.75	22 lbs [10 kg]
HB-14-N-ATC	1"	10	7	300	300	1.74	4.5	7.25	7.75	24 lbs [11 kg]
HB-16-N-ATC	1 1/2"	22	17.5	230	300	2.15	5.0	8.75	9.25	26 lbs [12 kg]
HB-17-N-ATC	2"	42	32	120	300	2.31	6.0	10	10.5	29 lbs [13 kg]
Air-To-OPEN (Normally CLOSED)										
HB-12-N-ATO	1/2"	5.0	3.5	300	300	1.76	4.5	7.25	7.75	22 lbs [10 kg]
HB-13-N-ATO	3/4"	6.5	3.5	300	300	1.76	4.5	7.25	7.75	22 lbs [10 kg]
HB-14-N-ATO	1"	10	7	300	300	1.74	4.5	7.25	7.75	24 lbs [11 kg]
HB-16-N-ATO	1 1/2"	22	17.5	170	225	2.15	5.0	8.75	9.25	26 lbs [12 kg]
HB-17-N-ATO	2"	42	32	85	135	2.31	6.0	10	10.5	29 lbs [13 kg]

Model Code Configuration Chart

Models		Code	Size	Code	Connection Type	Actuator	
HB	Full Port	**12**	1/2"	**N**	NPT	**ATC**	Air-to-Close
HBR	Reduced Port	**13**	3/4"	**F150**	150# FLG	**ATO**	Air-to-Open
		14	1"	**F300**	300# FLG		
		16	1 1/2"				
		17	2"				

HB Series Control Valve with Pneumatic Actuator

Type 2000 Valve Positioner

(Pneumatic or Electro-Pneumatic)

Type 2000 Valve Positioners (Pneumatic and Electro-Pneumatic) are mechanical devices designed to provide enhanced control, stability, and shut-off capability in extreme flow applications. The positioner, which is mounted to the valve's yoke assembly and linked to the valve stem, receives a signal from an external control source, compares the control signal to the actual position of the valve plug, and then sends a corrected signal to the valve's actuator, thereby positioning the valve plug for optimum flow modulation.

Type-2000	Pneumatic	Electro-Pneumatic
Input Signal	3-15 PSI	4-20 mA
Supply Pressure	145 PSI maximum	21.8 - 145 PSI
Linearity Error	0.7 % full span	<1.0% of full span
Hysteresis	0.4 % full span	<0.6% of full span
Repeatability	0.3 % full span	<0.5% of full span
Pressure Gain	750 P-out/P-in	750 P-out/P-in
Flow Capacity	SCFM	SCFM
@20 PSI	9.5	9.5
@87 PSI	28.3	28.3
@145 PSI	47.1	47.1
Air Consumption	SCFM	SCFM
@20 PSI	0.18	0.2
@87 PSI	0.53	0.6
@145 PSI	0.88	1.0
Impedance		260 Ohms at 70° F
Loop Load		5.2 Volts at 70° F
Port Size	1/4" NPT; Gauge Ports 1/8" NPT	1/2" NPT
Temperature Range	-40° F – 185° F	
Media	Oil-free Instrument Air Filtered to 40 micron	
Enclosure	NEMA 4X	

Type 2000 Valve Positioner

(Pneumatic or Electro-Pneumatic)

Valve Positioner Model Code Configuration

Example Model : **CA2000L1C3N**

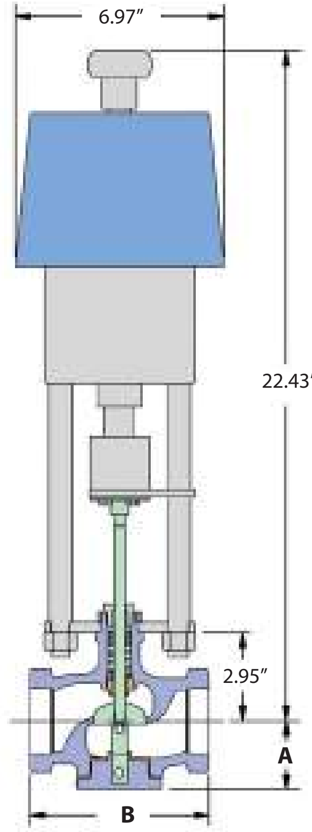
Model	Postioner Type	Indicator	Code
CA2000L1C3	Pneumatic	None (Standard Linear)	**N**
CA2010L1C3	Electro-Pneumatic	Dome (Option)	**D**
CA2020L1C3	Explosion-Proof		

HB Series Control Valve with Electric Actuator

The **HB Series Control Valve** with **Electric Actuator** is a robust, user-friendly alternative to the standard pneumatic actuator on the HB Series Control Valve. With fast and precise movement, this actuator is designed to handle a broad range of applications including instantaneous and semi-instantaneous water heaters. Ideal for installations where pneumatic lines are not present or are prohibitive.

WMEA Electric Actuator Specifications			
Power Supply	115VAC	24VAC	24VDC
Nominal Current (A)	0.66	3.15	2
Max Current (A)	0.86	4.1	2.6
Max Power Consumption (W)	57	53	48
Force	1,100 lbs		
Stem Velocity	0.088 - 0.177 in/sec		
Nominal 3/4" Travel Time	6 - 8 sec		
Duty Cycle, IEC 60034-1,8	S2 30min S4 50% ED @ 77°F		
Ambient Temperature	-4 to 140°F		
Shut-off Pressure (1/2" to 2" HB)	300 psig		
Actuator Weight	17.6 lbs		

HB Series Control Valve
(with Electric Actuator)



(For valve dimensions refer to HB Selection Chart)

CONTROL VALVES

Features and Benefits

- **Fast Response:** These actuators are respond extremely fast and will fully open or close the HB Control Valve in approximately 6 seconds making them ideal for instantaneous and semi-instantaneous water heaters. Typical signal response time is 2-3 seconds.
- **Fail-Safe Mode:** Super capacitors are used to drive the valve fully-closed or open in the event of power loss to the actuator. This replaces common back-ups such as springs with limited thrust or batteries with a limited life span.
- **High Stem Thrust:** Allows close-off of all HB valves sizes against the full rating of 300 psig.
- **Integral Positioner:** Accepts 4/0-20mA or 2/0-10 VDC control signals, eliminating the need for a separate I/P transducer.
- **Field-Configurable:** Using a PC, the actuator can be field-configured for minimum closing position, maximum opening position, fail-open, fail-close or stay-put failure mode in the event of power loss.

Options & Associated Control Loop Accessories

- USB Kit for parameter customization
- PID Electronic Controllers (TR890 Series)
- Thermocouples
- RTD's
- Pressure Transmitters

Additional Technical Information	
Motor Protection	Electric motor current monitoring with safety cut-off
Set Value Feedback	4/0-20mA or 2/0-10 VDC selectable, split range operation
Valve Positioner Function	Integrated positioner, deadband adjustable from 0.5 to 5%, shutoff min
Automatic Start-up	Recognizing the end position(s) and auto-scaling set and feedback values
Internal Fault Monitoring	Torque, set value, temperature, power supply, positioning deviation, etc
Diagnostic Function	Stores accumulated operation data (motor & total run time, number of starts) and data sets of current values (set value, feedback value, torque, temp, and error messages
Communication Interface	USB interface with Software - enables parameter adjustments
Cable Glands	2x M20x1.5 & 1x M16x1.5

Model Code Configuration Chart

Models		Code	Size	Code	Connection Type	Actuator		Power	
HB	Full Port	**12**	1/2"	**N**	NPT	**EFC**	Fail-Closed	**24V**	24VAC/DC
HBR	Reduced Port	**13**	3/4"	**F150**	150# FLG	**EFO**	Fail-Open	**115V**	115VAC
		14	1"	**F300**	300# FLG				
		16	1 1/2"						
		17	2"						

for MIXING & DIVERTING • Water & Other Liquids

Models	**W910TB**
Service	**Water, Other Liquids**
Sizes	**1/2", 3/4", 1", 1 1/4", 1 1/2", 2", 2 1/2", 3", 4"**
Connections	**Union Ends, 125# Flanged 250# Flanged (optional)**
Body Material	**1/2" – 2" Bronze 2 1/2" – 4" Cast Iron**
Seat Material	**Stainless Steel**
Max Inlet Pressure	**250 PSIG**

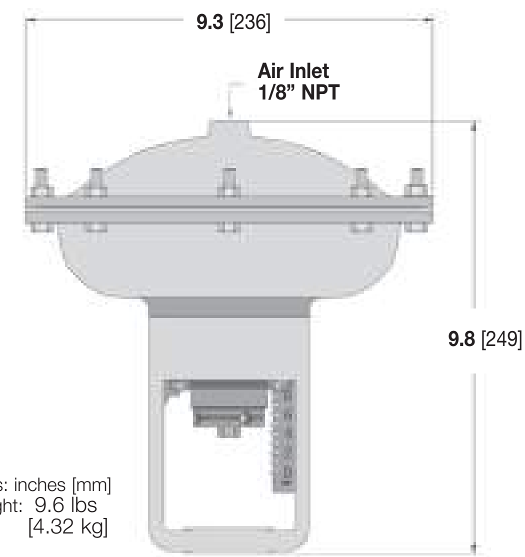
NOT FOR USE WITH STEAM

DESIGN PRESSURE/TEMPERATURE RATING – PMA/TMA		
Union Ends	250 PSIG	@ 450˚F
125# FLG	125 PSIG	@ 450˚F

Typical Applications

W910TB 3-way Pneumatically-Actuated control valve can be used for mixing or diverting and are actuated by a 3-15 PSIG instrument air signal placed to the top of the actuator housing that will modulate the position of the valve.

3-way valves are used for mixing two flows together, or for diverting a flow to or around a device (bypass). In order to produce a consistent flow quantity for stable operation, the pressure drop across both flow paths (inlet to outlet) must be nearly equal. The sleeve type design is constructed with an O-ring around the sleeve. The O-ring is suitable for water or glycol type service, up to a maximum of 300˚F. A higher temperature O-ring for use with other fluids, such as oil or for temperatures up to 410˚F, is available. Consult factory.



Units: inches [mm]
Weight: 9.6 lbs
[4.32 kg]

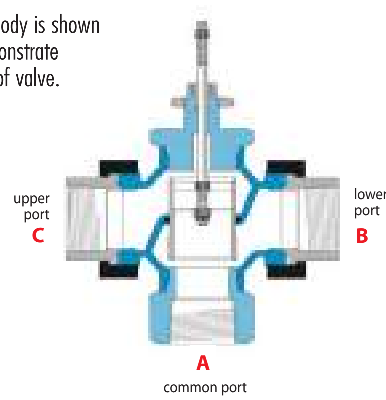
Principle of Operation

A control valve is comprised of an actuator mounted to a valve. The valve modulates flow through movement of a valve plug in relation to the port(s) located within the valve body. The valve plug is attached to a valve stem, which, in turn, is connected to the actuator. The pneumatic actuator directs the movement of the stem as dictated by the external control device.

W910TB Actuator Specifications	
Actuator Housing	Die cast aluminum, epoxy powder coated blue finish.
Setting Scale	Integral to housing
Adjustment Screw	Brass
Spring	Cadmium plated
Pressure Plate	Aluminum
Diaphragm	Nylon reinforced EPDM
Air Pressure to Diaphragm	30 PSIG maximum
Air Connection	1/8 " NPT Female
Operating Temperature	Ambient:-40°F (-40°C) to 180°F (82°C) Process Flow:-40°F (-40°C) to 410°F (210°C)

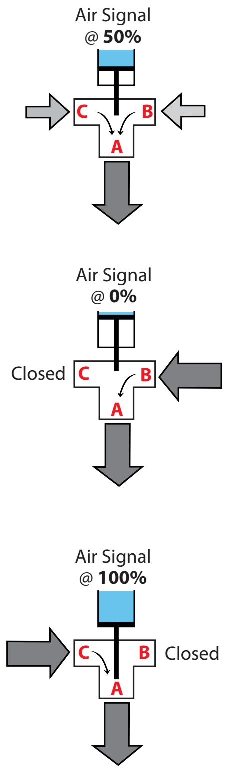
3-WAY VALVE • Bronze - NPT

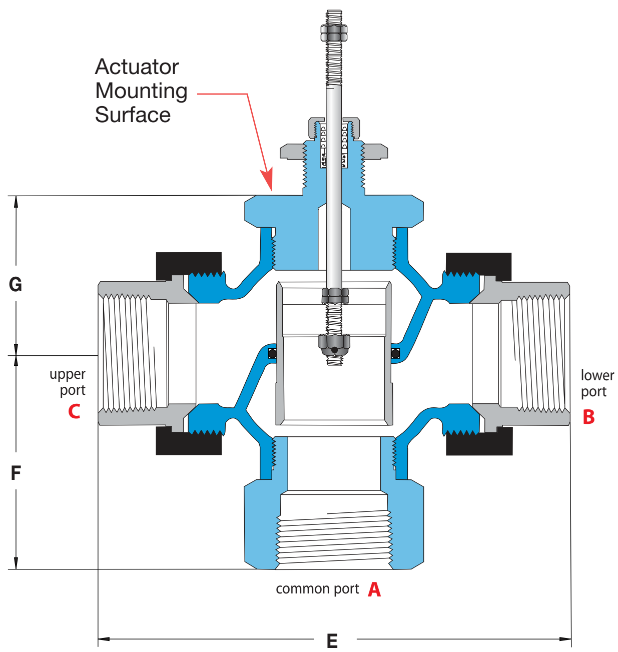
Valve Body is shown to demonstrate action of valve.



for Mixing or Diverting

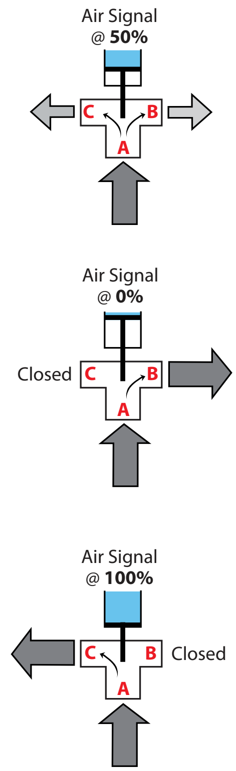
MIXING
FLOW DIAGRAM





1/2" - 2"
NPT/Union

DIVERTING
FLOW DIAGRAM



CAUTION: 3-Way Valves are not designed for use in steam applications.

To properly control the mixing of two flows, inlet pressures at ports B and C should be as equal as possible.

Specifications

Body Material	Trim Material	Trim Style	Connection	Pressure & Temperature Rating
Bronze	Bronze	Modified Linear	NPT with Malleable Iron Union Ends	250 PSIG @ 300°F (149°C)

Valve Body Selection

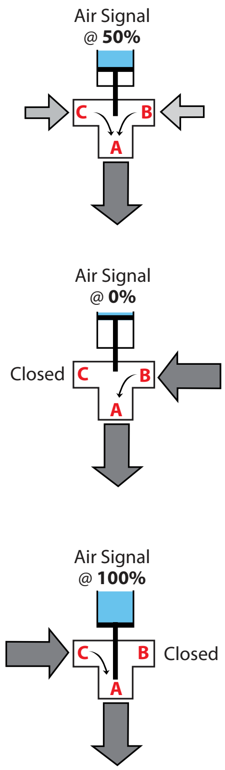
Mixing or Diverting

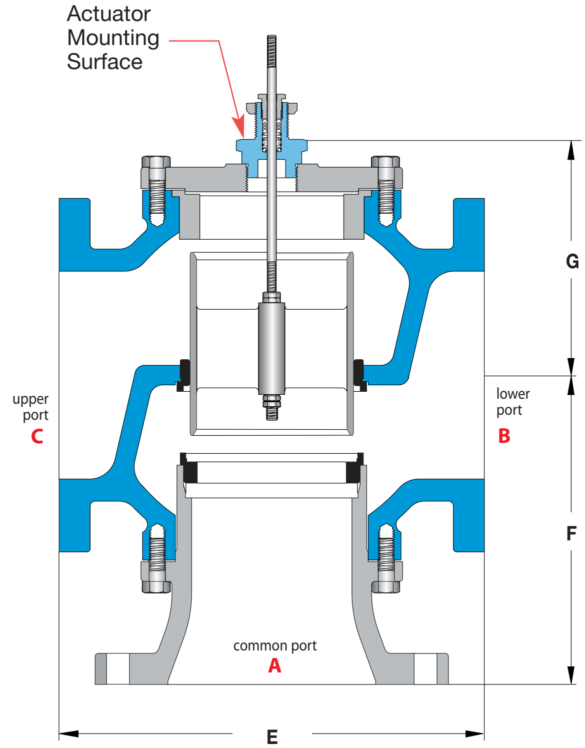
Valve Body Number	Actuator & Valve Model #	Size (NPT)	C_V	Maximum Close-Off Pressure (PSI△P)	Dimensions E	Dimensions F	Dimensions G	Approximate Shipping Wt.
A18	W910TB-A18	1/2"	2.8	250	4.8 [122]	1.8 [46]	1.8 [46]	13 lbs [5.9 kg]
A25	W910TB-A25	3/4"	5.6	250	5.6 [142]	2.3 [58]	2.3 [58]	15 lbs [6.8 kg]
A34	W910TB-A34	1"	8.4	250	6.0 [152]	2.3 [58]	2.3 [58]	16 lbs [7.2 kg]
A45	W910TB-A45	1 1/4"	15	250	7.2 [183]	2.8 [71]	2.6 [66]	19 lbs [8.6 kg]
A56	W910TB-A56	1 1/2"	21	250	7.7 [196]	3.5 [89]	2.6 [66]	21 lbs [9.5 kg]
A67	W910TB-A67	2"	33	250	8.6 [218]	4.1 [104]	3.1 [79]	26 lbs [11.8 kg]

All dimensions are inches [mm].

for Mixing or Diverting

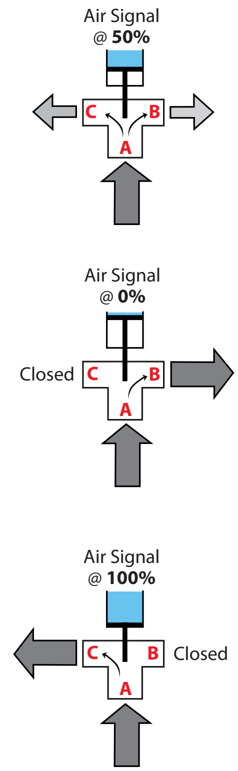
MIXING
FLOW DIAGRAM





2 1/2" - 4"
Flanged

DIVERTING
FLOW DIAGRAM



CAUTION: 3-Way Valves are not designed for use in steam applications.
To properly control the mixing of two flows, inlet pressures at ports B and C should be as equal as possible.

Specifications

Body Material	Trim Material	Trim Style	Connection	Pressure & Temperature Rating
Cast Iron	Bronze	Modified Linear	125# Flanged	125 PSIG @ 300°F (149°C)

Valve Body Selection

Mixing or Diverting

Valve Body Number	Actuator & Valve Model #	Size (FLG)	C_V	Maximum Close-Off Pressure (PSI△P)	Dimensions E	Dimensions F	Dimensions G	Approximate Shipping Wt.
B75	W910TB-B75	2 1/2"	58	125	9.0 [229]	7.1 [180]	5.2 [132]	62 lbs [28 kg]
B80	W910TB-B80	3"	72	125	10.0 [254]	8.0 [203]	6.0 [152]	80 lbs [36 kg]
B85	W910TB-B85	4"	102	125	13.0 [330]	10.0 [254]	6.9 [175]	140 lbs [64 kg]

All dimensions are inches [mm].

Capacity Charts

CAPACITIES – Steam *(lbs/hr)*

Inlet Pressure (PSIG)	Outlet Pressure (PSIG)	ΔP PSI	Reduced Port 1/2"	1/2"	3/4"	1"	1 1/2"	2"
C_V Factors			3.5	5.0	6.5	10	22	42
Orifice Size (in)			0.88	0.88	0.88	0.88	1.25	1.75
5	4	1	48	68	89	136	300	573
	0	5	96	137	178	274	602	1149
	-4	9	114	162	211	325	714	1363
	-8	**13**	**119**	**170**	**220**	**339**	**746**	**1424**
10	9	1	53	76	99	153	336	641
	5	5	110	156	203	313	689	1315
	0	10	138	197	255	393	865	1651
	-7	**17**	**148**	**211**	**274**	**422**	**929**	**1773**
15	10	5	122	174	226	348	765	1460
	5	10	156	223	290	447	983	1876
	0	15	172	246	320	492	1082	2066
	-5	**20**	**177**	**252**	**328**	**505**	**1110**	**2119**
20	15	5	133	189	246	379	833	1591
	10	10	173	247	321	494	1088	2076
	5	15	194	277	361	555	1221	2330
	-3	**23**	**205**	**293**	**381**	**587**	**1291**	**2464**
30	25	5	152	217	282	434	955	1822
	15	15	232	331	431	663	1459	2785
	5	25	260	371	482	742	1631	3115
	0	**30**	**262**	**375**	**487**	**750**	**1649**	**3149**
50	40	10	250	357	464	714	1570	2997
	30	20	324	463	601	925	2035	3886
	15	35	370	529	687	1057	2326	4440
	7	**43**	**376**	**537**	**697**	**1073**	**2361**	**4507**
80	70	10	307	438	570	877	1929	3682
	50	30	472	675	877	1350	2970	5670
	30	50	534	763	992	1525	3356	6407
	17	**63**	**544**	**777**	**1010**	**1554**	**3418**	**6526**
100	85	15	406	580	754	1160	2552	4872
	60	40	586	837	1089	1675	3684	7034
	40	60	643	918	1193	1836	4039	7710
	23	**77**	**655**	**936**	**1217**	**1872**	**4119**	**7864**
125	110	15	452	645	839	1290	2838	5418
	85	40	668	954	1240	1908	4199	8015
	50	75	782	1117	1452	2233	4913	9380
	31	**94**	**794**	**1135**	**1475**	**2270**	**4993**	**9532**
150	130	20	560	800	1040	1600	3519	6718
	100	50	800	1143	1485	2285	5027	9598
	70	80	904	1291	1678	2582	5680	10844
	40	**110**	**933**	**1333**	**1733**	**2666**	**5865**	**11196**
175	150	25	666	952	1237	1903	4187	7994
	115	60	931	1329	1728	2659	5850	11167
	75	100	1052	1503	1953	3005	6612	12622
	48	**127**	**1072**	**1531**	**1990**	**3062**	**6736**	**12859**
200	175	25	713	1018	1324	2037	4481	8554
	130	70	1061	1515	1970	3031	6668	12730
	90	110	1183	1690	2196	3379	7434	14192
	56	**144**	**1210**	**1729**	**2247**	**3457**	**7606**	**14521**
250	225	25	798	1140	1482	2281	5017	9578
	170	80	1273	1819	2364	3637	8002	15276
	120	130	1443	2062	2680	4124	9072	17319
	73	**177**	**1487**	**2125**	**2762**	**4249**	**9348**	**17846**
300	270	30	951	1359	1766	2718	5979	11414
	200	100	1535	2193	2850	4385	9648	18418
	140	160	1723	2461	3199	4922	10828	20672
	89	**211**	**1765**	**2521**	**3277**	**5042**	**11093**	**21177**

Note: The Steam Capacity Chart is based on ISA Standard 75.01.01-2007 (60534-2-1 Mod).
It assumes pipe sizes equal to the size of the valve ports, with no attached fittings.

CAPACITIES – Water *(GPM)*

Inlet Pressure (PSIG)	Outlet Pressure (PSIG)	ΔP PSI	Reduced Port 1/2"	1/2"	3/4"	1"	1 1/2"	2"
C_V Factors			3.5	5.0	6.5	10	22	42
Orifice Size (in)			0.88	0.88	0.88	0.88	1.25	1.75
5	4	1	3.5	5.0	6.5	10	22	42
	0	5	7.8	11	15	22	49	94
10	7	3	6.1	8.7	11	17	38	73
	5	5	7.8	11	15	22	49	94
	0	10	11	16	21	32	70	133
15	10	5	7.8	11	15	22	49	94
	5	10	11	16	21	32	70	133
	0	15	14	20	26	39	86	165
30	25	5	7.8	11	15	22	49	94
	15	15	14	19	25	39	85	163
	7	23	17	24	31	48	106	203
50	40	10	11	16	21	32	70	133
	30	20	16	22	29	45	98	188
	16	34	20	29	38	58	128	244
80	70	10	11	16	21	32	70	133
	50	30	19	27	36	55	120	230
	30	50	25	35	46	70	155	296
100	85	15	14	19	25	39	85	163
	65	35	21	30	38	59	130	248
	40	60	27	39	50	78	171	326
125	110	15	14	19	25	39	85	163
	85	40	22	32	41	63	139	266
	52	73	30	43	56	86	188	360
150	130	20	16	22	29	45	98	188
	100	50	25	35	46	71	156	297
	63	87	33	47	60	93	205	391
200	175	25	18	25	33	50	110	210
	130	70	29	42	54	84	184	351
	87	113	37	53	69	106	234	446
250	225	25	18	25	33	50	110	210
	170	80	31	45	58	89	197	376
	111	139	41	59	77	118	260	495
300	270	30	19	27	36	55	120	230
	200	100	35	50	65	100	220	420
	134	166	45	64	84	129	283	540

Note: 1) Capacities based on 70°F water (SG = 1.00).
2) Capacities based on 100% of Cv.

W910TB • 3-Way Valve Body

Capacity Chart

for MIXING & DIVERTING • Water & Other Liquids

W910TB Mixing & Diverting (3-Way Valves)

CAPACITIES – Water *(GPM)* **3-WAY VALVES**

Inlet pressures should be within 5% of each other. Specify if service is for other than water.

Pressure Drop (PSI△P)	Size, Body Number & Coefficient (Cv) 1/2" A18 Cv = 2.8	3/4" A25 Cv = 5.6	1" A34 Cv = 8.4	$1^1/4$" A45 Cv = 15	$1^1/2$" A56 Cv = 21	2" A67 Cv = 33	$2^1/2$" B75 Cv = 58	3" B80 Cv = 72	4" B85 Cv = 102
1	2.8	5.6	8.4	15	21	33	58	72	102
3	4.8	10	15	26	36	57	100	125	177
5	6.3	13	19	34	47	74	130	161	228
10	8.9	18	27	47	66	104	183	228	323
15	11	22	33	58	81	128	225	279	395
20	13	25	38	67	94	148	259	322	456
25	14	28	42	75	105	165	290	360	510
30	15	31	46	82	115	181	318	394	559
40	18	35	53	95	133	209	367	455	645
50	20	40	59	106	148	233	410	509	721
60	22	43	65	116	163	256	449	558	790
70	23	47	70	125	176	276	485	602	853
80	25	50	75	134	188	295	519	644	912
90	27	53	80	142	199	313	550	683	968
100	28	56	84	150	210	330	580	720	1020
125	31	63	94	168	235	369	648	805	1140
150	34	69	103	184	257	404			
175	37	74	111	198	278	437			
200	40	79	119	212	297	467			
225	42	84	126	225	315	495			
250	44	89	133	237	332	522			

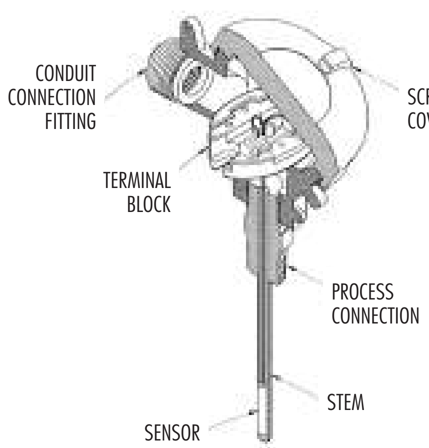
Note: Oil service or high temperature service requires special O-ring.

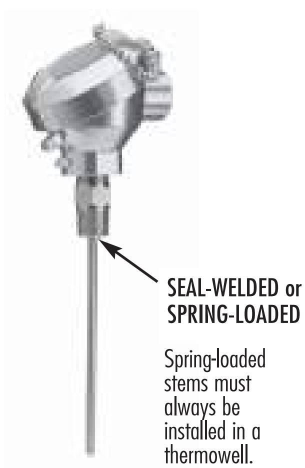
CONTROL VALVES

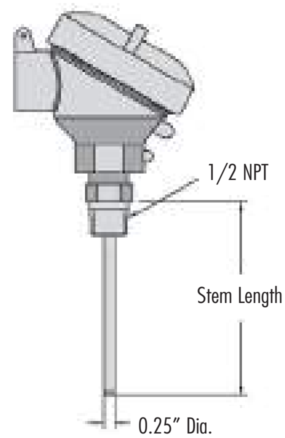
Understanding a Control Loop

Sensor for Temperature Control (Thermocouple or RTD)

Electronic Temperature Sensors are available with both Type J and Type K Thermocouples, as well as RTD sensors. A thermocouple (T/C) is made from two dissimilar metals that generate electrical voltage directly with changes in temperature. An RTD (Resistance Temperature Detector) is a variable resistor that will change its electrical resistance in direct proportion to changes in temperature in a precise, repeatable and nearly linear manner. The weatherproof head provides a conduit connection and can be used to house a transmitter (optional). The stem is either welded directly to the 1/2" NPT threaded connection, or is spring-loaded.







Stem (Sheath)

All Thermocouples and RTDs are furnished with a 316 stainless steel stem, with the internal wiring packed in powdered ceramic. The screw head cover style is available in two stem types: welded and spring loaded. The welded stem is suitable for use in liquid applications. The spring-loaded stem is designed to bottom out inside a thermowell, providing maximum heat sensitivity. Spring-loaded stems are not pressure tight and may allow process media to escape; therefore, they must always be installed in a thermowell.

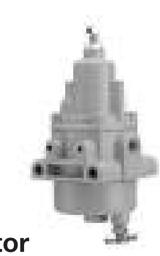
The insertion length (U) of a thermocouple or RTD represents its depth into the process vessel or thermowell. Thermocouples and RTDs are available in standard U-lengths from 2" to 24". Other lengths are available upon special order; consult factory.

TR890
Series Controller

The user-interface which allows adjustment of the set point and controls the electrical signals received from the sensor and outputted to the I/P Transducer. The TR893 is the most common controller model due to its larger, more user-friendly size.

TA901
Electropneumatic (I/P) Transducer

An electro-pneumatic transducer that converts an electrical signal (4-20 mA) from the Controller to an air signal (3-15 PSI) for supply to the top of the actuator of the control valve.



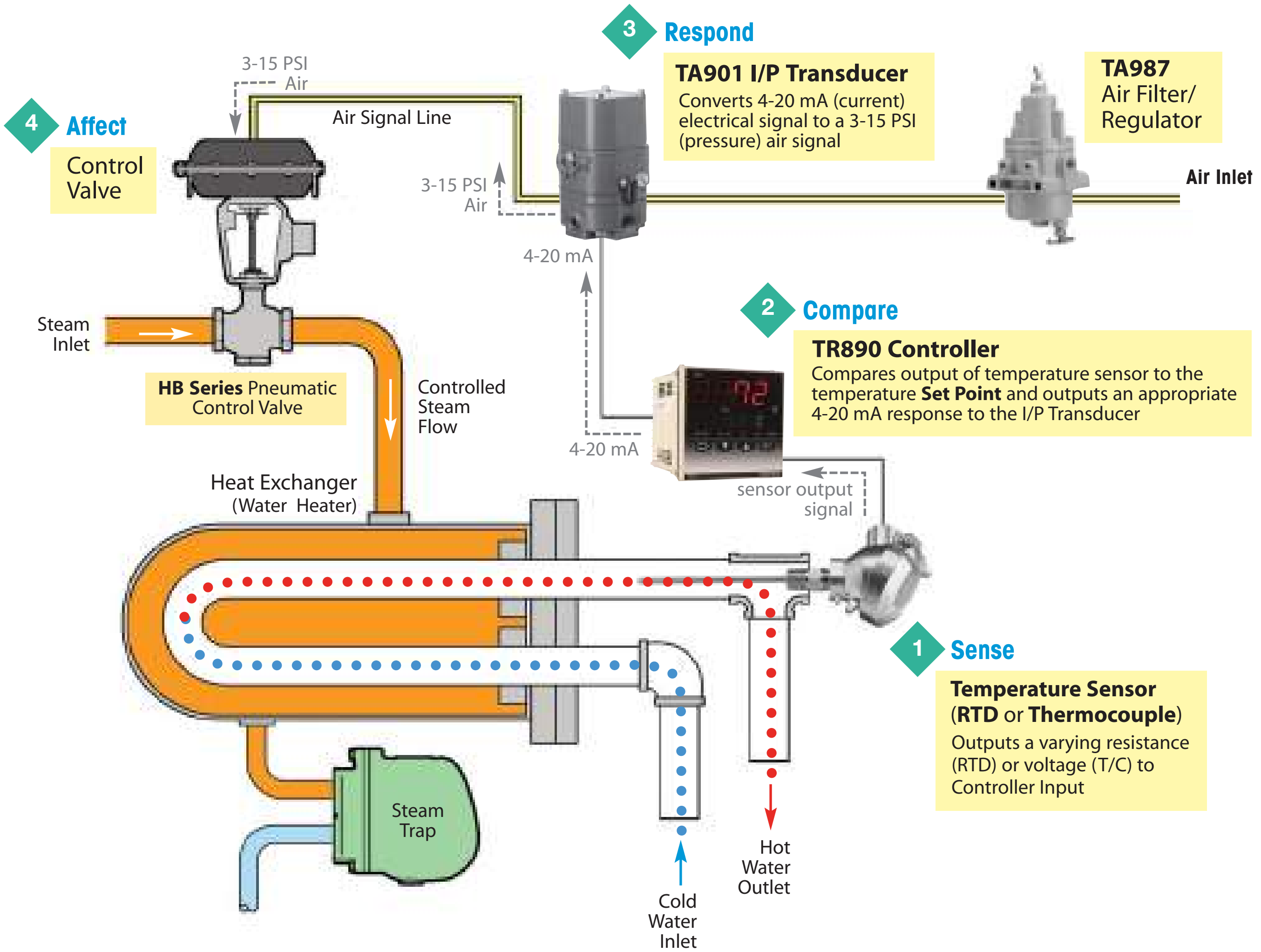
TA987
Air Filter/Regulator

This device is recommended for filtering and regulating the pressure of plant compressed air to the inlet of the I/P Transducer, which ensures the delivery of clean, dry air at the proper pressure to the pneumatic actuator.

Introduction

Understanding a Control Loop

Heat Exchanger (Instantaneous Water Heater)



Control Loop

A control loop is a process management system designed to maintain a process variable at a desired set point. Each step in the loop works in conjunction with the others to manage the system. Once the set point has been established, the control loop operates using a four-step process.

1. **Sense**
Measure the current condition of the process using a sensor, which can be a thermocouple or RTD transmitter.

2. **Compare**
Evaluate the measurement of the current condition against the set point using an electronic PID controller.

3. **Respond**
Reacts to any error that may exist between the measured temperature value and the temperature set point by generating a corrective pneumatic signal.

4. **Affect**
Actuate the control valve that will produce a change in the process variable.

The loop continually cycles through the steps, affecting the process variable (water temperature) in order to maintain the desired temperature set point.

CONTROL VALVES

Design and Operation of an Electronic PID Controller

Description

A controller is a comparative device that receives an input signal from a measured process variable, compares this value with that of a predetermined control point value (set point), and determines the appropriate amount of output signal required by the final control element to provide corrective action within a control loop.

Principle of Operation (Electronic PID Controller)

An electronic sensor (thermocouple, RTD or transmitter) installed at the measurement location continuously sends an input signal to the controller. At set intervals, the controller compares this signal to a predefined set point. If the input signal deviates from the set point, the controller sends a corrective electric output signal to the control element. This electric signal must be converted to a pneumatic signal when used with an air operated valve, such as a Watson McDaniel HB Series Control Valve. The conversion can be made using a Watson McDaniel TA901 I/P Transducer, which converts a 4 to 20 mA electric signal to a 3 to 15 PSI air signal. As an option, a Valve Positioner such as the Watson McDaniel CA2000 may be used to send an air signal to the Control Valve. These Positioners can be controlled with a 3-15 psi air signal from a Pneumatic Controller or a 4-20 mA signal from a PID Controller.

Features (Electronic PID Controller)

Watson McDaniel Electronic Controllers have full auto-tuning and PID capabilities, and offer a host of available options, including user selectable inputs, outputs and ranges.

PID Control is a feature of Watson McDaniel TR890 Electronic Controllers. PID combines the proportional, integral and derivative functions into a single unit.

- **Proportional (P) —** Proportional control reacts to the size of the deviation from set point when sending a corrective signal. The size of the corrective signal can be adjusted in relation to the size of the error by changing the width of the proportional band. A narrow proportional band will cause a large corrective action in relation to a given amount of error, while a wider proportional band will a cause smaller corrective action in relation to the same amount of error.

- **Integral (I) —** Integral control reacts to the length of time that the deviation from set point exists when sending a corrective signal. The longer the error exists, the greater the corrective signal.

- **Derivative (D) —** Derivative control reacts to the speed in which the deviation is changing. The corrective signal will be proportional to the rate of change within the process.

Auto-Tuning will automatically select the optimum values for **P**, **I** and **D**, thus eliminating the need for the user to calculate and program these values at system startup. This feature can be overridden when so desired. On some models, the control element can be manually operated.

Selecting an Electronic PID Controller

When selecting a PID controller, the following parameters must be specified. (Refer to the TR890 Series Electronic PID Controller Specifications and Model Coding chart on the following two pages.)

1) Model (Case Size)

The Case Size selection is determined by both available and designed space, and controller features. Watson McDaniel Electronic Controllers are available in the following panel sizes:

TR891: 48 x 48 mm (1/16 DIN)
TR892: 72 x 72 mm
TR893: 96 x 96 mm (1/4 DIN)
TR894: 96 (H) x 48 (W) mm (1/8 DIN)

2) Input

The Input is the measurement signal received by the controller from the sensor. One of the following three input types can be specified for the controller: **8**: Universal, **4**: Current or **6**: Voltage. The Universal input type is switchable between Thermocouple, RTD and mV input signals.

If temperature will be measured with a thermocouple or RTD sensor, the **Universal** input type must be selected for the controller (Model Code **Position 2 = 8**). If another process variable such as PRESSURE is being measured, verify the type of output signal from that sensor. If it's 4-20 mA or 0-10 Volts then the Current or Voltage input option would be chosen, respectively.

3) Control Output

The Control Output is the corrective signal transmitted from the controller to the control device. One of the following four control output types can be specified for the controller: **I**: 4-20 mA DC, **Y**: On/Off Contact, **P**: Solid State Relay (SSR) Driver or **V**: 0-10 VDC.

The most common control devices are the TA901 Electro-pneumatic (I/P) Transducer and CA2000-Series Valve Positioner with built-in I/P transducer, both of which accept a 4-20 mA signal. For these devices, the 4-20 mA control output type must be selected for the controller (Model Code **Position 3 = I**). The TA901 or CA2000-Series output an air signal to the actuator of the Control Valve, which is the final control element of the feedback loop.

The On/Off Contact and SSR Driver control output types are typically used to switch on AC power to a load. If the SSR Driver control output is selected, an external solid state relay (SSR) is required and can be used for activating electrical equipment with larger current requirements.

4) Power Supply

The power supply requirement for the electronic controller must be specified. The available choices are:
100-240 VAC, 50/60 Hz or 24 V AC/DC, 50/60Hz.

5) Event Output (Option)

The Event Output is used to signal an external device when an alarm condition is detected. Various alarm types can be detected by the controller. These include deviation of the measured value from the set value, the measured value exceeding absolute limits (i.e., high and low level alarm) and heater break/loop alarm (i.e., heater current outside of normal limits). If selected as an option, the controller will have two Event Outputs. In the case of a high/low alarm, one output is used for the high level alarm and the other for the low level alarm.

6) Options: Analog Output & Digital Input

The Analog Output is an optional secondary signal that transmits either the measured process value (PV), the target set value (SV) or the Control Output value from the controller to a remote data acquisition device, such as a recorder, personal computer or display unit. One of the following three analog output types can be specified for the controller: 0-10 mV DC, 4-20 mA DC or 0-10 V DC. The analog output type is independent of the measured input type or the control output type. However, the analog output type selection must be compatible with the data acquisition device input.

The Digital Input is an optional input that can be specified for the controller. The digital input functions as an On/Off switch and can be programmed to activate the Set Value Bias or Standby mode, or switch the Control Action type (i.e., to Reverse Acting or Direct Acting).

Note: The Analog Output and Digital Input combination is not available for Model TR891. Only one of these options can be selected for this model.

TR890 Series

Features PID & Auto-tuning

- Multiple Sizes
- ± 0.3% Accuracy
- Keyboard Programmable
- Reverse or Direct Acting
- Manual Output Override

The **TR890 Series** Electronic PID Controller is designed for use on applications where large load changes are expected, or extreme accuracy and fast response times are needed. With full auto-tune capabilities and a large selection of available inputs, the TR890 Series is ideally suited for use with a Watson McDaniel Control Valve.

Use of a Watson McDaniel No. TA987 Air Filter/Regulator is recommended for filtering and regulating the pressure of plant compressed air, and for delivering clean, dry air at the proper pressure to pneumatic control devices.

Approximate Shipping Weights:
TR891: 0.4 lbs [0.17 kg]
TR892: 0.6 lbs [0.28 kg]
TR893: 0.7 lbs [0.33 kg]
TR894: 0.5 lbs [0.24 kg]

Specifications

Models	**TR891:** 48 x 48 mm (1/16 DIN) **TR892:** 72 x 72 mm **TR893:** 96 x 96 mm (1/4 DIN) **TR894:** 96 x 48 mm (1/8 DIN)
Control	**Control Mode:** Auto-Tuning PID **Action:** Reverse acting (field switchable to direct acting)
Proportional Band	Off, 0.1-999.9% Full Scale Integral Time: Off, 1-6000 sec. Derivative Time: Off, 1-3600 sec.
Accuracy	± 0.3%
Display	Process Value: 4 Digit, 20 mm red LED Set Value: 4 digit, 10.2 mm green LED Sampling Cycle: 0.25 seconds
Inputs	**Universal:** switchable between) ▸ Thermocouple: B, R, S, K, E, J, T, N, PL II, WRe5-26 (U,L (DIN 43710) ▸ RTD: Platinum 100 Ω, 3-Wire ▸ mV: (scalable) -10–10, 0-10, 0-20, 0-50, 10-50, 0-100 mV DC **Current:** (scalable) 4-20, 0-20 mA **Voltage:** -1–1, 0-1, 0-2, 0-5, 1-5, 0-10 VDC
Control Output	**Current:** 4-20 mA (load resistance: 600 Ω maximum) **Contact:** Proportional cycle, 1-120 sec. (capacity: 240 VAC 2 A resistive / 1.2 A inductive) **SSR Drive Voltage:** Proportional cycle 1-120 sec. (output rating: 12 ± 1.5 VDC / 30 mA maximum) **Voltage:** 0-10 VDC Load Current 2 mA max
Power Requirements	**Supply Voltage:** 100-240 VAC, 50/60 Hz **or** 24 VAC/VDC 50/60 Hz **Consumption:** 100-240 VAC, 15VA 24 VDC, 8W 24 VAC, 9VA
Data Storage	Nonvolatile EEPROM memory
Case Material	Polyphenylene Oxide (PPO)
Ambient Temp.	14°F (-10°C) to 122°F (50°C)
Humidity	Maximum: 90% RH, non-condensing

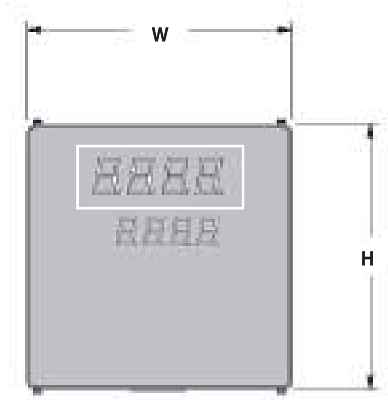
Event Outputs
(Contact Capacity: 240 VAC, 1 A/resistive load)
Dual Event Outputs (High and/or Low Alarms)
Single Event Output + Heater Break Alarm (includes CT30A sensor)
Single Event Output + Heater Break Alarm (includes CT50A sensor)

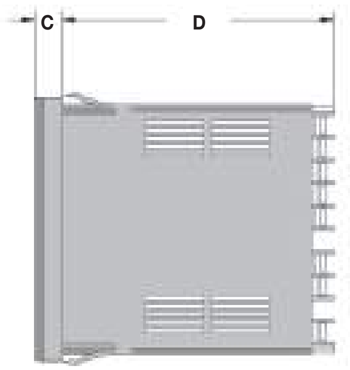
Options:

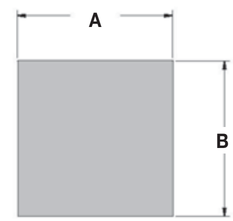
Analog Output: 0-10 mV DC (output resistance 10 Ω)
Analog Output: 4-20 mA DC (load resistance 300 Ω max)
Analog Output: 0-10 VDC (load current 2 mA max)

Digital Input (switch) including:
Set Value Bias setting range of -1999 - 5000, standby or DA/RA Selection
Operated by either non-voltage contact or open collector input rated at approx. 5V DC/1mA max.

Features PID & Auto-tuning







PANEL CUTOUT DIMENSIONS

HOW TO ORDER (Model Coding)

Sample Order Number: **TR893 8 I 90 1 00**

1	2	3	4	5	6
Model	**Input**	**Control Output**	**Power Supply**	**Event Output**	**Options**
TR891	**8** Universal	**I** 4-20 mA	**90** 100-240 VAC, 50/60 Hz	**0** None	**00** None
TR892	**4** mA	**Y** On/Off Contact	**08** 24 VAC/VDC, 50/60 Hz	**1** Dual Event (high and/or low)	**30** Analog Output (0-10 mVDC)
TR893	**6** VDC	**P** SSR Driver	Event Outputs 2 or 3 require Control Outputs Y or P	**2** Single Event (high or low) and heater break CT30A	**40** Analog Output (4-20 mA)
TR894		**V** 0-10 VDC		**3** Single Event (high or low) and heater break CT50A	**60** Analog Output (0-10 VDC)
					08 Digital Input (switch)
					38 Digital Input (switch) with 0-10 mVDC* Analog Output
					48 Digital Input (switch) with 4-20 mA* Analog Output
					68 Digital Input (switch) with 0-10 VDC* Analog Output

**Not available with Model TR891*

Electronic PID Controller Dimensions – units: inches [mm]

Model	A	B	C	D	H	W
TR891	1.77 [45]	1.77 [45]	0.43 [11]	3.94 [100]	1.89 [48]	1.89 [48]
TR892	2.68 [68]	2.68 [68]	0.43 [11]	3.94 [100]	2.83 [72]	2.83 [72]
TR893	3.63 [92]	3.63 [92]	0.43 [11]	3.94 [100]	3.78 [96]	3.78 [96]
TR894	1.77 [45]	3.63 [92]	0.43 [11]	3.94 [100]	3.78 [96]	1.89 [48]

Programmable Ranges

Thermocouple Inputs					RTD Inputs				Current & Voltage Inputs	
T/C Type	**Range Code**	**Fahrenheit Range**	**Range Code**	**Celsius Range**	**Range Code**	**Fahrenheit Range**	**Range Code**	**Celsius Range**	**Range Code**	**Range (User-scalable Readout)**
B*	**15**	0° to 3300°F	**01**	0° to 1800°C	**47**	-300° to 1100°F	**31**	-200° to 600°C	**71**	-10–10 mV
E	**21**	0° to 1300°F	**07**	0° to 700°C	**48**	-150.0° to 200.0°F	**32**	-100.0° to 100.0°C	**72**	0-10 mV
J	**22**	0° to 1100°F	**08**	0° to 600°C	**49**	-150° to 600°F	**33**	-100.0° to 300.0°C	**73**	0-20 mV
K	**18**	-150° to 750°F	**04**	-100.0° to 400.0°C	**50**	-50.0° to 120.0°F	**34**	-50.0° to 50.0°C	**74**	0-50 mV
K	**19**	0° to 1500°F	**05**	0° to 800°C	**51**	0.0° to 120.0°F	**35**	0.0° to 50.0°C	**75**	10-50 mV
K	**20**	0° to 2200°F	**06**	0° to 1200°C	**52**	0.0° to 200.0°F	**36**	0.0° to 100.0°C	**76**	0-100 mV
L	**28**	0° to 1100°F	**14**	0° to 600°C	**53**	0.0° to 400.0°F	**37**	0.0° to 200.0°C	**81**	-1–1 V
N	**24**	0° to 2300°F	**10**	0° to 1300°C	**54**	0° to 1000°F	**38**	0.0° to 500.0°C	**82**	0-1 V
PL II	**25**	0° to 2300°F	**11**	0° to 1300°C					**83**	0-2 V
R	**16**	0° to 3100°F	**02**	0° to 1700°C					**84**	0-5 V
S	**17**	0° to 3100°F	**03**	0° to 1700°C					**85**	1-5 V
T	**23**	-300° to 400°F	**09**	-199.9° to 200.0°C					**86**	0-10 V
U	**24**	-300° to 400°F	**13**	-199.9° to 200°C					**94**	0-20 mA
WRe5-26	**26**	0° to 4200°F	**12**	0° to 2300°C					**95**	4-20 mA

Range Codes are not required for ordering, but are used for field programming.
**750°F (400°C) falls below the accuracy range*

TA901

Electropneumatic

- 4 to 20 mA Input
- 3 to 15 PSI Output
- Intrinsically Safe
- Zero and Span Adjustments

The **TA901 Electropneumatic (I/P) Transducer** converts a milliamp current signal to a linearly proportional pneumatic output pressure. This transducer is designed for control applications that require a high degree of reliability and repeatability. The TA901 is used in the control operation of valve actuators and pneumatic valve positioners in the petrochemical, HVAC, energy management, textile, paper, and food & drug industries.

The TA901 I/P Transducer is tested and approved by Factory Mutual as Intrinsically Safe Class I, II and III, Division I, Groups C, D, E, F and G when installed in accordance with the Installation, Operation and Maintenance Instructions. It should be installed in a vertical position in a vibration-free area.

The Watson McDaniel TA987 Air Filter/Regulator is recommended for filtering and regulating the pressure of plant compressed air, and for delivering clean, dry air at the proper pressure to pneumatic control devices.

Specifications

Model
TA901

Input
4-20 mA

Output
1-17 PSIG Per ANSI/FCI 87-2 (can be calibrated to provide 1-9 PSIG or 9-17 PSIG)

Volume Booster
Built-in volume booster allows flow capacity up to 20 SCFM

Connections
Pneumatic: 1/4" NPT

Electric: 1/2" NPT

Air Requirements
Clean, oil-free, dry air filtered to 40 microns

Minimum Supply Pressure: 3 PSIG

Maximum Supply Pressure: 100 PSIG

Sensitivity: < ±0.1% of span per PSIG

Air Consumption: 0.03 SCFH typical

Flow Rate: 4.5 SCFM at 25 PSIG supply

Relief Capacity: 2.0 SCFM at 5 PSIG above 20 PSIG setpoint

Mounting
Pipe, panel or bracket in a vibration-free area. Field adjustment will be required if mounted in a nonvertical position.

Adjustment
Adjustable zero and span

Accuracy
Terminal Based Linearity: < ±0.75% of span

Repeatability: < 0.5% of span

Hysteresis: < 1.0% of span

Response Time: < 0.25 sec. @ 3-15 PSIG

Intrinsic Safety
Tested and approved by Factory Mutual as Intrinsically Safe Class I, II and III, Division I, Groups C, D, E, F and G when installed in accordance with Installation, Operation and Maintenance Instructions

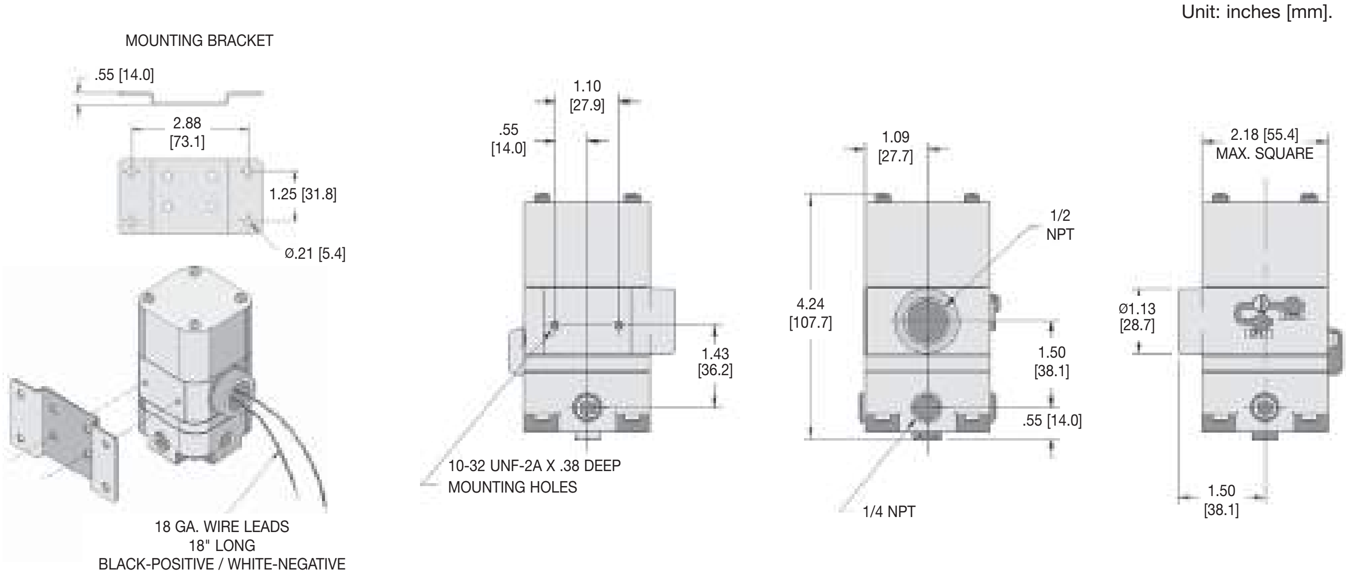
Ambient Temperature
-20°F (-30°C) to 140°F (60°C)

Approximate Shipping Weight
2.1 lbs [0.94 kg]

How to Order

Order using Item Number: **TA901**

Unit: inches [mm].



- Cast Aluminum Housing
- Removable Nylon Mesh Filter
- Low Air Consumption
- Drip Well

The **TA987 Air Filter/Regulator** is recommended for filtering and regulating the pressure of plant compressed air, and for delivering clean, dry air at the proper pressure to pneumatic control devices. Supply air enters the inlet port, passes through the filtering element, and exits through the reducing valve to the outlet port. The filtering element removes particles as small as 40 microns. A drip well is provided for the accumulation of oil and water and a drain cock is included to allow purging of the unit. The filtering element is readily accessible for cleaning by removal of the drip well bowl.

The maximum allowable supply pressure to TA987 Air Filter/Regulator is 250 PSIG. Improper application may cause failure of the regulator, resulting in possible personal injury or property damage.

Specifications

Model TA987

Air Requirements
Maximum Supply Pressure: 250 PSIG
Output Range: 0 to 30 PSIG, adjustable
Sensitivity: 0.036 PSIG
Air Consumption: < 6 SCFH

Air Requirements (con't.)
Flow Rate: 20 SCFM at 100 PSIG supply/20 PSIG output
Relief Capacity: 0.1 SCFM at 5 PSIG above setpoint
Effect of Supply Pressure Variation: < 0.2 PSIG for 25 PSIG

Filter
Removes particles 40 microns or greater

Port Size
1/4" NPT

Housing
Cast aluminum

Mounting
Side, pipe, panel or through body

Ambient Temperature
-20°F (-30°C) to 160°F (71°C)

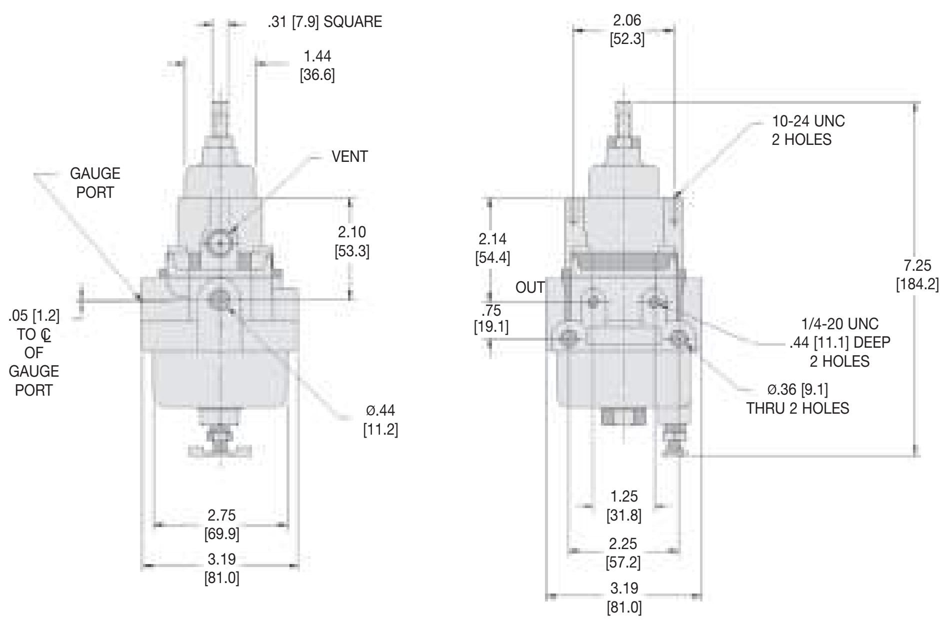
Approximate Shipping Weight
1.9 lbs [0.86 kg]

CONTROL VALVES

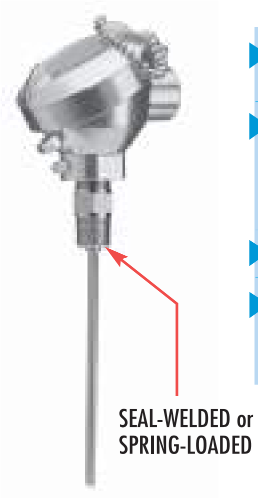
How to Order

Order using Item Number: **TA987**

Units: inches [mm].



Connection Head Type

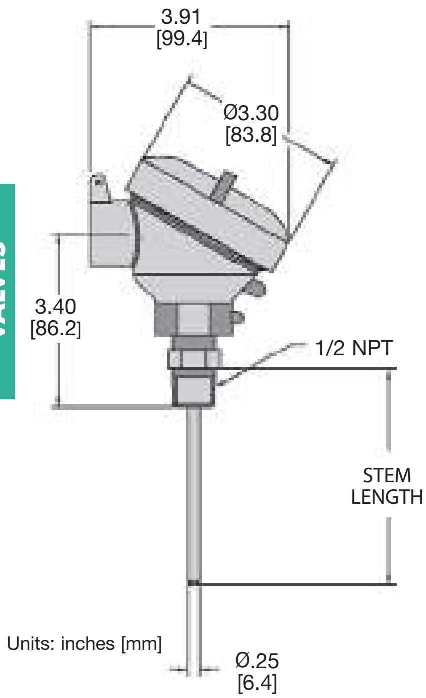


- **Thermocouple or RTD**
- **Cast Aluminum Polypropylene or Stainless Steel Head**
- **Weather-Proof**
- **Welded or Spring Loaded Stem**

The Watson McDaniel **Connection Head** is available with both Type J and Type K Thermocouples, as well as RTD sensors. The weatherproof head provides a conduit connection and is available in cast aluminum (screw cover), polypropylene (flip cover) and stainless steel (screw cover). The stem is either welded directly to the 1/2" NPT threaded connection, or is spring-loaded to provide maximum sensitivity. The spring-loaded stem must always be installed in a thermowell.

Extension wire and transmitter accessories are also available. Please consult factory.

For applications where the process media may be corrosive or contained under pressure, the use of a thermowell is required to prevent damage to the sensor and facilitate its removal from the process. To prevent leakage of the process media, spring loaded sensors must always be installed in a thermowell.



Specifications

Sensors	Description
TJD	Type J (Thermocouple)
TKD	Type K (Thermocouple)
TDD	100 Ω RTD
TMD	1000 Ω RTD

Hot Junction
T/C: Ungrounded
RTD: Platinum, 3-Wire

Stem 316 stainless steel
1/4" diameter

Insulation Ceramic

Head Cast aluminum, polypropylene or stainless steel

Process Connection
1/2" NPT welded or spring-loaded

Conduit Connection
3/4" NPT Female

Approximate Shipping Weight
1.1 lbs [0.50 kg]

Specifications

Thermocouple

Type	Color Code	Positive Lead	Negative Lead	Temperature Range
J	Black	Iron* (Fe) [white]	Constantan (Cu-Ni) [red]	32° to 1382°F (0° to 750°C)
K	Yellow	Nickel-Chromium (Ni-Cr) [yellow]	Nickel-Aluminum* (Ni-Al) [red]	32° to 2282°F (0° to 1250°C)

magnetic lead

RTD

Type	Material	Resistance @ 0°C	Temperature Coefficient	Temperature Range
D	Platinum (Pt)	100 Ω	α = 0.00385 Ω/Ω/°C	-50° to 700°F (-45° to 400°C)
M	Platinum (Pt)	1000 Ω	α = 0.00385 Ω/Ω/°C	-50° to 700°F (-45° to 400°C)

How to Order Temperature Sensors

Example Model Code: **TJD Z 04 U W A**

Sensor Type	Stem Style	Stem Length	Hot Junction	Connection	Head Material
TJD Type J (T/C) **TKD** Type K (T/C) **TDD** 100 Ω RTD **TMD** 1000 Ω RTD	**Z** 316SS, 1/4" O.D.	**02** 2 1/2" Stem **04** 4" Stem **06** 6" Stem **09** 9" Stem **12** 12" Stem	**U** Ungrounded (T/C) **D** 3-Wire (RTD)	**S** Spring Loaded, 1/2" NPT **W** Welded, 1/2" NPT	**A** Aluminum **P** Polypropylene **S** Stainless Steel

Other sensor styles available.
T/C = Thermocouple

Other Lengths: Specify in inches (24" maximum)

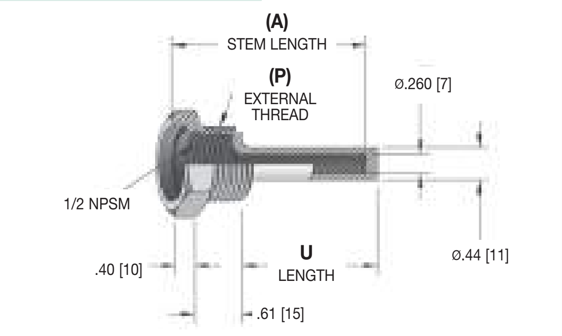
Thermowells

for RTD & Thermocouple Temperature Sensors

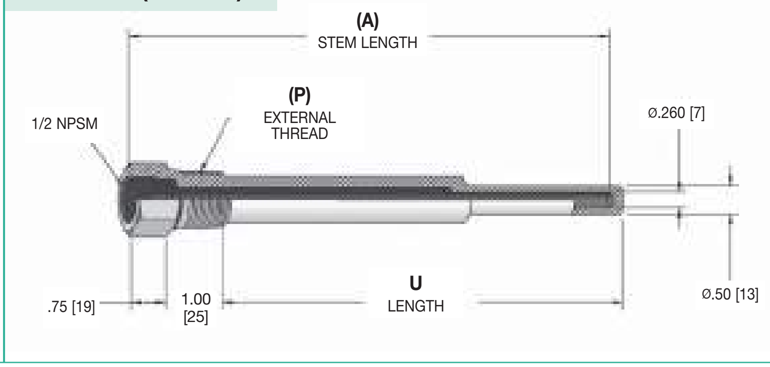
A **Thermowell** is a pressure tight receptacle designed to accept a temperature sensing element and provide a means to insert that element into a vessel or pipe. It acts as a barrier between a process medium and the sensing element of a temperature measuring device and protects against corrosive process media. A thermowell also allows the sensing element to be removed from the application while maintaining a closed system. The material chosen must be compatible with the process medium to which it is exposed.

The U-length (insertion length) of a thermowell indicates its insertion depth into a process vessel or piping system and is measured from the tip of the thermowell to the underside of the threads. Lagging extension thermowells are used on applications where insulation covers the vessel or piping system. The extension length (T-length) is the measurement between the instrument connection and process connection of the thermowell.

Standard (2 1/2" - 6")

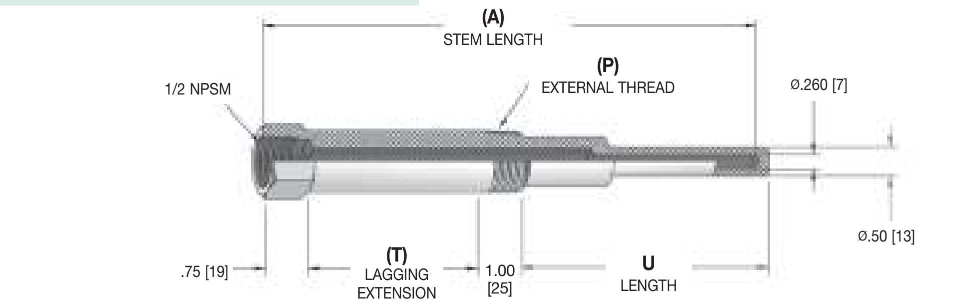


Standard (9" - 24")



Units inches: [mm]

with Lagging Extension (4" - 24")



Lengths

(A) Stem Length	Standard U Length	Lagging (T) Lagging Extension	Lagging U Length
2 1/2"	1.75 [44]	—	—
4"	2.50 [64]	1.00 [25]	1.50 [38]
6"	4.50 [114]	2.00 [51]	2.50 [64]
9"	7.50 [191]	3.00 [76]	4.50 [114]
12"	10.50 [267]	3.00 [76]	7.50 [191]
15"	13.50 [343]	3.00 [76]	10.50 [267]
18"	16.50 [419]	3.00 [76]	13.50 [343]
24"	22.50 [572]	3.00 [76]	19.50 [495]

Pressure Ratings (PSI)

Material	Operating Temperature 70°F	200°F	400°F	600°F	800°F	1000°F
Carbon steel	5000	5000	4800	4600	3500	-
304 stainless steel	6550	6000	4860	4140	3510	3130
316 stainless steel	6540	6400	6000	5270	5180	4660

How to Order 76-Series Thermowells

Example Model Code: **76-4JN6**

Thermowell Model	(P) External Thread	(A) Stem Length	(T) Lagging Extension	Material
76 Thermowell	**3** 1/2 NPT*	**D** 2 1/2" Stem	**A** 1" Extension (4" Stem only)	**2** Brass
	4 3/4 NPT	**G** 4" Stem	**C** 2" Extension (6" Stem only)	**5** 304SS
	5 1 NPT*	**J** 6" Stem	**E** 3" Extension (9" thru 24" Stem only)	**6** 316SS
		M 9" Stem	**N** No Extension	
		R 12" Stem		
		V 15" Stem		
		Wa 18" Stem		
		Wk 24" Stem		

**Not available with 2 1/2" Stem Length*

Other thermowell styles available. Please consult factory.

Liquid Drainers

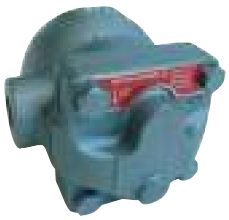
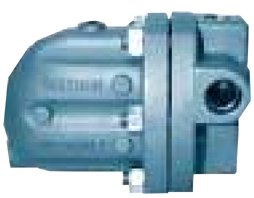
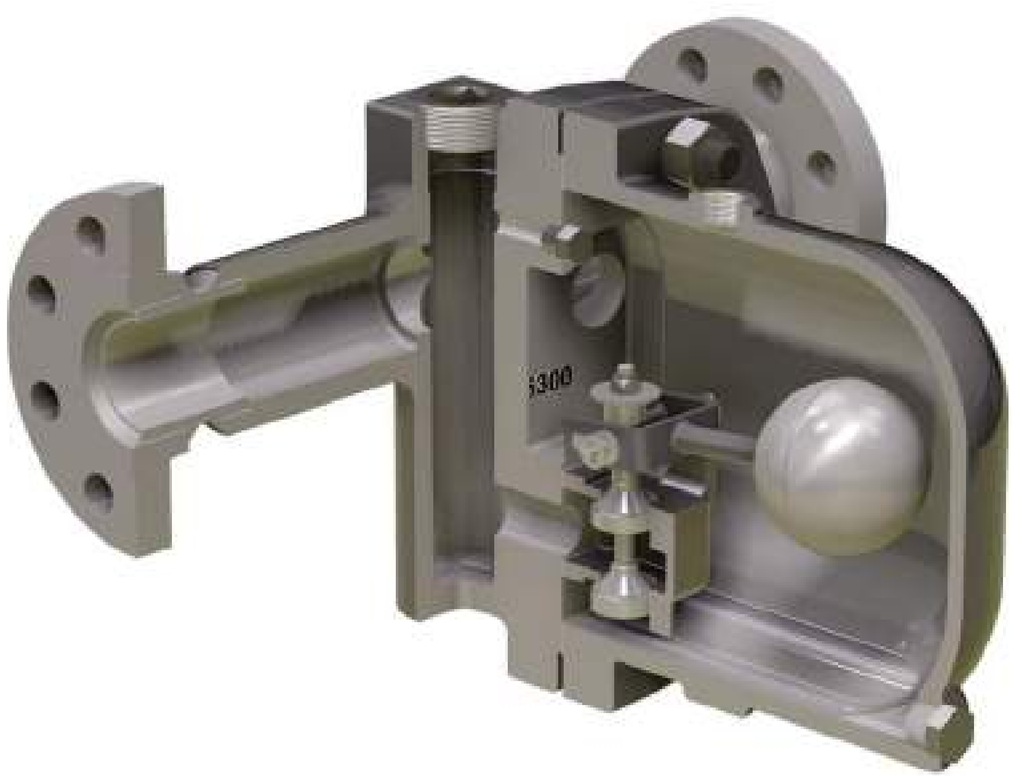
	Description	Material	Application
WLD1900 	**Float Type** with Parallel Pipe Connection	Cast Iron	**General Purpose** **Float Type Liquid Drainer with Cast or Ductile Iron Body** Low to moderately high volumes of liquid drainage.
WLD1400 	**Float Type** with In-Line Pipe Connection	Ductile Iron	
WLDE 	**Float Type** with Parallel Pipe Connection	**WLDE:** Ductile Iron **WLDES:** Cast Steel	**Extremely High Capacity**
WLD600 	**Float Type** with In-Line Pipe Connection	**WLD600:** Cast Steel **WLD601:** Stainless Steel	**Cast Steel** or **Stainless Steel Body**
WLD1800 	**Guided Float Type** Vertical Connection	Stainless Steel	**Corrosive** applications. Pressures up to 450 PSIG. Repairable and Non-Repairable versions available.
WLD1500 	**Inverted Bucket Style**	Cast Iron	Low to medium capacity.
WLD1703S 	**Disc Type**	Stainless Steel	Very compact size.

Table of Contents



Float Type Liquid Drainer

Why use Liquid Drainers?

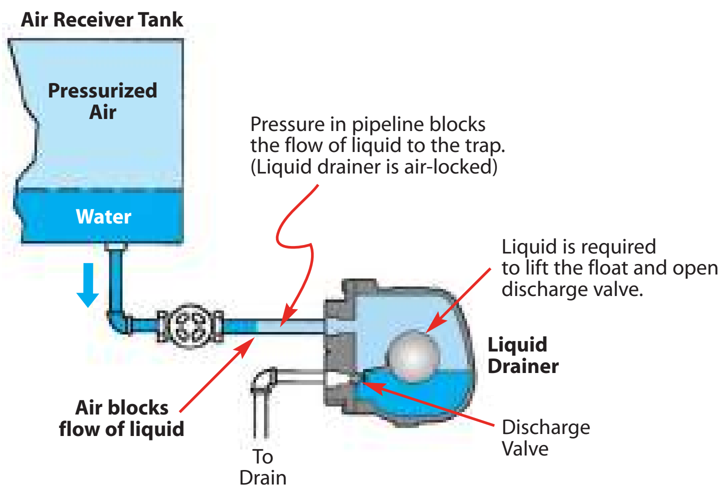
Liquid Drain Traps are primarily used to remove condensation from tanks or pipes containing air or other pressurized gases. The proper liquid drain trap should be selected based on pressure limitation, volume of liquid to be drained and material compatibility.

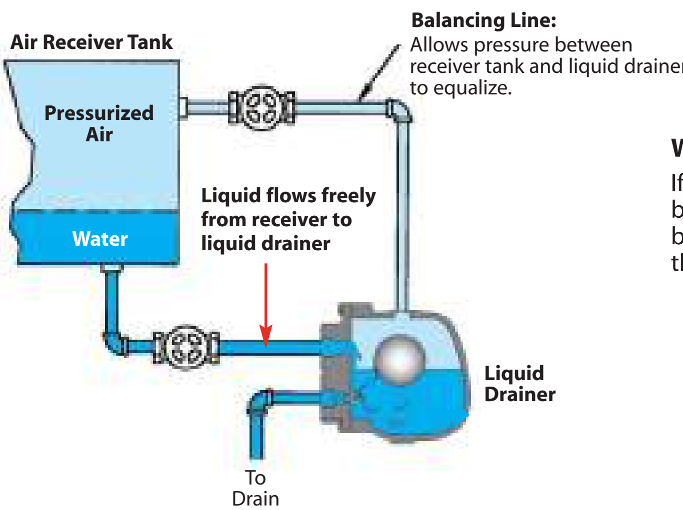
When are Balancing Lines required?

If a Float Type Liquid Drain Trap is selected, it may be required to add a balancing (or equalizing) line to allow any air or gases trapped in the drainer to escape. If the balancing line is not installed, these gases can prevent proper operation by air-binding the trap. Inverted Bucket Type and Disc Type Drain Traps will self-vent, eliminating the risk of air-binding and therefore do not require balancing lines.

Without a Balancing Line

In applications where the volume of liquid being drained is large enough to fill the complete diameter of the pipe, the potential for air binding exists. This is occurs because Float type drain traps are normally closed, with the weight of the float keeping the valve in the closed position. Liquid must first enter the body of the trap to lift the float and open the valve. When the liquid tries to flow down the pipe, the air pressure inside the trap will continue to build and stop the flow of liquid causing the trap to air bind. A balancing line will equalize the pressure allowing the liquid to freely enter the trap and lift the float, allowing proper discharge to take place.



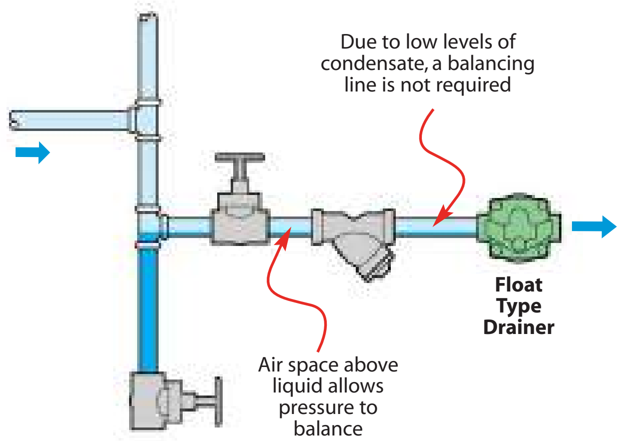


With a Balancing Line

If a Float Type Liquid Drainer is used on a receiver or tank, a balancing line is normally required. The balancing line must be installed above the highest liquid level point to ensure that condensate does not block the balancing line.

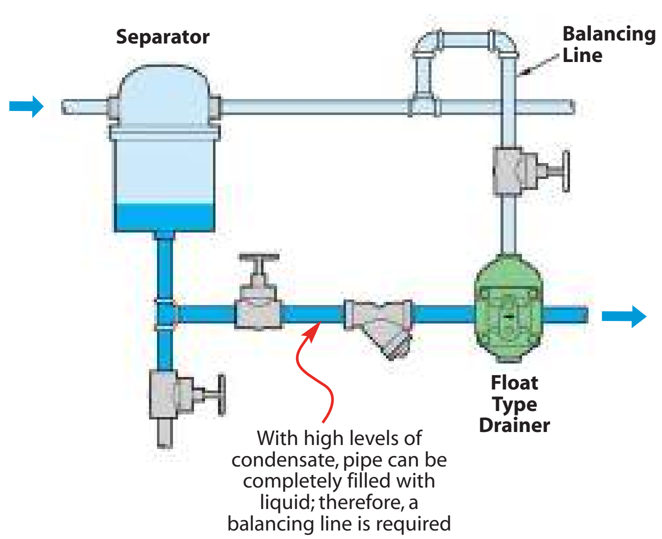
Some Examples of Liquid Drainer Applications

Figure 1 Draining Condensate from Air Line with a Float Type Liquid Drainer



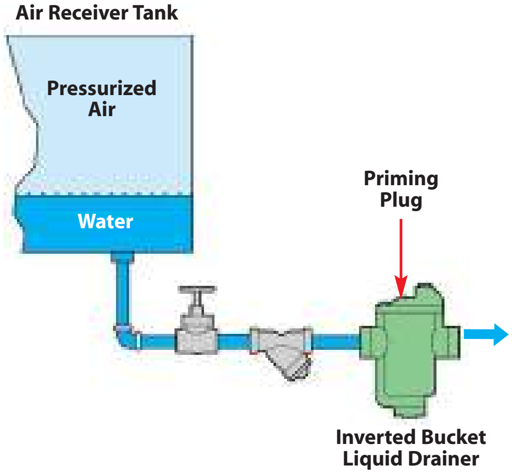
Typically, most air line applications have a low level of condensate to discharge, and the piping does not become flooded with condensate. In this type of application a Float Type Liquid Drainer can be used without the need of a balancing line. Due to the low level of liquid being drained, an air space exists above the liquid in the pipe which balances the pressure allowing liquid to flow freely.

Figure 2 Draining Condensate from a Separator on a Large Air Main



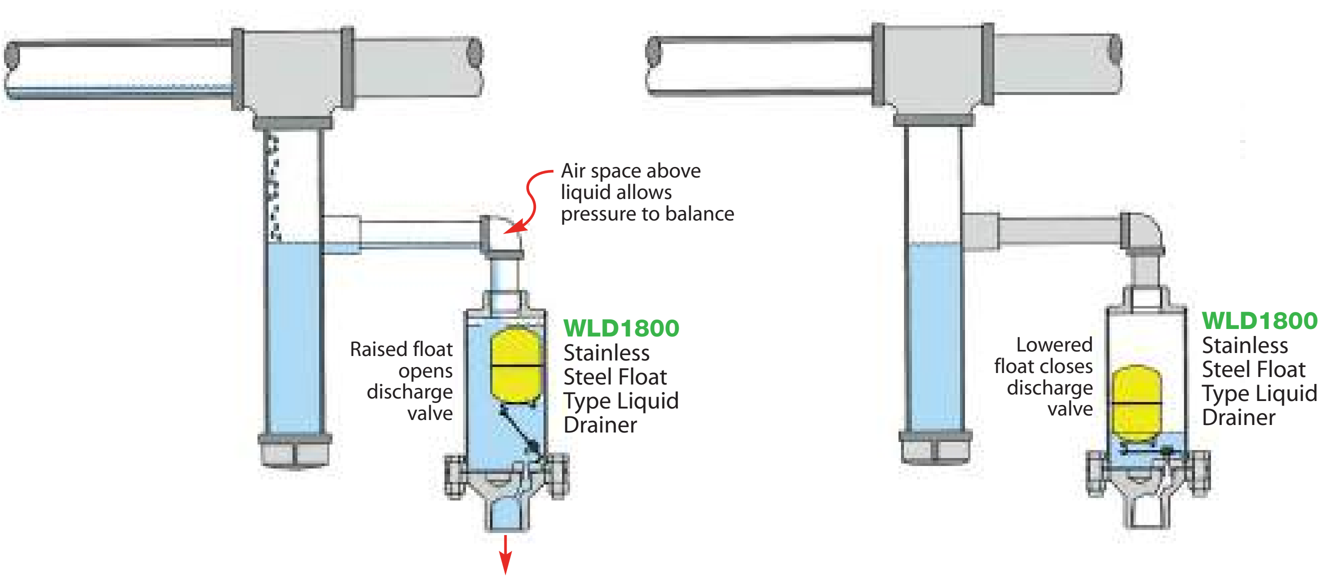
When large loads of condensate are required to be discharged, make sure a properly sized liquid drain trap is used. On large load applications, a balancing line is required, because non-condensable gases can be easily trapped in the drain trap due to fluctuating condensate levels.

Figure 3 **Draining Condensate from a Receiver with an Inverted Bucket Style Liquid Drainer**



In an application where an Inverted Bucket Liquid Drainer is used, a balancing line may not be required. This style of drainer has a small internal bleed hole on the bucket float which allows a small amount of air to be vented. For the Inverted Bucket Liquid Drain Trap to operate, it must be primed with liquid prior to operation.

Figure 4 **Draining Condensate from Drip Leg with a Guided Float Type Liquid Drainer**
All Stainless Steel



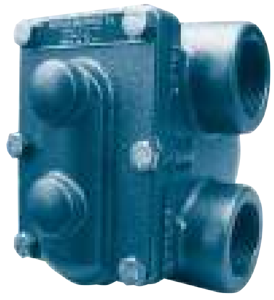
Guided Float Type Liquid Drainers

The Guided Float Type Liquid Drainers are available in either repairable or non-repairable configurations. All Stainless Steel body and internal components are suitable for corrosive applications. In low-flow drip applications, a balancing line is normally not required.

Float Type Liquid Drainer

WLD1900 Series
Float Type

Model	**WLD1900**
Sizes	3/4", 1", 1 1/4", 1 1/2", 2"
Connections	NPT
Body Material	Cast Iron
PMO Max. Operating Pressure	**250 PSIG**
TMO Max. Operating Temperature	450°F
PMA Max. Allowable Pressure	250 PSIG up to 450°F
TMA Max. Allowable Temperature	450°F @ 250 PSIG



WLD1900
3/4" & 1"

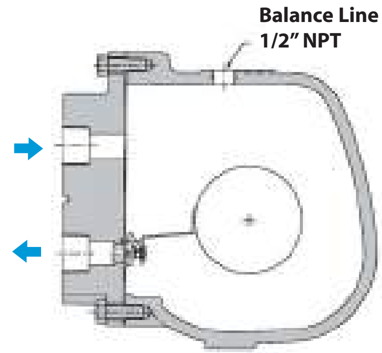
WLD1900
2"

Typical Applications

The **WLD1900 Series** is used in applications where immediate and continuous discharge of liquid is required. Typically used in process applications for draining condensate from air or other gases.

How It Works

The WLD1900 Series liquid drainers contain a float-operated valve. When liquid enters the drainer, the float rises opening the valve which allows liquid to be drained.



Features

- All stainless steel internals
- Hardened valve seat for longer service life
- Cast Iron body
- In-line repairable

Sample Specification

The liquid drain trap shall be float operated with a cast iron body, all stainless steel internals and a hardened valve seat. The unit shall be in-line repairable and equipped with a FNPT threaded connection for the use of a balance line.

Installation

The installation should include isolation valves to facilitate maintenance and an in-line strainer. The trap must be level and upright for the float mechanism to operate. Trap must be adequately sized and properly located in the system. Installation may require an equalizing or balancing line connected from top of drainer body to the above piping, for proper drainage.

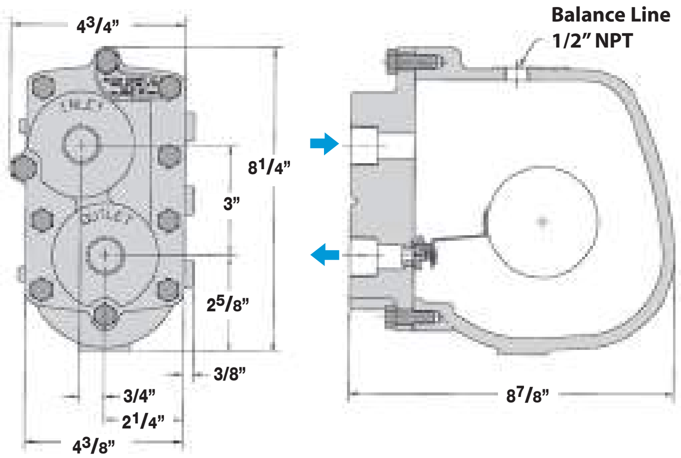
Maintenance

All working components can be replaced with the drain trap remaining in the pipeline. Repair kits include float, valve seat & disc, and gaskets. For full maintenance details see Installation and Maintenance Manual.

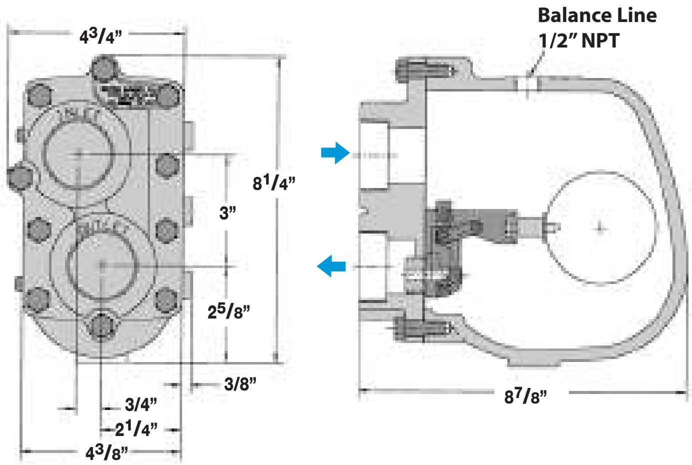
MATERIALS	
Body	Cast Iron
Cover	Cast Iron
Gasket	Garlock 3400
Cover Screws	Stainless Steel, Gr 5
Float	Stainless Steel, AISI 304
Internals	Stainless Steel, 300 Series
Valve Seat	Stainless Steel, 17-4 PH
Valve Disc	Stainless Steel, AISI 420F

DIMENSIONS – *inches/pounds*

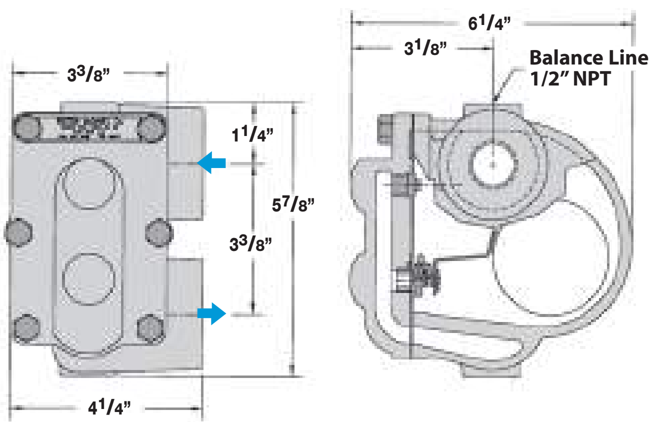
Drawing	Model	Size	PMO (PSIG)	Weight (lbs)
A	WLD1913-015	3/4"	15	9
A	WLD1914-015	1"	15	9
A	WLD1915-015	1 1/4"	15	9
C	WLD1916-015	1 1/2"	15	21
D	WLD1917-015	2"	15	53
A	WLD1913-030	3/4"	30	9
A	WLD1914-030	1"	30	9
A	WLD1915-030	1 1/4"	30	9
C	WLD1916-030	1 1/2"	30	21
D	WLD1917-030	2"	30	53
A	WLD1913-090	3/4"	90	9
A	WLD1914-090	1"	90	9
C	WLD1915-090	1 1/4"	90	21
C	WLD1916-090	1 1/2"	90	21
D	WLD1917-090	2"	90	53
A	WLD1913-150	3/4"	150	9
A	WLD1914-150	1"	150	9
C	WLD1915-150	1 1/4"	150	21
C	WLD1916-150	1 1/2"	150	21
D	WLD1917-150	2"	150	53
B	WLD1913-200	3/4"	200	20
B	WLD1914-200	1"	200	20
C	WLD1915-200	1 1/4"	200	21
C	WLD1916-200	1 1/2"	200	21
D	WLD1917-200	2"	200	53
B	WLD1913-250	3/4"	250	20
B	WLD1914-250	1"	250	20
C	WLD1915-250	1 1/4"	250	21
C	WLD1916-250	1 1/2"	250	21
D	WLD1917-250	2"	250	53



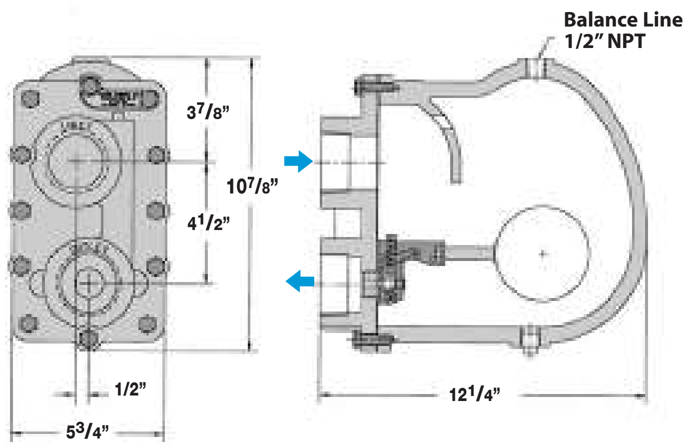
Drawing - B



Drawing - C



Drawing - A



Drawing - D

LIQUID DRAINERS

How to Size / Order

Determine the capacity (lbs/hr) required at the specified differential pressure. Locate differential pressure on capacity chart; move down column to capacity required. Make sure to select the correct model based on the maximum inlet pressure.

Example:
Required to drain 3,000 lbs/hr at a differential pressure of 5 PSI. The maximum inlet pressure is 30 PSIG.

Select Model: **WLD1916-030,** 1 1/2″, capacity up to 4,710 lbs/hr based on 5 PSI differential pressure.

Capacity in lbs/hr is based on differential pressure across the drainer. Select a model with an equal or higher PMO (max. operating pressure) than the maximum inlet pressure to the drainer. If the pressure to the drainer exceeds the PMO, the drainer may not open. If discharging to atmosphere, the differential pressure is equal to the inlet pressure.

CAPACITIES – *Cold Water (lbs/hr)*

Model	Size	PMO (PSIG)	Orifice Size	Differential Pressure (PSI)																
				1	2	5	10	15	20	30	40	60	90	100	125	150	175	200	225	250
WLD1913-015	3/4″	15	.250″	910	1260	1940	2690	3260												
WLD1914-015	1″	15	.250″	910	1260	1940	2690	3260												
WLD1915-015	1 1/4″	15	.312″	1130	1570	2420	3360	4070												
WLD1916-015	1 1/2″	15	.500″	2400	3330	5140	7140	8650												
WLD1917-015	2″	15	.625″	3000	4170	6430	8920	10810												
WLD1913-030	3/4″	30	.228″	830	1150	1770	2450	2970	3410	4130										
WLD1914-030	1″	30	.228″	830	1150	1770	2450	2970	3410	4130										
WLD1915-030	1 1/4″	30	.228″	830	1150	1770	2450	2970	3410	4130										
WLD1916-030	1 1/2″	30	.390″	2200	3060	4710	6540	7930	9080	11000										
WLD1917-030	2″	30	.500″	2400	3330	5140	7140	8650	9910	12000										
WLD1913-090	3/4″	90	.166″	260	360	550	770	930	1060	1290	1480	1790	2170							
WLD1914-090	1″	90	.166″	260	360	550	770	930	1060	1290	1480	1790	2170							
WLD1915-090	1 1/4″	90	.312″	1130	1570	2420	3360	4070	4660	5650	6470	7830	9500							
WLD1916-090	1 1/2″	90	.312″	1130	1570	2420	3360	4070	4660	5650	6470	7830	9500							
WLD1917-090	2″	90	.422″	1350	1870	2890	4010	4860	5570	6740	7730	9360	11350							
WLD1913-150	3/4″	150	.128″	150	210	330	450	550	630	760	870	1050	1280	1340	1490	1590				
WLD1914-150	1″	150	.128″	150	210	330	450	550	630	760	870	1050	1280	1340	1490	1590				
WLD1915-150	1 1/4″	150	.250″	910	1260	1940	2690	3260	3740	4530	5190	6280	7620	8000	8890	9800				
WLD1916-150	1 1/2″	150	.250″	910	1260	1940	2690	3260	3740	4530	5190	6280	7620	8000	8890	9800				
WLD1917-150	2″	150	.332″	1200	1670	2580	3580	4330	4960	6010	6890	8340	10100	10620	11810	12500				
WLD1913-200	3/4″	200	.166″	260	360	550	770	930	1060	1290	1480	1790	2170	2280	2530	2760	2970	3150		
WLD1914-200	1″	200	.166″	260	360	550	770	930	1060	1290	1480	1790	2170	2280	2530	2760	2970	3150		
WLD1915-200	1 1/4″	200	.250″	910	1260	1940	2690	3260	3740	4530	5190	6280	7620	8000	8890	9690	10420	11100		
WLD1916-200	1 1/2″	200	.250″	910	1260	1940	2690	3260	3740	4530	5190	6280	7620	8000	8890	9690	10420	11100		
WLD1917-200	2″	200	.281″	1960	2720	4200	5830	7060	8090	9800	11230	13600	16500	17320	19250	20980	22570	23800		
WLD1913-250	3/4″	250	.128″	150	210	330	450	550	630	760	870	1050	1280	1340	1490	1630	1750	1860	1970	2070
WLD1914-250	1″	250	.128″	150	210	330	450	550	630	760	870	1050	1280	1340	1490	1630	1750	1860	1970	2070
WLD1915-250	1 1/4″	250	.203″	600	830	1280	1770	2150	2460	2980	3420	4140	5020	5270	5860	6390	6870	7320	7740	8140
WLD1916-250	1 1/2″	250	.203″	600	830	1280	1770	2150	2460	2980	3420	4140	5020	5270	5860	6390	6870	7320	7740	8140
WLD1917-250	2″	250	.250″	910	1260	1940	2690	3260	3740	4530	5190	6280	7620	8000	8890	9690	10420	11100	11740	12340

WLD1400 Series
Float Type

Model	WLD1400
Sizes	1/2", 3/4", 1", 1½", 2"
Connections	NPT
Body Material	Ductile Iron
PMO Max. Operating Pressure	300 PSIG
TMO Max. Operating Temperature	450°F
PMA Max. Allowable Pressure	300 PSIG up to 450°F
TMA Max. Allowable Temperature	450°F @ 300 PSIG

Typical Applications

The **WLD1400 Series** is used on air and gas applications as drip traps on piping runs as well as drainage for systems and various process vessels that have moderate condensate loads.

How It Works

The WLD1400 Series liquid drainers contain a float-operated valve. When liquid enters the drainer, the float rises opening the valve which allows liquid to be drained.

Features

- All stainless steel internals
- Hardened valve seat for longer service life
- Ductile Iron body
- In-line repairable

Sample Specification

The liquid drain trap shall be float operated with a ductile iron body, all stainless steel internals and a hardened valve seat. The unit shall be in-line repairable and equipped with a FNPT threaded connection for the use of a balance line.

Installation

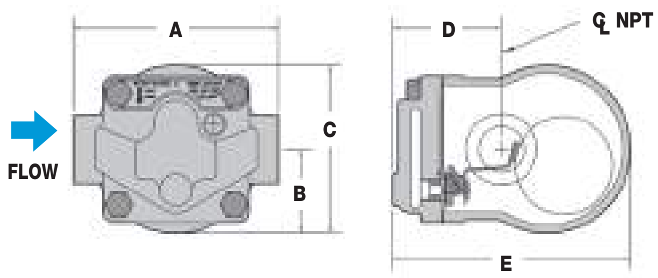
The installation should include isolation valves to facilitate maintenance and an in-line strainer. The trap must be level and upright for the float mechanism to operate. Trap must be adequately sized and properly located in the system. Installation may require an equalizing or balancing line connected from top of drainer body to the above piping, for proper drainage.

Maintenance

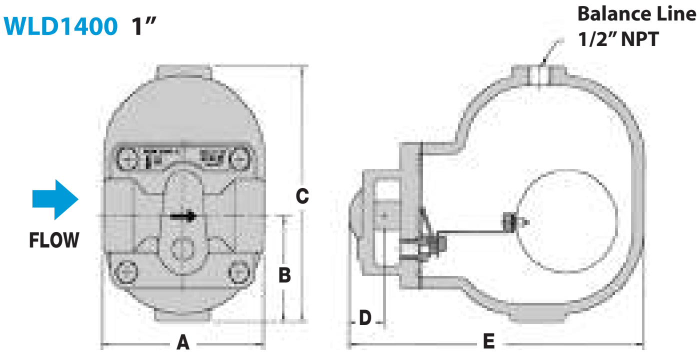
All working components can be replaced with the drain trap remaining in the pipeline. Repair kits include float, valve seat & disc, and gaskets. For full maintenance details see Installation and Maintenance Manual.

MATERIALS	
Body & Cover	Ductile Iron
Gasket	Garlock 3400
Cover Screws	Stainless Steel, Gr 5
Float	Stainless Steel, AISI 304
Internals	Stainless Steel, 300 Series
Valve Seat	Stainless Steel, 17-4 PH
Valve Disc	Stainless Steel, AISI 420F

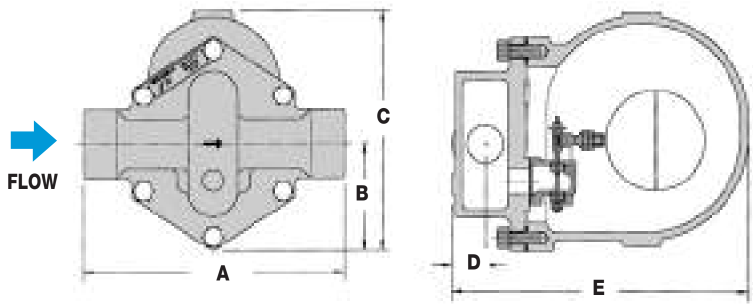
WLD1400 1/2″ & 3/4″



WLD1400 1″



WLD1400 1 1/2″ & 2″



DIMENSIONS & WEIGHTS – *inches/pounds*

Size	A	B	C	D	E	Weight
1/2″, 3/4″	4.8	1.9	3.9	2.5	5.5	6
1″	4.8	3.1	7.5	1.1	8.8	16
1 1/2″	10.6	4.3	9.6	1.4	12	40
2″	11.9	4.3	9.6	1.4	12	40

How to Size / Order

Determine the capacity (lbs/hr) required at the specified differential pressure. Locate differential pressure on capacity chart; move down column to capacity required. Make sure to select the correct model based on the maximum inlet pressure.

Example:
Required to drain 3,500 lbs/hr at a differential pressure of 2 PSI. The maximum inlet pressure is 15 PSIG.

Select Model: **WLD1416-N-065**, 1 1/2″, capacity up to 4,300 lbs/hr based on 2 PSI differential pressure. PMO = 65 PSI

Capacity in lbs/hr is based on differential pressure across the drainer. Select a model with an equal or higher PMO (max. operating pressure) than the maximum inlet pressure to the drainer. If the pressure to the drainer exceeds the PMO, the drainer may not open. If discharging to atmosphere, the differential pressure is equal to the inlet pressure.

CAPACITIES – *Cold Water (lbs/hr)*

Model Code	Size	PMO (PSIG)	Orifice Size	Differential Pressure (PSI) 1	2	5	10	15	20	30	50	65	75	100	125	145	200	225	300
WLD1412-N-065	1/2″	65	.157″	250	340	530	730	880	1010	1230	1560	1770							
WLD1413-N-065	3/4″	65	.157″	250	340	530	730	880	1010	1230	1560	1770							
WLD1414-N-065	1″	65	.273″	980	1360	2090	2910	3520	4040	4890	6220	7050							
WLD1416-N-065	1 1/2″	65	.157″	3125	4300	6600	9350	11225	13250	16350	20950	23500							
WLD1417-N-065	2″	65	.273″	10600	14900	23300	31500	38150	44750	53600	69200	76375							
WLD1412-N-145	1/2″	145	.100″	110	150	230	320	380	440	530	680	770	940	1050	1130	1200			
WLD1413-N-145	3/4″	145	.100″	110	150	230	320	380	440	530	680	770	940	1050	1130	1200			
WLD1414-N-145	1″	145	.202″	490	670	1040	1440	1750	2000	2430	3090	3500	4290	4760	5110	5350			
WLD1416-N-145	1 1/2″	145	.100″	1575	2175	3400	4650	5525	6325	7750	9925	11000	12300	13975	15300	16500			
WLD1417-N-145	2″	145	.202″	3875	5450	8575	11500	12350	13200	20950	27175	31050	34150	38500	42225	45950			
WLD1412-N-225	1/2″	225	.079″	60	80	130	180	220	250	300	380	430	530	590	630	690	740	780	
WLD1413-N-225	3/4″	225	.079″	60	80	130	180	220	250	300	380	430	530	590	630	690	740	780	
WLD1414-N-225	1″	225	.184″	320	450	690	960	1160	1330	1610	2050	2330	2850	3170	3400	3710	3960	4100	
WLD1416-N-250	1 1/2″	250	.079″	1000	1375	2150	3050	3600	4100	5025	6400	7300	8050	8900	9750	10550	12450	13150	
WLD1417-N-250	2″	250	.184″	1900	2675	4250	5850	7000	8225	10050	12950	15125	16700	18300	20200	22100	25850	27100	
WLD1414-N-300	1″	300	.153″	230	320	500	690	840	960	1170	1480	1680	2060	2290	2460	2680	2860	3020	3460

Model	WLDE	WLDES
Sizes	1 1/2", 2", 2 1/2"	2 1/2"
Connections	NPT	NPT, SW, Flanged
Body Material	Ductile Iron	Cast Steel
PMO Max. Operating Pressure	200 PSIG	300 PSIG
TMO Max. Operating Temperature	450°F	450°F
PMA Max. Allowable Pressure	300 PSIG up to 450°F	300 PSIG up to 750°F
TMA Max. Allowable Temperature	450°F @ 300 PSIG	750°F @ 300 PSIG

Typical Applications

The **WLDE/WLDES Series** high-capacity condensate drainers meet the flow requirements that are typically found in heavy industrial process applications for air and other gases.

How It Works

The WLDE/WLDES Series liquid drainers contain a float-operated valve. When liquid enters the drainer, the float rises opening the valve which allows liquid to be drained.

Features

- Ductile Iron or Cast Steel body and cover
- All stainless steel internals for long service life
- High capacity liquid removal
- Rugged construction design for heavy industrial use
- In-line repairable

Sample Specification

The liquid drain trap shall be float operated with a ductile iron or cast steel body and all stainless steel internals. The unit shall be in-line repairable and equipped with a FNPT threaded connection for the use of a balance line.

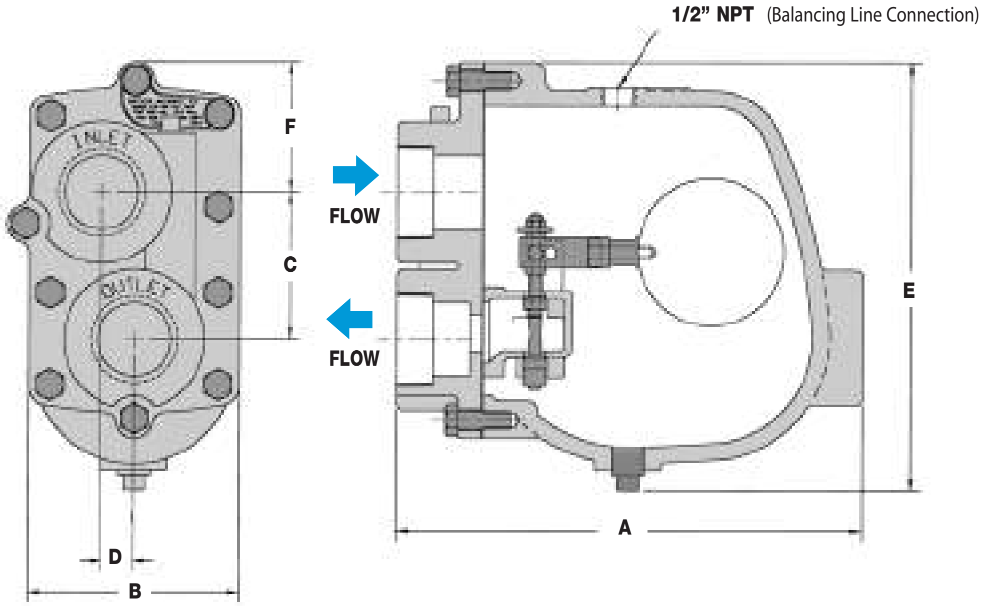
Installation

The installation should include isolation valves to facilitate maintenance and an in-line strainer. The trap must be level and upright for the float mechanism to operate. Trap must be adequately sized and properly located in the system. Installation may require an equalizing or balancing line connected from top of drainer body to the above piping, for proper drainage.

Maintenance

All working components can be replaced with the drain trap remaining in the pipeline. Repair kits include float, valve seat & disc and gaskets. For full maintenance details see Installation and Maintenance Manual.

MATERIALS	
Body & Cover	**WLDE** - Ductile Iron **WLDES** - Cast Steel
Cover Screw	Carbon Steel, Gr 5
Cover Gasket	Garlock
Valve Discs	Stainless Steel, AISI 303
Main Valve Assembly Housing	Stainless Steel, AISI 304
Valve Assembly Gasket	Garlock
Ball Float	Stainless Steel, AISI 304
All other components	Stainless Steel



DIMENSIONS & WEIGHTS – *inches*

Model	PMO (PSIG)	Pipe Size	A	B	C	D	E	F	Weight (lbs)
WLDE	200	1 1/2″	9 1/8	4 5/16	3	11/16	8 13/16	2 1/8	24
WLDE	20	2″	12 1/8	5 11/16	4 1/2	1/2	11 1/8	3 15/16	61
WLDE	200	2″							
WLDE	50	2″	16	8 7/16	7 5/16	1 7/16	15 1/8	3 1/8	150
WLDE	50	2 1/2″	15 1/2	8 7/16	7 5/16	1 7/16	15 1/8	3 1/8	150
WLDE	125	2 1/2″							
WLDE	200	2 1/2″							
WLDES	300*	2 1/2″							

* Note: All WLDES models have same dimensions.

How to Size / Order

Determine the capacity (lbs/hr) required at the specified differential pressure. Locate differential pressure on capacity chart; move down column to capacity required. Make sure to select the correct model based on the maximum inlet pressure.

Example:
Required to drain 80,000 lbs/hr at a differential pressure of 5 PSI. The maximum inlet pressure is 100 PSIG.
Select Model: **WLDE-125-18-N**, 2 1/2″, capacity up to 87,294 lbs/hr based on 5 PSI differential pressure. PMO = 125 PSI

Capacity in lbs/hr is based on differential pressure across the drainer. Select a model with an equal or higher PMO (max. operating pressure) than the maximum inlet pressure to the drainer. If the pressure to the drainer exceeds the PMO, the drainer may not open. If discharging to atmosphere, the differential pressure is equal to the inlet pressure.

CAPACITIES – *Cold Water (lbs/hr)*

Model Code / PMO (PSIG)	Pipe Size	Orifice Size	Differential Pressure (PSI) 1/4	1/2	1	2	5	10	20	40	50	75	100	125	200	300
WLDE-20-17-N	2″	.937″	3929	5556	7858	11113	17571	24849	35141							
WLDE-50-17-N	2″	2.125″	12248	18153	25312	37751	62218	90068	123365	161302	176522					
WLDE-50-18-N	2 1/2″	2.125″	19520	27605	39039	55209	87294	123452	174588	246904	276047					
WLDE-125-18-N	2 1/2″	2.125″	19520	27605	39039	55209	87294	123452	174588	246904	276047	338088	390390	436469		
WLDE-200-16-N	1 1/2″	.375″	1051	1486	2102	2973	4700	6647	9401	13295	14864	18205	21021	23502	29728	
WLDE-200-17-N	2″	.75″	3403	4813	6807	9626	15220	21525	30441	43050	48131	58949	68068	76102	96263	
WLDE-200-18-N	2 1/2″	1.5″	11100	15713	22200	31427	49690	70273	99381	140546	157135	192450	222200	248452	314269	
WLDES-50-18-N	2 1/2″	2.125″	19520	27605	39039	55209	87294	123452	174588	246904	276047					
WLDES-125-18-N	2 1/2″	2.125″	19520	27605	39039	55209	87294	123452	174588	246904	276047	338088	390390	436469		
WLDES-200-18-N	2 1/2″	1.5″	11100	15713	22200	31427	49690	70273	99381	140546	157135	192450	222200	248452	314269	
WLDES-300-18-N	2 1/2″	1.5″	11100	15713	22200	31427	49690	70273	99381	140546	157135	192450	222200	248452	314269	427024

Float Type Liquid Drainer

WLD600 • Carbon Steel
WLD601 • 316 SS

Model	**WLD600 & WLD601**
Sizes	**3/4", 1", 1 1/2", 2", 3", 4"**
Connections	**NPT, SW, Flanged**
Body Material **WLD600**	**Carbon Steel**
Body Material **WLD601**	**316 Stainless Steel**
PMO Max. Operating Pressure	**450 PSIG**
TMO Max. Operating Temperature	**750°F**
PMA Max. Allowable Pressure	***990 PSIG @ 100°F**
TMA Max. Allowable Temperature	***750°F @ 670 PSIG**

**** 3/4"- 2" only.***

Note: For dimensions and capacities of 3" & 4" liquid drain traps, refer to model FT600 in the Steam Trap section.

Typical Applications

The **WLD600/WLD601 Series** are used in applications where immediate and continuous discharge of large amounts of liquid is required. Typically used in heavy industrial process applications for draining condensate from air or other gases.

How It Works

The WLD600/WLD601 Series liquid drainers contain a float-operated valve. When liquid enters the drainer, the float rises opening the valve which allows liquid to be drained.

Features

- All stainless steel internals for long service life
- Body & cover available in Carbon Steel or 316 SS
- Rugged construction designed for heavy industrial applications
- In-line repairable

Sample Specification

The liquid drain trap shall be float operated with a cast steel body (or stainless steel body for WLD601) and all stainless steel internals. The unit shall be in-line repairable and equipped with a FNPT threaded connection for the use of a balance line.

Installation

The installation should include isolation valves to facilitate maintenance and an in-line strainer. The trap must be level and upright for the float mechanism to operate. Trap must be adequately sized and properly located in the system. Installation may require an equalizing or balancing line connected from top of drainer body to the above piping, for proper drainage.

Maintenance

All working components can be replaced with the drain trap remaining in the pipeline. Repair kits include float, valve seat & disc and gaskets. For full maintenance details see Installation and Maintenance Manual.

Options

316 SS Body & Cover: use Model WLD601.

MATERIALS	
Body & Cover WLD600	Cast Steel, ASTM A-216 WCB
Body & Cover WLD601	Cast 316 SS
Cover Studs	Steel, SA 193, Gr B7
Cover Nuts	Steel, SA 194, Gr 2H
Cover Gasket	Stainless Steel Reinforced Grafoil
Valve Assembly	Stainless Steel, AISI 431
Gasket, Valve Assembly	Stainless Steel Reinforced Grafoil
Pivot Assembly	Stainless Steel, 17-4 PH
Mounting Screws	Stainless Steel Hex Head, 18-8
Float	Stainless Steel, ASTM 240 TY 304

How to Size / Order

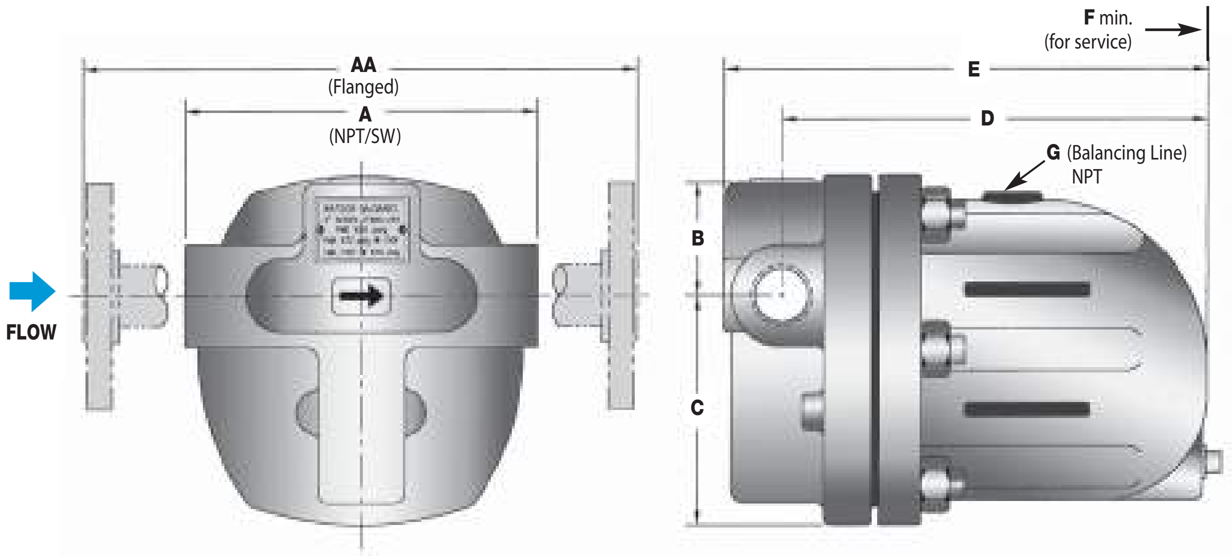
Determine the capacity (lbs/hr) required at the specified differential pressure. Locate differential pressure on capacity chart; move down column to capacity required. Make sure to select the correct model based on the maximum inlet pressure.

Example:
Required to drain 2,000 lbs/hr at a differential pressure of 300 PSI. The maximum inlet pressure is 325 PSIG.

Select Model: **WLD600-450-14-N**, 1" NPT, capacity up to 2,250 lbs/hr based on 300 PSI differential pressure

Connections: (**N**=NPT, **SW**=Socket Weld, **F150**=150# FLG, **F300**=300# FLG, **F600**=600# FLG)

Example Models: **WLD600-450-14-SW** = 1" Socket Weld
WLD600-450-14-F600 = 1" 600# FLG



DIMENSIONS & WEIGHTS – *inches / pounds*										
									Weight (lbs)	
Size	A	AA	B	C	D	E	F	G *	NPT/SW	FLG
3/4"	6 1/8	10 1/8	2 1/8	3 7/16	7 7/16	8 7/16	5 13/16	3/8	25	31
1"	6 1/2	10 7/16	2 1/2	5 1/2	8 7/16	9 1/2	6 5/16	3/8	31	36
1 1/2"	9 13/16	14	3 7/16	9	10 7/16	11 15/16	7 13/16	1/2	82	91
2"	11 13/16	16	3 1/8	7 7/16	11 1/8	13 5/16	6 13/16	1/2	93	107

* Balancing Port available with 1/2" flanged connection. Specify on order.

Capacity in lbs/hr is based on differential pressure across the drainer. Select a model with an equal or higher PMO (max. operating pressure) than the maximum inlet pressure to the drainer. If the pressure to the drainer exceeds the PMO, the drainer may not open. If discharging to atmosphere, the differential pressure is equal to the inlet pressure.

CAPACITIES – *Cold Water (lbs/hr)* — **For WLD600 & WLD601**

Model Code PMO (PSIG)	Pipe Size	Orifice Size	Differential Pressure (PSI) 2	5	10	20	30	40	65	70	80	100	145	200	300	350	450
WLD600-65-13-N	3/4"	.156	340	520	730	1010	1220	1440	1770								
WLD600-65-14-N	1"	.276	1390	2140	2970	4130	5000	5730	7210								
WLD600-65-16-N	1 1/2"	.689	4160	6430	8920	12380	15000	17190	21630								
WLD600-65-17-N	2"	1.122	14730	22720	31540	43790	53060	60790	76500								
WLD600-145-13-N	3/4"	.126	210	320	450	620	760	870	1090	1130	1200	1340	1590				
WLD600-145-14-N	1"	.205	690	1070	1490	2060	2500	2870	3610	3740	3980	4420	5270				
WLD600-145-16-N	1 1/2"	.591	2360	3630	5050	7010	8490	9730	12240	12670	13500	15000	17890				
WLD600-145-17-N	2"	.807	5840	9010	12510	17370	21040	24110	30340	31420	33470	37200	44360				
WLD600-200-13-N	3/4"	.106	170	260	360	500	600	690	870	900	960	1060	1270	1480			
WLD600-200-14-N	1"	.185	450	690	960	1330	1620	1850	2330	2410	2570	2860	3410	3970			
WLD600-200-16-N	1 1/2"	.531	1650	2550	3540	4910	5950	6820	8580	8890	9470	10520	12540	14610			
WLD600-200-17-N	2"	.657	2890	4460	6190	8590	10410	11930	15010	15540	16560	18400	21940	25540			
WLD600-300-13-N	3/4"	.079	80	130	180	250	300	340	430	450	480	530	630	730	890		
WLD600-300-14-N	1"	.156	340	520	730	1010	1220	1400	1770	1830	1950	2160	2580	3010	3640		
WLD600-300-16-N	1 1/2"	.531	1650	2550	3540	4910	5950	6820	8580	8890	9470	10520	12540	14610	17700		
WLD600-300-17-N	2"	.657	2890	4460	6190	8590	10410	11930	15010	15540	16560	18400	21940	25540	30950		
WLD600-450-13-N	3/4"	.063	50	70	100	140	160	190	240	250	260	290	350	400	490	530	590
WLD600-450-14-N	1"	.126	210	320	450	620	760	870	1090	1130	1200	1340	1590	1860	2250	2420	2720
WLD600-450-16-N	1 1/2"	.531	1650	2550	3540	4910	5950	6820	8580	8890	9470	10520	12540	14610	17700	19040	21440
WLD600-450-17-N	2"	.657	2890	4460	6190	8590	10410	11930	15010	15540	16560	18400	21940	25540	30950	33290	37490

WLD1800/1800R Series
Guided Float Type

Model	**WLD1800** Non-repairable **WLD1800R** Repairable
Sizes	1/2", 3/4"
Connections	NPT
Body Material	Stainless Steel
PMO Max. Operating Pressure	**400 PSIG**
TMO Max. Operating Temperature	500˚F
PMA Max. Allowable Pressure	400 PSIG @ 500˚F
TMA Max. Allowable Temperature	500˚F @ 400 PSIG

WLD1800
(Non-Repairable)

WLD1800R
(Repairable)

Typical Applications

The **WLD1800/1800R Series** are used on industrial air and gas applications for drainage of liquid from systems.

How It Works

The WLD1800 Series liquid drainers contain a float-operated valve. When liquid enters the drainer, the float rises opening the valve which allows liquid to be drained.

Features

- **Stainless steel body**
- **All stainless steel internals for longer service life**
- **Guided float ensures proper valve seating on every cycle**
- **Repairable unit available (WLD1800R)**

Sample Specification

The liquid drain trap shall have a guided-float operation with a tamper-proof seal-welded stainless steel body and all stainless steel internals. The unit shall be available with an in-line repairable version. All units to be equipped with FNPT threaded end connections.

Installation

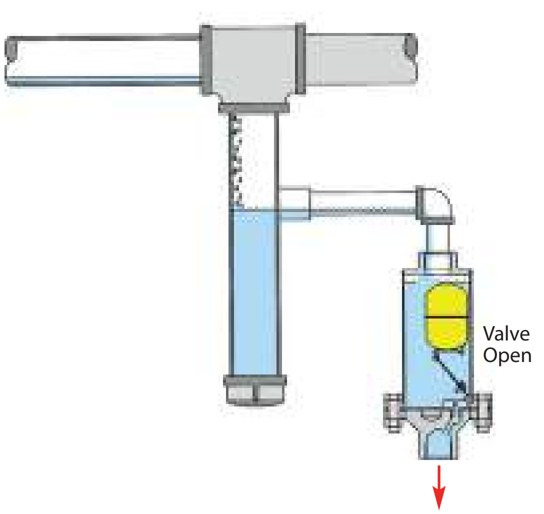
The installation should include an in-line strainer. The trap must be level and upright for the float mechanism to operate. Trap must be adequately sized and properly located in the system.

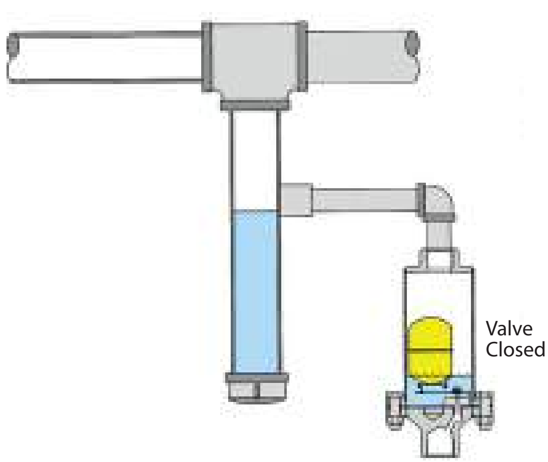
Maintenance

The WLD1800 is non-repairable. The WLD1800R is fully repairable and all working components can be replaced. Repair kits include float, lever & seat assembly, and gaskets. For full maintenance details see Installation and Maintenance Manual.

MATERIALS	
Body	Stainless Steel, AISI 304
Inlet & Outlet Fittings	Stainless Steel, AISI 304
Float Assembly	Stainless Steel, AISI 304
Valve & Lever Assembly	Stainless Steel, AISI 303
Seat	Hardened Stainless Steel
*Gasket (Repairable only)	Grafoil
Washer, Seat	302 Stainless Steel
*Bolt, Hex, HD	Stainless Steel, AISI 316
*Nut, Jam	Stainless Steel, 18-8

** WLD1800R repairable models only.*





WLD1800 - Non-Repairable

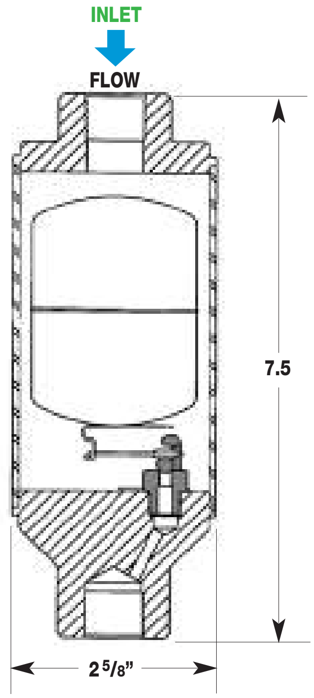
Weight: 4 lbs

Connection Inlet x Outlet	Model Code	PMO PSI	Orifice Size
3/4" x 1/2"	**WLD1811-N**	400	.078"
3/4" x 3/4"	**WLD1812-N**	400	.078"
1/2" x 1/2"	**WLD1813-N**	400	.078"
3/4" x 1/2"	**WLD1821-N**	255	.101"
3/4" x 3/4"	**WLD1822-N**	255	.101"
1/2" x 1/2"	**WLD1823-N**	255	.101"
3/4" x 1/2"	**WLD1831-N**	175	.125"
3/4" x 3/4"	**WLD1832-N**	175	.125"
1/2" x 1/2"	**WLD1833-N**	175	.125"

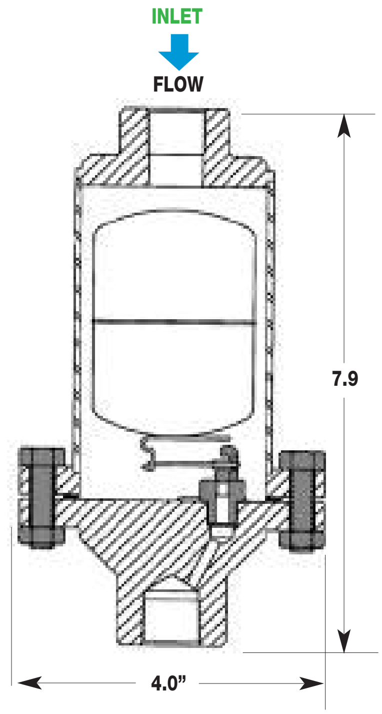
WLD1800R - Repairable

Weight: 5 lbs

Connection Inlet x Outlet	Full Model Code	PMO PSI	Orifice Size
3/4" x 1/2"	**WLD1811R-N**	400	.078"
3/4" x 3/4"	**WLD1812R-N**	400	.078"
1/2" x 1/2"	**WLD1813R-N**	400	.078"
3/4" x 1/2"	**WLD1821R-N**	255	.101"
3/4" x 3/4"	**WLD1822R-N**	255	.101"
1/2" x 1/2"	**WLD1823R-N**	255	.101"
3/4" x 1/2"	**WLD1831R-N**	175	.125"
3/4" x 3/4"	**WLD1832R-N**	175	.125"
1/2" x 1/2"	**WLD1833R-N**	175	.125"



WLD1800
(Non-Repairable)



WLD1800R
(Repairable)

How to Size / Order

Determine the capacity (lbs/hr) required at the specified differential pressure. Locate differential pressure on capacity chart; move down column to capacity required. Make sure to select the correct model based on the maximum inlet pressure.

Example: Required to drain 1,000 lbs/hr at a differential pressure of 200 PSI. The maximum inlet pressure is 250 PSIG.

Select Model: **WLD1822-N** 3/4" x 3/4" (non-repairable) **or** **WLD1822R-N** 3/4" x 3/4" (repairable); capacity up to 1,200 lbs/hr based on 200 PSI differential pressure.

CAPACITIES – *Cold Water (lbs/hr)*

Series	PMO* (PSIG)	Orifice Size	Differential Pressure (PSI) 1	2	5	10	15	20	30	50	100	150	175	200	250	275	300	350	400
WLD1810	400	.078"	60	80	120	130	180	260	315	400	570	700	750	800	900	940	1050	1050	1120
WLD1820	255	.101"	90	120	175	195	275	385	470	610	860	1050	1125	1200	1350	1425			
WLD1830	175	.125"	160	230	325	365	510	730	790	1150	1630	2000	2150						

* PMO based on a liquid with a specific gravity of 1.0. Consult factory for the PMO of a liquid with specific gravity less than 1.0.

CAPACITY CORRECTION FACTORS

Specific Gravity	1	.98	.96	.94	.92	.90	.88	.86	.84	.82	.80	.75	.70	.65	.60	.55	.50
Correction Factor	1	.99	.98	.97	.959	.949	.938	.927	.917	.906	.894	.866	.837	.806	.775	.742	.707

Note: *To obtain capacity with a liquid other than water, multiply water capacity by correction factor.*

WLD1500 Series
Inverted Bucket Type

Model	WLD1501, WLD1502, WLD1504, WLD1521, WLD1522, WLD1524
Sizes	3/4", 1"
Connections	NPT
Body Material	Cast Iron
PMO Max. Operating Pressure	200 PSIG
TMO Max. Operating Temperature	450ºF
PMA Max. Allowable Pressure	250 PSIG up to 450ºF
TMA Max. Allowable Temperature	450ºF @ 250 PSIG

WLD1521/1522/1524
with Strainer

Typical Applications

The **WLD1500 Series** Inverted Bucket Liquid Drain Traps are recommended for the removal of liquids from compressed air systems. A scrubber wire is used to keep bleed hole on top of inverted bucket from clogging due to oil that may be present in the water being drained. Oil mixed with water is typically found on compressed air systems.

How It Works

When there is condensate in the system, the inverted bucket inside the liquid drain trap rests on the bottom due to its weight; with the valve in the open position. This allows liquid entering the trap to be discharged through the seat orifice located at the top. When air enters the trap, the bucket floats to the surface and closes off the discharge valve, containing the air in the system. Eventually, air is bled off through a small hole in the top of the bucket and the bucket sinks; repeating the cycle.

Features

- Hardened stainless steel valves and seat
- Only two moving parts
- Scrubber wire in air vent of bucket
- Discharge orifice at top of trap reduces potential for clogging
- In-line repairable

Sample Specification

Drain trap shall be an inverted bucket trap design with cast iron body, all stainless steel internals, hardened valve & seat, plus a scrubber wire. The unit shall be in-line repairable.

Installation

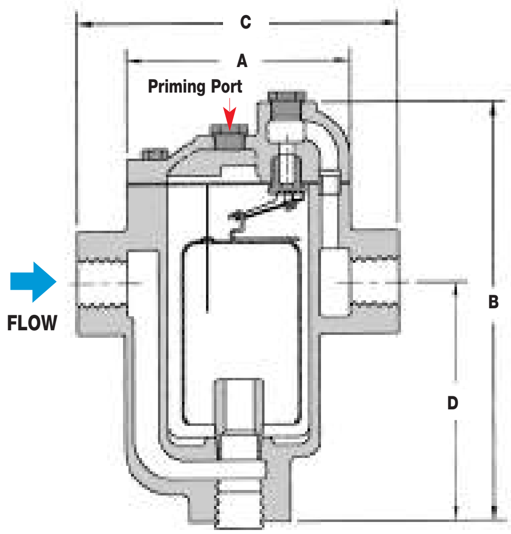
Installation should include isolation valves for maintenance purposes. Trap must be installed in upright position to function properly. It may be necessary to prime the bucket trap by filling it with water through the priming port prior to startup.

Maintenance

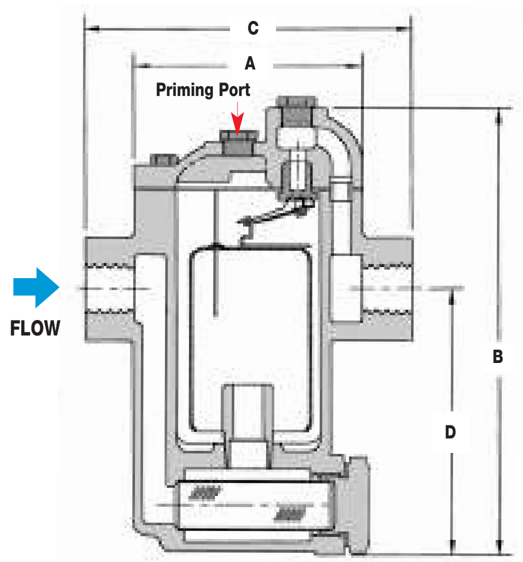
Close isolation valves prior to any maintenance. All working components can be replaced with the drain trap remaining in the pipeline. Repair kits include lever & seat assembly, strainer screen and gaskets. For full maintenance details see Installation and Maintenance Manual.

MATERIALS	
Body & Cover	Cast Iron, ASTM A-278 Class 30
Nuts & Bolts	High-Tensile Steel
Gasket	Non-Asbestos Fiber
Bucket	Stainless Steel
Scrubber	Stainless Steel
Lever & Seat Assembly	Stainless Steel
Valve & Seat	Hardened Stainless Steel
Integral Strainer*	Stainless Steel

** WLD1521, WLD1522 & WLD1524 models only.*



WLD1501/1502/1504



WLD1521/1522/1524
with Strainer

DIMENSIONS & WEIGHTS – *inches /pounds*

Model	Size	A	B	C	D	Weight
WLD1501-13-N	3/4"	3 13/16	5 7/16	5	2 13/16	5
WLD1502-13-N	3/4"	3 13/16	6 15/16	5	4 5/16	6
WLD1504-14-N	1"	7	11 13/16	7 13/16	7	27
WLD1521-13-N	3/4"	3 13/16	6 1/8	5	3 7/16	5.5
WLD1522-13-N	3/4"	3 13/16	7 1/8	5	4 7/16	6
WLD1524-14-N	1"	7	12 7/16	7 13/16	7 7/16	30

How to Size / Order

Determine the capacity (lbs/hr) required at the specified differential pressure. Locate differential pressure on capacity chart; move down column to capacity required. Make sure to select the correct model based on the maximum inlet pressure.

Example:
Required to drain 200 lbs/hr at a differential pressure of 5 PSI. The maximum inlet pressure is 30 PSIG.

Select Model: **WLD1521-13-N**, 3/4" NPT, with strainer, capacity up to 220 lbs/hr based on 5 PSI differential pressure.

Capacity in lbs/hr is based on differential pressure across the drainer. Select a model with an equal or higher PMO (max. operating pressure) than the maximum inlet pressure to the drainer. If the pressure to the drainer exceeds the PMO, the drainer may not open. If discharging to atmosphere, the differential pressure is equal to the inlet pressure.

CAPACITIES – *Cold Water (lbs/hr)*

Model Code	PMO (PSIG)	Size	Differential Pressure (PSI) 2	5	10	25	50	80	100	125	150	180	200
WLD1501-13-N WLD1521-13-N	150	3/4"	145	220	325	510	720	900	1010	1130	1215		
WLD1502-13-N WLD1522-13-N	200	3/4"	170	260	380	595	835	1045	1175	1315	1410	1550	1645
WLD1504-14-N WLD1524-14-N	200	1"	500	760	1105	1740	2460	3065	3450	3865	4140	4555	4835

LIQUID DRAINERS

Disc Type Liquid Drainer

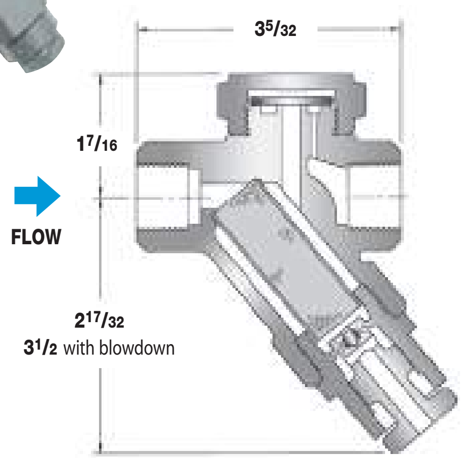
WLD1703S Series
Disc Type

Model	WLD1703S
Sizes	1/2"
Connections	NPT
Body Material	Stainless Steel
Options	Blowdown Valve
PMO Max. Operating Pressure	250 PSIG
TMO Max. Operating Temperature	750°F
PMA Max. Allowable Pressure	915 PSIG up to 250°F
TMA Max. Allowable Temperature	610°F @ 750 PSIG

WLD1703S with Strainer

WLD1703SB with Strainer & Blowdown Valve

WLD1703SB with Strainer & Blowdown Valve



Units: inches

Typical Applications

The **WLD1703S** is used on air and gas applications as drip traps on system mains and other piping runs. These drain traps are ideal for outdoor applications where units are subject to freezing.

How It Works

The disc type liquid drain trap has a cyclic on/off operation with a disc that is pushed open when condensate is present and pulled closed when air or gas tries to escape.

Features

- Rugged, stainless steel body and hardened seat
- Handles a wide range of pressures up to 250 PSIG
- Works in any position (horizontal preferable)
- Integral strainer with blowdown option
- Three-holed balanced discharge
- Freeze-proof in vertical flow-down position

Sample Specification

Drain Trap shall be a Disc Type with an all stainless steel construction. Body shall have a built-in strainer with optional blowdown valve. Integral seat design and disc to be hardened for long service life. Unit shall be capable of installation in any orientation and self-draining when mounted vertically with flow direction downwards.

Installation

Drain Trap can be installed in any position; however, horizontal is preferred. Installation should include isolation valves for maintenance purposes.

Maintenance

Dirt is the most common cause of premature failure. The strainer may require periodic cleaning. For full maintenance details see Installation and Maintenance Manual.

Options

Blowdown valve allows strainer to be cleaned without removal.

MATERIALS

Body	Stainless Steel, AISI 420F
Disc	Stainless Steel, AISI 420
Cap	Stainless Steel, AISI 416
Strainer Screen	Stainless Steel, AISI 304
Blowdown Valve*	Stainless Steel, AISI 303

** WLD1703SB model only.*

CAPACITIES – *Cold Water (lbs/hr)*

Model Code	Description	Pipe Size	Inlet Pressure (PSIG) 2	5	10	25	50	80	100	125	150	180	200	250
WLD1703S-12-N	Strainer	1/2"	90	130	190	300	425	530	600	670	715	790	835	955
WLD1703SB-12-N	Strainer & Blowdown													

Note: *1) Maximum back pressure not to exceed 80% of inlet pressure.*
2) To determine gallons per minute of flow, divide values in chart by 500. ***Example:*** *600 lbs/hr = 600 ÷ 500 = 1.2 GPM*

Pipeline Accessories

Ancillary Products to support your Steam and Hydronic Systems.

Table of Contents

Watson McDaniel

Pipeline Accessories

STAINLESS STEEL CHECK VALVES

Watson McDaniel Check Valves are available in all 316 SS construction in 1⁄2″ thru 3″ sizes and are specifically designed to handle the difficult environments associated with steam and hot condensate service. Check valves can be installed on the discharge side of steam traps to eliminate backflow into the trap. With the specially designed 1⁄4 PSI low cracking pressure spring, these check valves come standard on all Watson McDaniel Pressure Motive Pumps.

Y–STRAINERS

Strainers remove dirt and pipe scale from steam systems to protect critical components such as Regulators, Pumps and Steam Traps from damage. Available in Cast Iron, Carbon Steel and Stainless Steel up to 4″ in size.

SUCTION/MIXING TEES

This is a unique and specialized product used for blending, mixing, aeration or heating by mixing steam and water together. Available in Cast Iron, Bronze and Stainless Steel.

DRIP PAN ELBOWS

Drip Pan Elbows are used to collect and remove condensate. Typically used with steam safety relief valves.

FLASH TANKS

Flash tanks are installed in condensate return systems to vent flash steam and neutralize pressure in condensate return lines. The flash steam may be used for low pressure heating applications or vented to atmosphere.

EJECTORS

Ejectors are used for non-electric pumping of fluids or evacuating a tank or vessel of air or other gases. Used on sterilizing equipment for pre and post-evacuation of the chamber.

AIR ELIMINATORS

Air Eliminators are used on tanks or piping systems to vent air without allowing the liquid inside the tank or piping to escape. Available in Cast Iron and Stainless Steel.

SAFETY RELIEF VALVES

Watson McDaniel Safety Relief Valves are ASME qualified for steam service and are available in Bronze and Cast Iron in 1/2″ thru 6″ sizes.

STEAM TRAP TEST VALVES

Test Valves can be installed downstream of any steam trap to visually inspect the discharge of condensate from the traps. Available in Stainless Steel up to 1″ in size.

EXHAUST HEADS

Exhaust Heads are used to separate entrained water from steam that is being vented directly into the atmosphere, preventing damage to rooftops and other equipment from hot water.

VACUUM BREAKERS

Vacuum Breakers "break the vacuum" caused by the condensing of steam or draining of liquid. These are primarily installed on the top of heat exchangers, allowing condensate to properly drain from the system.

FREEZE & SCALD PROTECTION VALVES

Freeze Protection Valves automatically open and discharge liquid to protect equipment from freeze damage. Scald Protection Valves automatically open and discharge overheated liquid from a system to protect personnel from possible injury due to scalding.

STEAM HUMIDIFIERS

Steam Humidifiers control humidity in commercial offices, hospitals, warehouses and various types of industrial facilities.

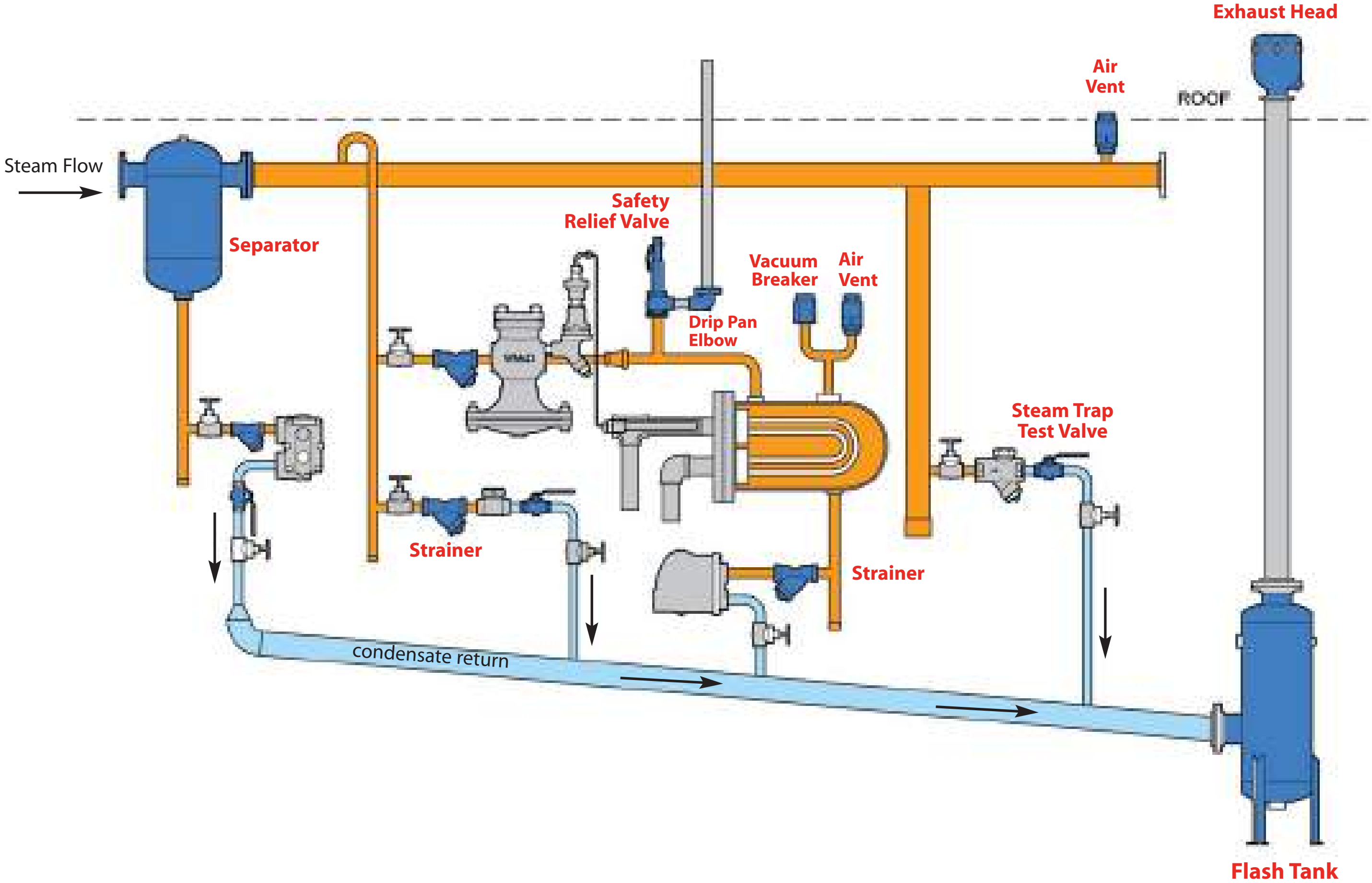
THERMOSTATIC AIR VENTS

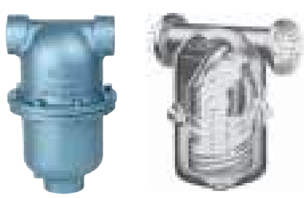
Air Vents purge unwanted air from steam systems which can inhibit the steam from entering process equipment, vessels and piping. Air vents should be placed at all high points in the piping system and on heat transfer equipment.

AIR/STEAM MOISTURE SEPARATORS

Separators are used for the removal of entrained moisture in steam and compressed air lines. Separators should be placed before all regulating valves to eliminate problems caused by water logging and wire drawing of the valve seats.

Application & Usages





AIR/STEAM MOISTURE SEPARATORS

Separators are used for the removal of entrained water from steam or air.

CHECK VALVES

The **WSSCV** is an all stainless steel in-line check valve for steam, gas or liquid service. Used in the petrochemical, pulp & paper, textile and food & beverage industries.

STRAINERS

Strainers are used to remove dirt particles from fluid or steam and provide inexpensive protection for critical equipment such as pumps, meters, valves, traps and turbines.

DRIP PAN ELBOW

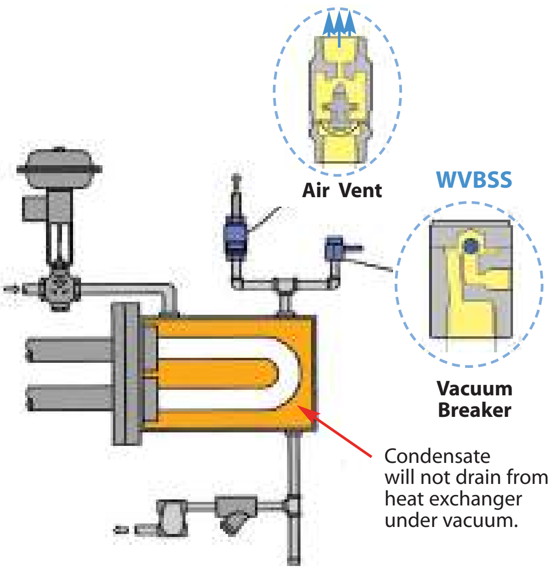
Drip Pan Elbows are used to collect and remove condensate. Typically used on steam boilers and safety valves.

SAFETY RELIEF VALVES

Safety Relief Valves are used for over-pressure protection on steam systems.

Application & Usages

Air Vents & Vacuum Breakers



AIR VENTS (AV2000)

Air vents are used in steam systems for the removal of air and other non-condensable gases from process equipment, vessels and piping. Place at end of steam main and directly on process equipment.

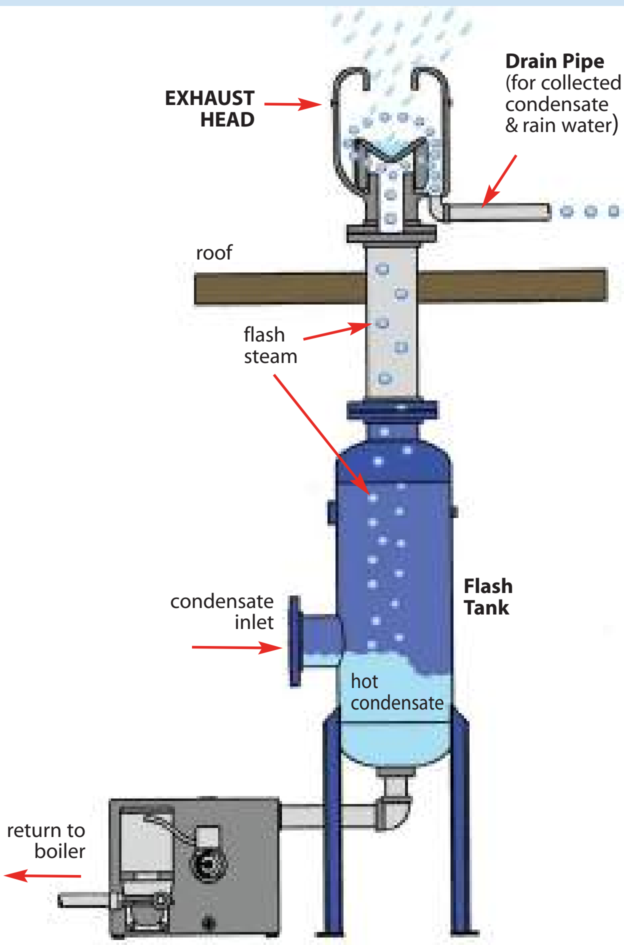
VACUUM BREAKER (WVBSS)

Vacuum breakers allow air to enter a system in order to "break the vacuum."

In a heat exchanger, the vacuum is caused by condensing steam which inhibits condensate drainage.

Drainage of liquids from storage tanks will also cause an undesirable vacuum which inhibits flow or can possibly collapse tank or vessel.

Flash Tanks & Exhaust Heads



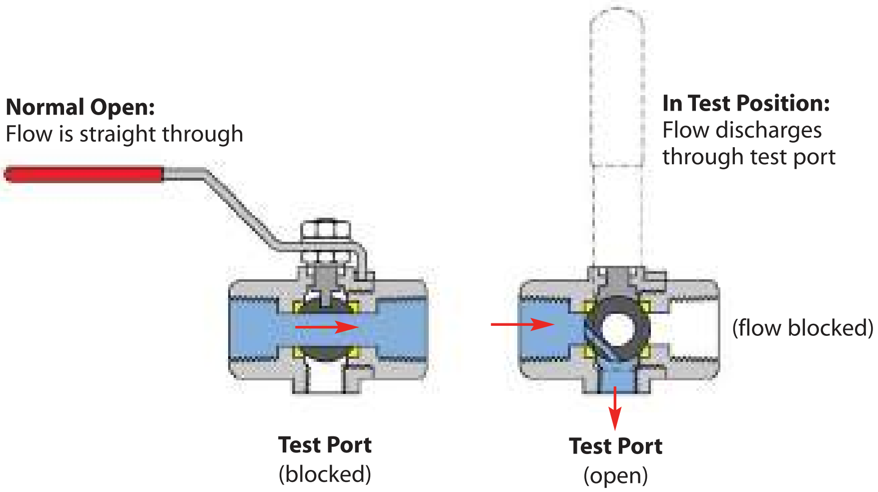
EXHAUST HEADS

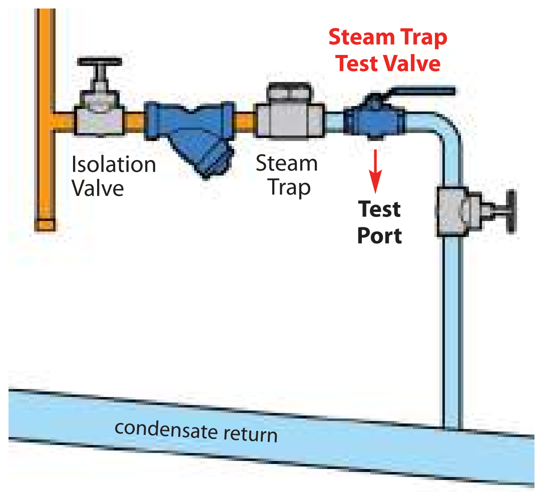
Exhaust Heads separate entrained water from steam prior to being discharged directly to the atmosphere. Eliminates damage to rooftops and other equipment caused by hot condensate.

FLASH TANKS

Flash tanks are installed in condensate return systems to vent flash steam and neutralize pressure in condensate return lines. The flash steam may be vented to atmosphere or used for low pressure heating applications.

Steam Trap Test Valve

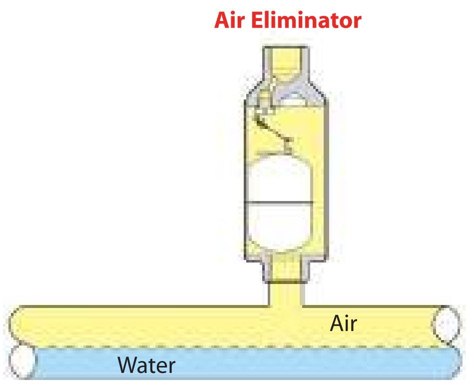


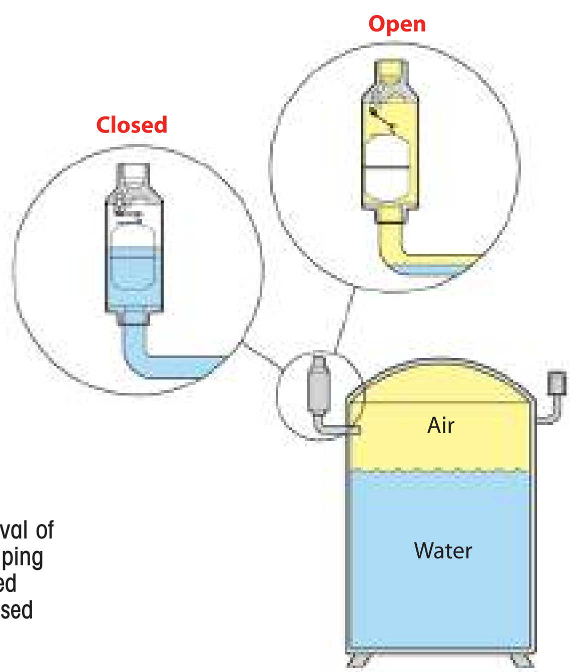


STEAM TRAP TEST VALVE

The **WSTTV** Steam Trap Test Valve offers simple, immediate and visible diagnosis of any steam trap. Turning the handle 90° to the "Test" position will direct flow of steam trap out the test port for visual evaluation of discharge. This is the most effective method to inspect the function of a steam trap.

Air Eliminators



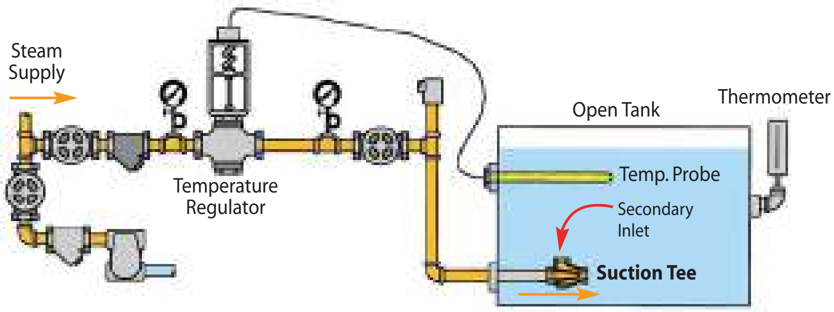


AIR ELIMINATORS

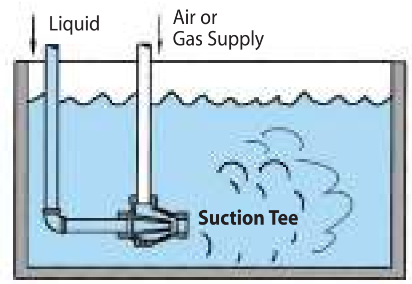
The **AV813** and the **AE1800 Series**
Air Eliminators are used for the removal of air and other gases from vessels or piping systems without allowing the contained liquid to escape. Air Eliminators are used only for liquid systems.

Application & Usages

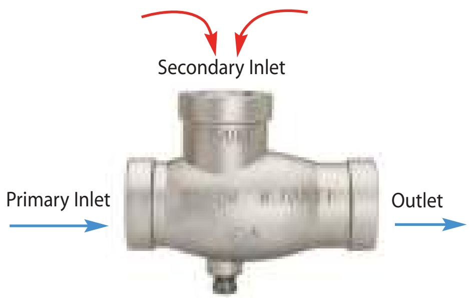
Suction & Mixing Tees



Controlling temperature of large open tank by steam injection
Suction Tees promote the mixing of steam and water. When steam flows through the suction tee, a slight vacuum is created which pulls water through the secondary inlet.



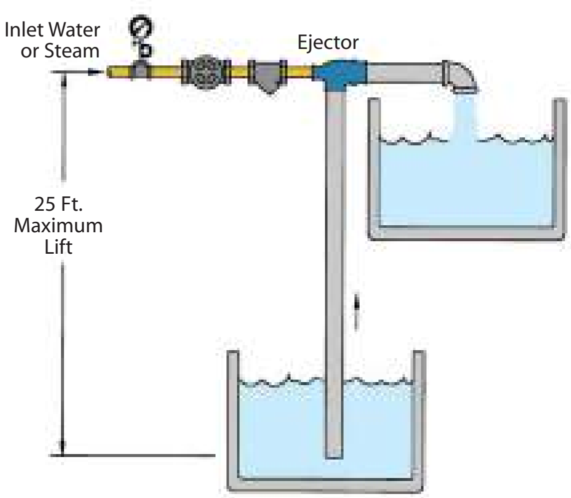
Aeration or Agitation
Liquid pumped through the Suction Tee produces suction, which pulls in air through the secondary inlet.

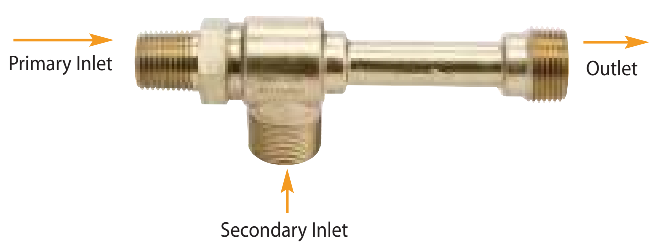


SUCTION OR MIXING TEE

The Watson McDaniel Cast Iron, Bronze or Stainless Steel **Suction Tee** is a specialized type of pipe fitting used for blending, agitation, recirculation, mixing, aeration and heating.

Ejector (Pumping Liquid)





EJECTORS

Watson McDaniel **Ejectors** perform a variety of functions depending upon the application and motive fluid (steam or water) used. See performance charts on the following pages. Applications include: exhausting, agitating, aerating, circulating, pumping and mixing.

When liquid or steam flows thru the primary inlet, a vacuum is created which causes water to be pulled through the secondary inlet. The maximum height that water or any liquid with a specific gravity of 1 can be lifted is 25 feet. Increases in the temperature of the liquid being lifted will cause this maximum height to decrease.

Stainless Steel

Model	WSSCV
Sizes	1/2", 3/4", 1", 1¼", 1½", 2", 3"
Connections	NPT, SW
Body Material	316 Stainless Steel
PMO Max. Operating Pressure	500 PSIG
PMA Max. Allowable Pressure	750˚F PSIG @ 100ºF
TMA Max. Allowable Temperature	850˚F @ 420 PSIG

Note: WSSCV with 1/4 PSI cracking pressure is required for all mechanical pump applications. The 5 PSIG cracking pressure version is also available. See model code chart.

Typical Applications

The Model **WSSCV** is an all stainless steel in-line check valve for steam, gas, or liquid service. It provides tight shut-off, minimizes water hammer and also stops recycling of pumps by preventing back flow of liquid. Used in the petrochemical, pulp & paper, textile and food & beverage industries. The WSSCV all stainless steel check valves will operate much longer and are less problematic than bronze or cast iron check valves.

Features & Options

- 316 Stainless Steel Body and Internals
- Low cracking pressure on spring (1/4 PSI) to minimize resistance and maximize flow.
- Available with optional 5 PSI cracking pressure (must specify at time of order)
- Available with NPT, SW, or optional Flanged connections
- Spring made from Inconel-X-750 to handle extreme temperature as well as corrosive applications
- Body is seam-welded to eliminate O-rings or gasket seals which can be affected by high temperature steam or hot condensate
- Spring assisted closing of check valve to minimize noise and wear

Sample Specification

Check valve shall have a 316 stainless steel body and disc. Spring shall be made from Inconel-X-750. Check valve body to be seam welded together to eliminate need for O-ring or gasket.

MATERIALS	
Body	316 Stainless Steel
Disc	316 Stainless Steel
Spring	Inconel-X-750

NPT

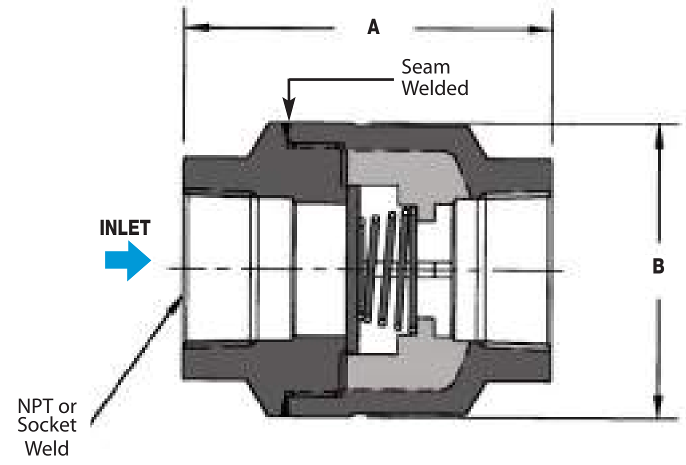
Size/Connection NPT	Model Code	Cracking Pressure* PSI	Weight lbs
1/2"	WSSCV-12-N-0	0.25	1.0
3/4"	WSSCV-13-N-0	0.25	1.5
1"	WSSCV-14-N-0	0.25	2.3
1¼"	WSSCV-15-N-0	0.25	3.5
1½"	WSSCV-16-N-0	0.25	5.3
1½"	WSSCVQF-16-N-0†	0.00	5.3
2"	WSSCV-17-N-0	0.25	8.5
3"	WSSCV-19-N-0	0.25	21
1/2"	WSSCV-12-N-5	5.0	1.0
3/4"	WSSCV-13-N-5	5.0	1.5
1"	WSSCV-14-N-5	5.0	2.3
1¼"	WSSCV-15-N-5	5.0	3.5
1½"	WSSCV-16-N-5	5.0	5.3
2"	WSSCV-17-N-5	5.0	8.5
3"	WSSCV-19-N-5	5.0	21

Socket Weld

Size/Connection SW	Model Code	Cracking Pressure* PSI	Weight lbs
1/2"	WSSCV-12-SW-0	0.25	1.0
3/4"	WSSCV-13-SW-0	0.25	1.5
1"	WSSCV-14-SW-0	0.25	2.3
1¼"	WSSCV-15-SW-0	0.25	3.5
1½"	WSSCV-16-SW-0	0.25	5.3
2"	WSSCV-17-SW-0	0.25	8.5
3"	WSSCV-19-SW-0	0.25	21
1/2"	WSSCV-12-SW-5	5.0	1.0
3/4"	WSSCV-13-SW-5	5.0	1.5
1"	WSSCV-14-SW-5	5.0	2.3
1¼"	WSSCV-15-SW-5	5.0	3.5
1½"	WSSCV-16-SW-5	5.0	5.3
2"	WSSCV-17-SW-5	5.0	8.5
3"	WSSCV-19-SW-5	5.0	21

* Differential Pressure at which valve opens and flow occurs.
† WSSCVQF is a special design check valve for use on the inlet side of the PMPT & PMPNT Pumps. It is center-guided and contains no spring. Used for increasing fill rate of pump.

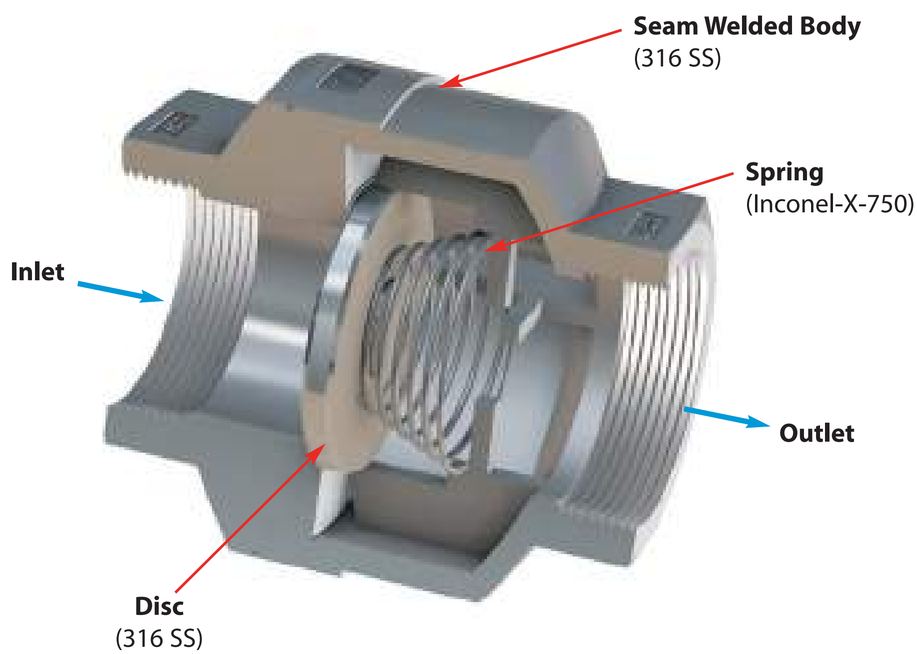
Stainless Steel



DIMENSIONS & SPECIFICATIONS – *inches*							
Size	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	3"
MODEL CODE	WSSCV-12	WSSCV-13	WSSCV-14	WSSCV-15	WSSCV-16	WSSCV-17	WSSCV-19
A	2.69	3.00	3.32	3.81	4.75	5.03	6.87
B	1.62	2.12	2.56	3.06	3.44	4.38	6.19
Weight (lbs)	1.1	1.5	1.9	3.8	4.7	7.7	18.8
Standard Cracking Pressure*	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**
Optional Cracking Pressure*	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**
Cv	7	13	22	39	54	93	180

* **Note:** Differential Pressure at which valve opens and flow occurs (PSI).

WSSCV Check Valve Construction



PIPELINE ACCESSORIES

"UV" Steam-ASME Section VIII Pressure Vessels

Model	**SVB**
Sizes	**1/2", 3/4", 1", 1 1/4", 1 1/2", 2", 2 1/2"**
Connections	**NPT**
Body Material	**Bronze**
PMO Max. Operating Pressure	**250 PSIG (steam)**
TMO Max. Operating Temperature	**406 °F**

Typical Applications

The **SVB** Safety Valves are used for over-pressure protection on unfired pressure vessels in saturated steam systems. Valves are 100% factory tested and made in the USA.

How It Works

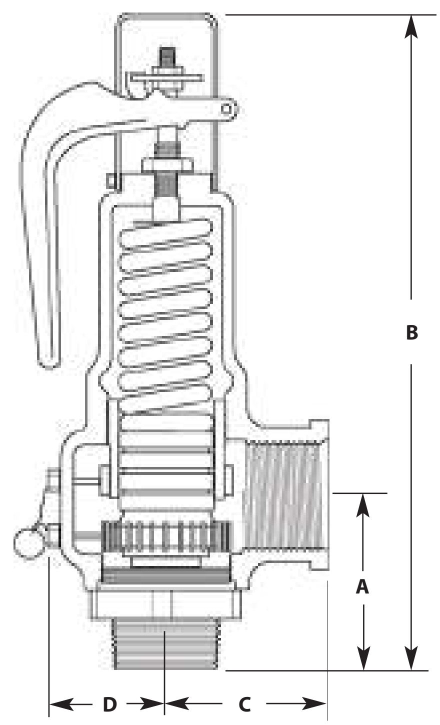
In the event steam pressure increases to the set point, the safety valve will "pop open" discharging steam faster than it can be produced; allowing system pressure to return to safe levels at which point the valve will close.

Features

- Stainless Steel springs
- Teflon®-PFA seat resists corrosive boiler chemicals
- Two control rings for maximum performance and adjustability
- Tapped body drain allows piping of condensate away from valve to protect the internals from fouling

Sample Specification

Safety valves shall be cast bronze construction with stainless steel springs, Teflon-PFA seats and stainless steel stems. Units shall be qualified to the ASME Boiler Code, Section VIII and suitable for steam service.



DIMENSIONS & WEIGHTS – *inches*

Model Code	Orifice Size	Inlet x Outlet MNPT x FNPT	A	B	C	D	Weight (lbs)
SVB-12M-13S-D	D	1/2" x 3/4"	2.21	6.52	1.37	0.84	1.6
SVB-13M-13S-D	D	3/4" x 3/4"	2.21	6.52	1.37	0.84	1.6
SVB-13M-14S-E	E	3/4" x 1"	2.50	7.16	1.75	1.06	2.0
SVB-14M-14S-E	E	1" x 1"	2.64	7.30	1.75	1.06	2.2
SVB-14M-15S-F	F	1" x 1 1/4""	2.95	9.34	2.00	1.44	4.1
SVB-15M-15S-F	F	1 1/4" x 1 1/4"	2.95	9.34	2.00	1.44	4.3
SVB-15M-16S-G	G	1 1/4" x 1 1/2"	3.38	11.01	2.37	1.69	7.4
SVB-16M-16S-G	G	1 1/2" x 1 1/2"	3.38	11.01	2.37	1.69	7.6
SVB-16M-17S-H	H	1 1/2" x 2"	3.63	11.96	2.75	2.06	11.5
SVB-17M-17S-H	H	2" x 2"	3.63	11.96	2.75	2.06	11.6
SVB-16S-18S-J	J	1 1/2" FNPT x 2 1/2" FNPT	3.80	14.00	3.50	2.06	20.0
SVB-17M-18S-J	J	2" x 2 1/2"	4.06	14.25	3.50	2.06	19.9
SVB-18M-18S-J	J	2 1/2" x 2 1/2"	4.50	14.68	3.50	2.06	20.8

MATERIALS

Body	Bronze
Guide Ring	Brass
Disc	Brass
Seat Insert	Teflon®-PFA
Stem	Stainless Steel

“UV” Steam-ASME Section VIII Pressure Vessels

CAPACITIES – *Pounds of saturated steam per hour (lbs/hr)*

Set Pressure (PSIG)	Orifice "D" .129" Diameter	Orifice "E" .230" Diameter	Orifice "F" .359" Diameter	Orifice "G" .586" Diameter	Orifice "H" .919" Diameter	Orifice "J" 1.509" Diameter
15	179	320	499	820	1279	2100
20	207	369	576	945	1474	2421
25	234	418	652	1070	1670	2742
30	262	467	729	1195	1865	3063
35	292	521	813	1333	2080	3416
40	322	574	897	1471	2295	3769
45	352	628	981	1609	2510	4122
50	383	682	1065	1747	2725	4475
55	413	736	1149	1885	2941	4828
60	443	790	1233	2022	3156	5181
65	473	844	1317	2160	3371	5535
70	503	897	1401	2298	3586	5888
75	534	951	1485	2436	3801	6241
80	564	1005	1569	2574	4016	6594
85	594	1059	1653	2712	4231	6947
90	624	1113	1737	2849	4446	7300
95	654	1167	1821	2987	4661	7653
100	684	1220	1905	3125	4876	8007
105	715	1274	1989	3263	5091	8360
110	745	1328	2073	3401	5306	8713
115	775	1382	2157	3539	5521	9066
120	805	1436	2241	3677	5736	9419
125	835	1489	2325	3814	5951	9772
130	866	1543	2409	3952	6167	10125
135	896	1597	2493	4090	6382	10479
140	926	1651	2577	4228	6597	10832
145	956	1705	2661	4366	6812	11185
150	986	1759	2745	4504	7027	11538
155	1017	1812	2829	4641	7242	11891
160	1047	1866	2913	4779	7457	12244
165	1077	1920	2997	4917	7672	12597
170	1107	1973	3081	5055	7887	12951
180	1167	2081	3249	5331	8317	13657
190	1228	2189	3417	5606	8747	14363
200	1288	2296	3585	5882	9177	15069
210	1349	2404	3753	6158	9608	15776
220	1409	2512	3921	6433	10038	16482
230	1469	2619	4089	6709	10468	17188
240	1530	2727	4257	6985	10898	17894
250	1590	2834	4425	7260	11328	18601
Approx. 1 PSI Incr.	6.0	10.8	16.8	27.6	43.0	70.6

Notes: 1) Ratings are 90% of actual capacity.
2) For Set Pressures over 250 PSIG, consult factory.
3) For other sizes, consult factory.

"UV" Steam-ASME Section VIII Pressure Vessels

Model	**SVI**
Sizes	**1 1/2", 2", 2 1/2", 3", 4", 6"**
Connections	**NPT, FLG**
Body Material	**Cast Iron**
PMO Max. Operating Pressure	**250 PSIG (Steam)**
TMO Max. Operating Temperature	**422° F**

Typical Applications

The **SVI** Safety Valves are used for over-pressure protection on unfired pressure vessels in saturated steam systems. Valves are 100% factory tested and made in the USA.

How It Works

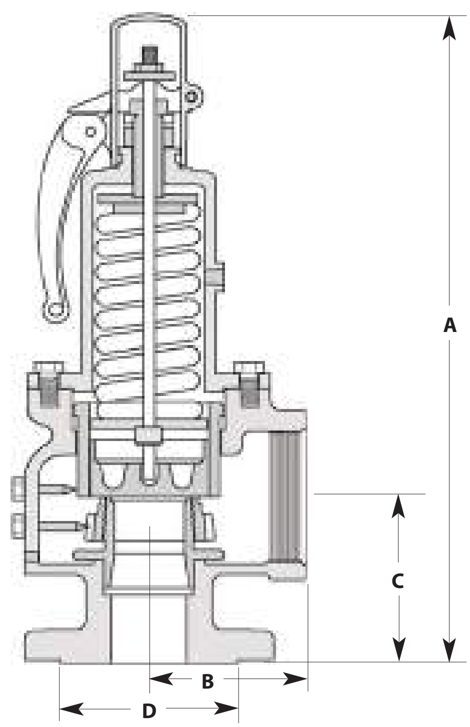
In the event steam pressure increases to the set point, the safety valve will "pop open" discharging steam faster than it can be produced; allowing system pressure to return to safe levels at which point the valve will close.

Features

- Stainless Steel wetted trim nozzle & disc
- Metal to metal seating, lapped to optimum flatness
- Tapped body drain allows piping of condensate away from valve to protect the internals from fouling
- Two control rings assure maximum performance and adjustability

Sample Specification

Safety valves shall be high capacity design with cast iron construction featuring rust-proof stainless steel stems, springs, washers and metal-to-metal lapped seats. Units shall be qualified to the ASME Boiler Code Section VIII and suitable for steam service.



DIMENSIONS & WEIGHTS – *inches*

Model Code	Valve Size Inlet x Outlet	Orifice Size	A	B	C	Hex Flat D	Weight (lbs)
SVI-16F-18S-J	1 1/2" 250#FLG x 2 1/2" FNPT	J	15	4	4.31		35
SVI-17F-19S-K	2" 250#FLG x 3" FNPT	K	16	4	4.63		36
SVI-17S-19S-K	2" FNPT x 3" FNPT	K	16	4	4.63	3.75	37
SVI-18F-19S-K	2 1/2" 250#FLG x 3" FNPT	K	16	4	4.63		41
SVI-19F-19S-K	3" 250#FLG x 3" FNPT	K	16	4	4.63		45
SVI-18F-20S-L	2 1/2" 250#FLG x 4" FNPT	L	22	5.13	5.63		84
SVI-18S-20S-L	2 1/2" FNPT x 4" FNPT	L	22	5.13	5.63	5.38	81
SVI-19F-20S-L	3" 250#FLG x 4" FNPT	L	22	5.13	5.63		85
SVI-20F-20S-L	4" 250#FLG x 4" FNPT	L	22	5.13	5.63		90
SVI-19S-20S-M	3" FNPT x 4" FNPT	M	22	5.13	5.63	5.38	80
SVI-19F-20S-M	3" 250#FLG x 4" FNPT	M	22	5.13	5.63		87
SVI-20F-20S-M	4" 250#FLG x 4" FNPT	M	22	5.13	5.63		95
SVI-20F-22F-N	4" 250#FLG x 6" 125#FLG	N	28	7.25	6.75		210
SVI-20F-22F-P	4" 250#FLG x 6" 125#FLG	P	28	7.25	6.75		215
SVI-22F-23F-Q	6" 250#FLG x 8" 125#FLG	Q	42	10	9.25		530
SVI-22F-23F-R	6" 250#FLG x 8" 125#FLG	R	42	10	9.25		530

MATERIALS

Body	Cast Iron
Guide Ring	Brass
Disc	Stainless Steel
Stem	Stainless Steel

"UV" Steam-ASME Section VIII Pressure Vessels

CAPACITIES – *Pounds of saturated steam per hour (lbs/hr)*

Set Pressure (PSIG)	Orifice Letter / Area in Square Inches							
	"J"= 1.358	"K" = 1.926	"L" = 2.990	"M" = 3.774	"N" = 4.550	"P" =6.692	"Q" = 11.593	"R" = 16.798
15	2008	2848	4421	5580	6728	9895	17141	24820
20	2315	3283	5097	6433	7756	11408	19762	28615
25	2622	3719	5773	7287	8785	12921	22383	32410
30	2929	4154	6449	8140	9814	14434	25004	36205
35	3267	4633	7193	9079	10945	16098	27887	40379
40	3604	5112	7936	10017	12077	17762	30771	44554
45	3942	5591	8680	10956	13208	19426	33654	48729
50	4280	6070	9423	11894	14340	21091	36537	52903
55	4618	6549	10167	12833	15471	22755	39420	57078
60	4955	7028	10911	13771	16603	24419	42303	61252
65	5293	7507	11654	14710	17735	26083	45186	65427
70	5631	7986	12398	15649	18866	27748	48069	69601
75	5969	8465	13141	16587	19998	29412	50952	73776
80	6306	8944	13885	17526	21129	31076	53835	77951
85	6644	9423	14629	18464	22261	32740	56719	82125
90	6982	9902	15372	19403	23392	34405	59602	86300
95	7319	10381	16116	20341	24524	36069	62485	90474
100	7657	10860	16859	21280	25655	37733	65368	94649
105	7995	11339	17603	22218	26787	39397	68251	98823
110	8333	11818	18346	23157	27919	41062	71134	102998
115	8670	12297	19090	24096	29050	42726	74017	107173
120	9008	12776	19834	25034	30182	44390	76900	111347
125	9346	13255	20577	25973	31313	46055	79783	115522
130	9684	13734	21321	26911	32445	47719	82666	119696
135	10021	14213	22064	27850	33576	49383	85550	123871
140	10359	14692	22808	28788	34708	51047	88433	128045
145	10697	15171	23552	29727	35839	52712	91316	132220
150	11034	15650	24295	30666	36971	54376	94199	136395
155	11372	16129	25039	31604	38103	56040	97082	140569
160	11710	16608	25782	32543	39234	57704	99965	144744
165	12048	17087	26526	33481	40366	59369	102848	148918
170	12385	17566	27270	34420	41497	61033	105731	153093
175	12723	18045	28013	35358	42629	62697	108614	157267
180	13061	18524	28757	36297	43760	64361	111497	161442
185	13399	19003	29500	37236	44892	66026	114381	165617
190	13736	19482	30244	38174	46023	67690	117264	169791
195	14074	19961	30988	39113	47155	69354	120147	173966
200	14412	20440	31731	40051	48287	71018	123030	178140
205	14749	20919	32475	40990	49418	72683	125913	182315
210	15087	21398	33218	41928	50550	74347	128796	186489
215	15425	21876	33962	42867	51681	76011	131679	190664
220	15763	22355	34706	43806	52813	77675	134562	194839
225	16100	22834	35449	44744	53944	79340	137445	199013
230	16438	23313	36193	45683	55076	81004	140329	203188
235	16776	23792	36936	46621	56207	82668	143212	207362
240	17113	24271	37680	47560	57339	84332	146095	211537
245	17451	24750	38424	48498	58471	85997	148978	215711
250	17789	25229	39167	49437	59602	87661	151861	219886
Approx. 1 PSI incr.	68	96	149	188	226	333	577	835

Notes: 1) Ratings are 90% of actual capacity. 2) For Set Pressures over 250 PSIG, consult factory. 3) For other sizes, consult factory.
4) ASME Section I – Steam Boilers – pounds of saturated steam per hour @ 3% or 2 PSIG accumulation (whichever is greater).
5) ASME Section VIII – Pressure Vessels – pounds of saturated steam per hour @ 10 % or 3 PSIG accumulation (whichever is greater).

Cast Iron

Model	**DPL**
Sizes	**3/4" through 8"**
Connections	**NPT, FLG**
Body Material	**Cast Iron**
PMO Max. Operating Pressure	**250 PSIG**

DPL
Flanged

Typical Applications

The **DPL** Drip Pan Elbow is used to collect and remove condensate. Typically used with steam boilers, pressure relief valves, safety valves and steam pressure vessels and lines.

Features

- Collects discharge condensate from steam systems
- Returns condensate to safe areas
- Increases life of safety valves
- Reduces discharge piping strain
- Female NPT or Flanged connections available

Sample Specification

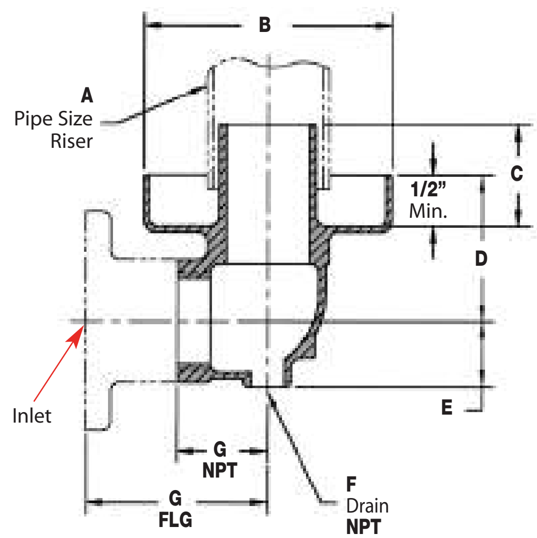
Drip Pan Elbow shall be made of cast iron and conform to the Power Piping Code. It shall have a pan to collect condensate in the steam riser pipe and a drain to pipe away the condensate.

HOW TO ORDER

Specify pipe size needed for application.

MATERIALS

Body	Cast Iron



DIMENSIONS & WEIGHTS – *inches*

Size	Connection	Model Code	A	B	C	D	E	F	G	Weight (lbs)
3/4"	NPT	**DPL-13-N**	$1\frac{1}{2}$	$3\frac{3}{4}$	$1\frac{3}{4}$	$2\frac{3}{4}$	$1\frac{1}{32}$	1/4	$1\frac{1}{2}$	2
1"	NPT	**DPL-14-N**	$1\frac{1}{2}$	$3\frac{3}{4}$	$1\frac{3}{4}$	$2\frac{3}{4}$	$1\frac{1}{32}$	1/4	$1\frac{1}{2}$	2
$1\frac{1}{4}$"	NPT	**DPL-15-N**	2	$5\frac{1}{2}$	$2\frac{15}{32}$	$4\frac{1}{8}$	$1\frac{7}{16}$	3/8	$2\frac{1}{8}$	8
$1\frac{1}{2}$"	NPT	**DPL-16-N**	2	$5\frac{1}{2}$	$2\frac{15}{32}$	$4\frac{1}{8}$	$1\frac{7}{16}$	3/8	$2\frac{1}{8}$	8
2"	NPT	**DPL-17-N**	3	$6\frac{1}{4}$	$2\frac{3}{8}$	$3\frac{5}{8}$	$1\frac{5}{8}$	1/2	$2\frac{1}{4}$	9
$2\frac{1}{2}$"	NPT	**DPL-18-N**	4	$7\frac{3}{8}$	3	$4\frac{5}{16}$	$1\frac{15}{16}$	3/4	$2\frac{11}{16}$	13
3"	NPT	**DPL-19-N**	4	8	$3\frac{1}{2}$	$4\frac{7}{8}$	$2\frac{5}{16}$	3/4	$3\frac{1}{8}$	19
4"	NPT	**DPL-20-N**	6	$9\frac{5}{8}$	$4\frac{1}{2}$	$5\frac{3}{4}$	$2\frac{7}{8}$	3/4	$3\frac{3}{4}$	28
6"	125# FLG	**DPL-22-F125**	8	$12\frac{3}{4}$	$6\frac{5}{8}$	$7\frac{9}{16}$	$4\frac{3}{16}$	3/4	8	105
8"	125# FLG	**DPL-23-F125**	10	$16\frac{1}{2}$	$7\frac{1}{2}$	$8\frac{9}{16}$	$5\frac{3}{8}$	1	$10\frac{3}{4}$	202

Note: DPL is sized to outlet connection of SRV (safety relief valve).

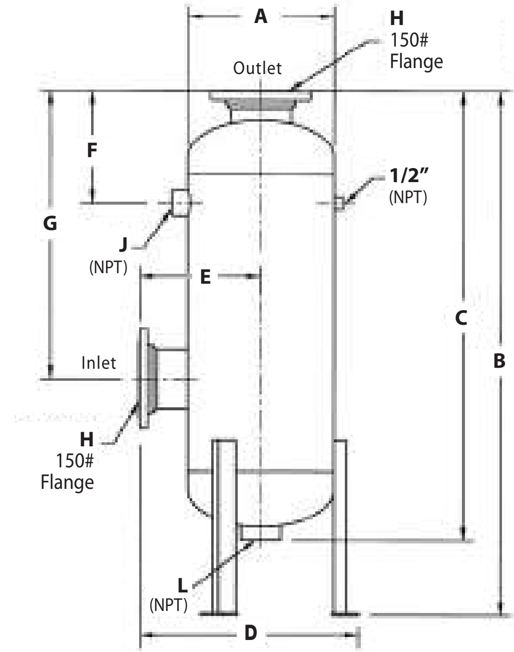
Flash Steam Recovery Vessel

WFLV Series

Carbon Steel

Model	WFLV
Sizes	6”, 8”, 12”, 16”
Connections	150# RF
Body Material	Carbon Steel
PMO Max. Operating Pressure	150 PSIG
TMO Max. Operating Temperature	366°F
PMA Max. Allowable Pressure	150 PSIG @ 562˚F

Note: 250 PSIG unit available. Consult factory.



Typical Applications

The **WFLV** Flash tanks are installed in condensate return systems to separate off flash steam from hot condensate and neutralize pressure in condensate return lines. The flash steam may be used for low pressure heating applications or vented to atmosphere.

How to Size / Order

Use **Table 1** to determine amount of Flash Steam that will be generated by the hot pressurized condensate. The percentage of Flash Steam formed is found where Condensate Pressure and Flash Tank Pressure intersect.

Multiply your Condensate Load by the decimal equivalent of the Flash Steam Percent to determine the amount of Flash Steam in lbs/hr. Then, use **Figure 1** to determine Flash Tank Size required:

Example: Condensate Pressure: **100 PSIG**
Flash Tank Pressure: **20 PSIG**
Condensate Load: **8,000 lbs/hr**
% Flash Steam: **8.7**% from chart
Decimal Equivalent % Flash Steam = **.087**

.087 x 8000 = 696 lbs/hr of flash steam

Therefore Choose: **12” FLASH TANK**

Note: All Watson McDaniel flash steam recovery vessels are supplied with ASME Section VIII Code Stamp.

Figure 1 – Recovery Vessel Capacities

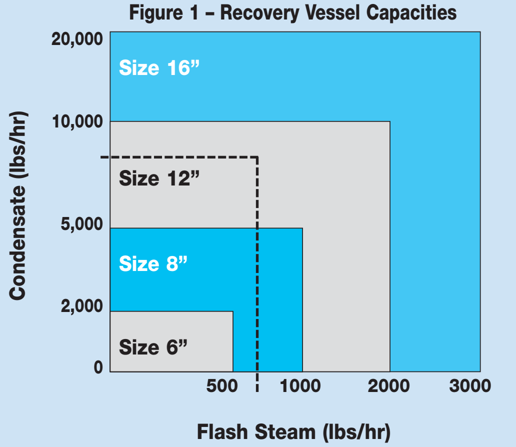


Table 1 – PERCENT (%) FLASH STEAM

Produced when condensate is discharged to atmosphere (0 PSIG) or into a flash tank controlled at various pressures

Condensate Pressure (PSIG)	Flash Tank Pressure (PSIG)								
	0	5	10	20	30	40	60	80	100
5	1.6	0.0							
10	2.9	1.3	0.0						
15	3.9	2.4	1.1						
20	4.9	3.3	2.1	0.0					
30	6.5	5.0	3.7	1.7	0.0				
40	7.8	6.3	5.1	3.0	1.4	0.0			
60	10.0	8.5	7.3	5.3	3.7	2.3	0.0		
80	11.8	10.3	9.1	7.1	5.5	4.2	1.9	0.0	
100	13.3	11.8	10.6	**8.7**	7.1	5.8	3.5	1.6	0.0
125	14.9	13.5	12.3	10.4	8.8	7.5	5.3	3.4	1.8
150	16.3	14.9	13.7	11.8	10.3	9.0	6.8	4.9	3.3
200	18.7	17.3	16.2	14.3	12.8	11.5	9.4	7.6	6.0
250	20.8	19.4	18.2	16.4	14.9	13.7	11.5	9.8	8.2
300	22.5	21.2	20.0	18.2	16.8	15.5	13.4	11.7	10.2
350	24.1	22.8	21.7	19.9	18.4	17.2	15.1	13.4	11.9
400	25.6	24.2	23.1	21.4	19.9	18.7	16.7	15.0	13.5

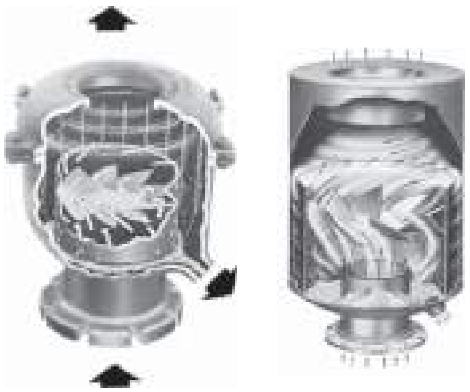
DIMENSIONS & WEIGHTS – *inches*

Tank Diameter	Model Code	Side In/Top Out 150#FLG (H)	A	B	C	D	E	F	G	J	L	Weight (lbs)
6”	WFLV-6-18-F150	2 1/2”	6 5/8	47	38 1/2	12	8	9	25 1/2	3/4	1 1/2	105
8”	WFLV-8-20-F150	4”	8 5/8	48	39 3/4	13	8 1/2	9 1/2	25 5/8	3/4	2	172
12”	WFLV-12-21-F150	5”	12 3/4	49 1/2	41 1/4	21	11 3/4	11 1/2	26	1 1/2	3	210
16”	WFLV-16-22-F150	6”	16	58	50	24	13 3/8	12 1/2	32	2	3	300

EHC, EHF & EHFSS

Cast Iron, Carbon Steel & Stainless Steel

Model	EHC	EHF	EHFSS
Sizes	1", 1 1/2", 2", 2 1/2", 3", 4", 5", 6", 8", 10"	2, 2 1/2", 3", 4", 5", 6", 8", 10"	
Connections	NPT, 125# FLG	150# FLG	
Body Material	Cast Iron	Carbon Steel	Stainless Steel



Typical Applications

Exhaust Heads are used to separate entrained water from flash steam prior to being discharged or vented to the atmosphere. Typically used to eliminate water damage to rooftops and other equipment.

How It Works

Exhaust heads use the cyclonic effect where the velocity of the steam is used to generate centrifugal motion that whirls the steam and throws the entrained water to the wall of the unit where it is released to a drain below. Correct sizing of exhaust heads for steam service is important in order to assure the highest possible desiccation of the steam.

Sample Specification

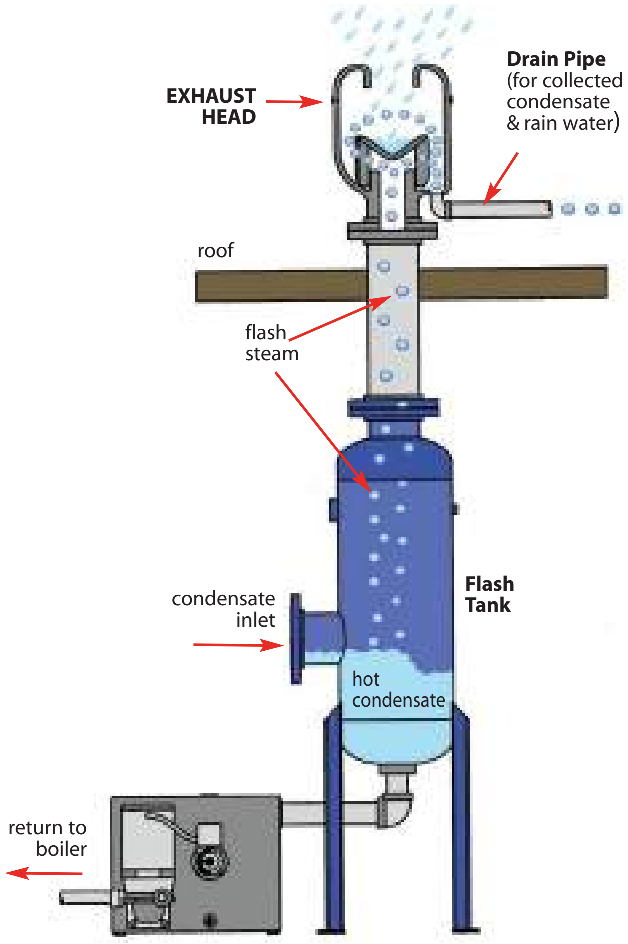
Exhaust Head shall be a cyclone design for vertical venting to atmosphere. Unit shall have a vortex containment plate feature to prevent re-entrainment of liquid. Exhaust Head to be constructed in cast iron, carbon steel or stainless steel and available in FNPT and flanged connections.

Installation

Exhaust Head must be installed at the top of a vertical vent pipe. Exercise standard piping and structural practices when installing this unit. Proper drainage of the exhaust head is essential for proper operation. Pipe the drain Connection of the exhaust head to a roof gutter or down spout.

Exhaust Head Use:

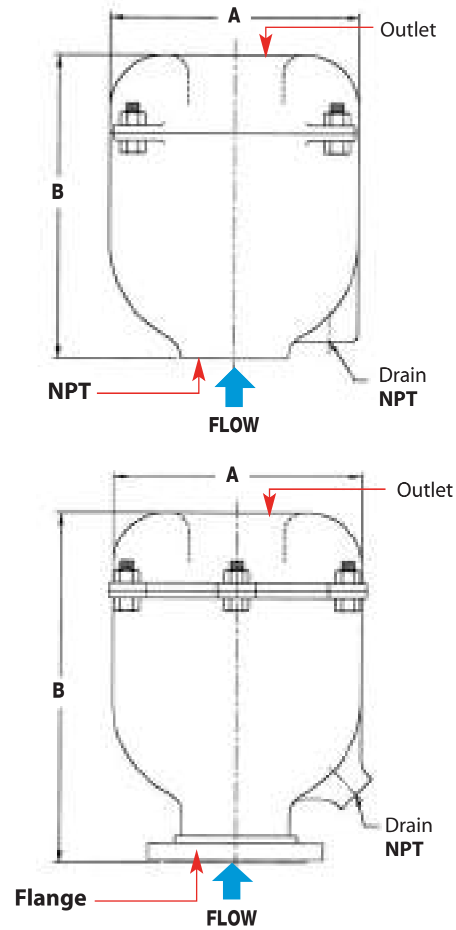
The EHC Series Exhaust Heads are used to separate entrained water from flash steam prior to being vented to the atmosphere. Typically used to eliminate water damage to rooftops and other equipment.



PIPELINE ACCESSORIES

EHC, EHF & EHFSS

Cast Iron, Carbon Steel & Stainless Steel



EHC (Cast Iron)

EHC DIMENSIONS *(inches),* **CAPACITIES** *(lbs/hr)*

Inlet Size	Inlet Connection	Model Code (Cast Iron)	A	B	Drain NPT	Weight (lbs)	Capacity*
1"	NPT	EHC14-N	5 1/4	6 1/8	1/2	12	160
1 1/2"	NPT	EHC16-N	5 1/4	6 1/8	1/2	12	370
2"	NPT	EHC17-N	7 1/2	8 7/8	3/4	32	1,000
2 1/2"	NPT	EHC18-N	7 1/2	8 7/8	3/4	32	1,000
3"	NPT	EHC19-N	8 3/4	11 1/4	3/4	50	2,100
4"	NPT	EHC20-N	10	11 7/8	1	50	2,700
3"	125# FLG	EHC19-F125	8 3/4	15	3/4	60	2,700
4"	125# FLG	EHC20-F125	10	15	1	82	2,700
5"	125# FLG	EHC21-F125	13	14	1 1/2	90	4,000
6"	125# FLG	EHC22-F125	14 3/4	18 3/4	1 1/2	137	6,000
8"	125# FLG	EHC23-F125	18	20	2	170	10,500
10"	125# FLG	EHC24-F125	23	24	2	335	16,000

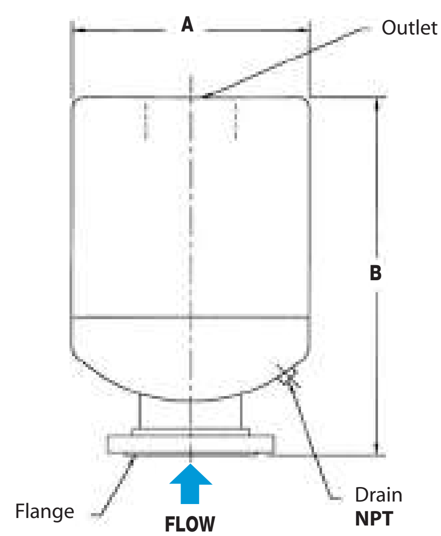
** Capacity in pounds of exhaust steam per hour at atmospheric pressure of 14.7 PSIA.*
Note: For Stainless Steel versions replace EHF with EHFSS in model code. Example: ***EHFSS17-150***

EHF (Carbon Steel) & EHFSS (Stainless Steel)

EHF & EHFSS DIMENSIONS *(inches)* **& CAPACITIES** *(lbs/hr)*

Inlet Size	Inlet Connection	Model Code (Carbon Steel)	A	B	Drain NPT	Weight (lbs)	Capacity*
2"	150# FLG	EHF17-F150	8 5/8	16	1	95	1,000
2 1/2"	150# FLG	EHF18-F150	8 5/8	16	1	110	1,000
3"	150# FLG	EHF19-F150	10 3/4	19	1 1/2	115	1,600
4"	150# FLG	EHF20-F150	14	24	1 1/2	125	2,700
5"	150# FLG	EHF21-F150	16	26	1 1/2	145	4,000
6"	150# FLG	EHF22-F150	18	30	1 1/2	177	6,000
8"	150# FLG	EHF23-F150	20	36	2	320	10,500
10"	150# FLG	EHF24-F150	24	42	2	340	16,000

** Capacity in pounds of exhaust steam per hour at atmospheric pressure of 14.7 PSIA.*

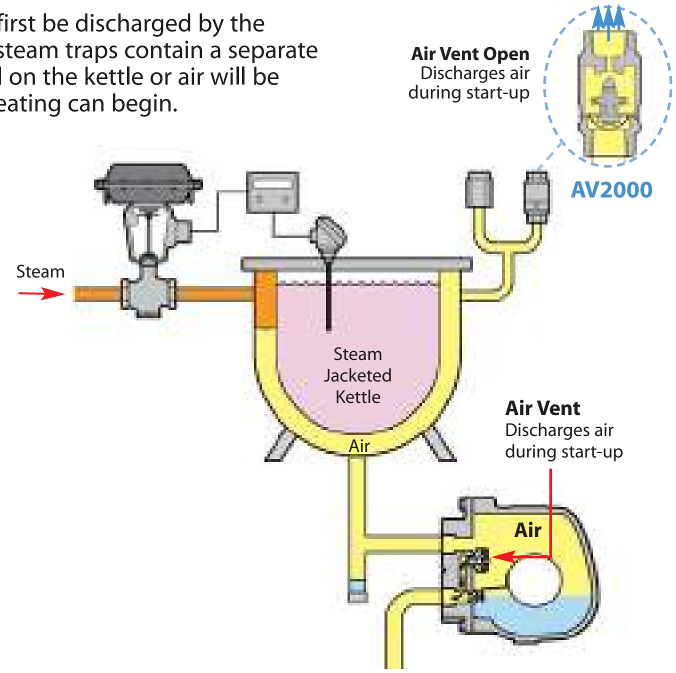


Why Are Air Vents & Vacuum Breakers Needed?

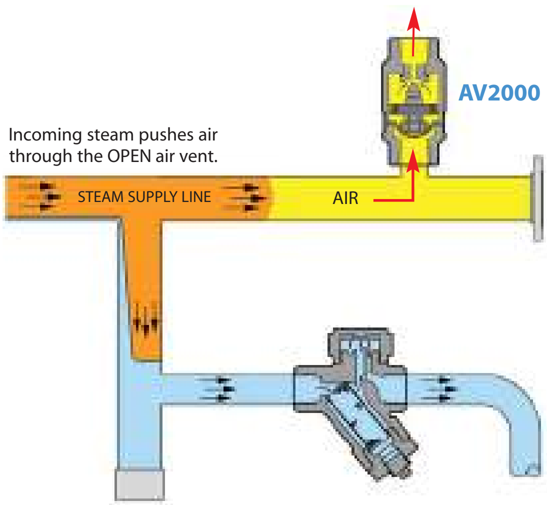
Air Discharging on Start-Up

(Air Vent Open)

On start-up, the steam jacketed kettle is filled with air which must first be discharged by the Air Vents to allow steam to enter for heating. Float & Thermostatic steam traps contain a separate thermostatic vent; however, additional air vents should be installed on the kettle or air will be trapped. The faster air is expelled, the faster steam can enter and heating can begin.



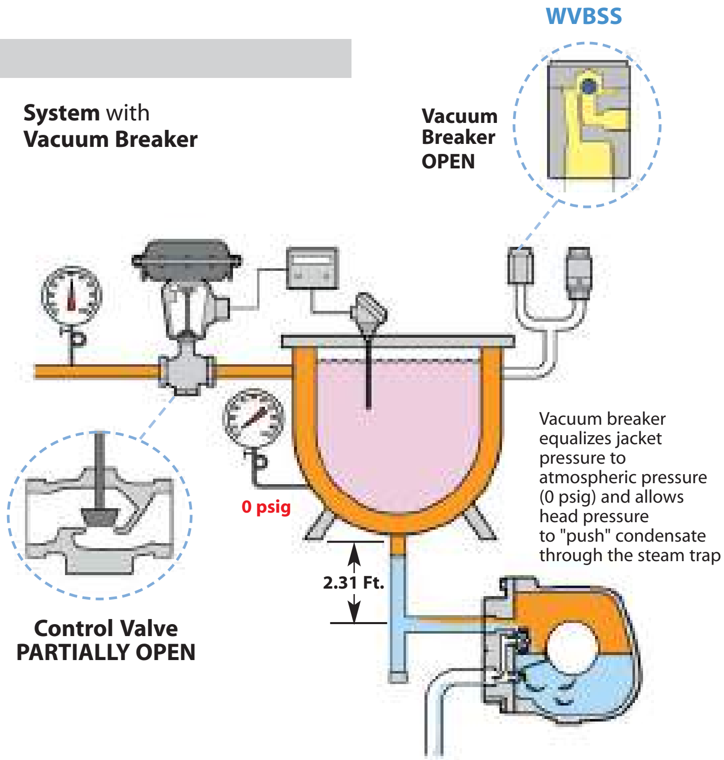
Air Vents are installed at the end of steam mains as well as other high points in the system. Temperature sensitive Air Vent is **OPEN** when cooler air is present and **CLOSED** when hot steam enters the system.



Temperature Set Point is Reached

Steam Flow is significantly Reduced after the Temperature Set Point is reached

Once the set temperature is achieved, only a small amount of steam is required to maintain the temperature of the product inside the jacketed kettle. The steam supply valve will modulate to a near shut-off condition, dropping the pressure, and the kettle will then be operating in vacuum. This action will impede the discharge of condensate as the pressure in the jacket will be less than atmospheric. Therefore, a vacuum breaker is required to allow air to enter the jacket and equalize the pressure. This then allows drainage of condensate through the steam trap by gravity. If the vertical discharge leg from the jacket is 2.3 ft., this will provide 1 psi head pressure to assist with condensate drainage.



Vacuum Breaker

WVBSS

Stainless Steel

Model Code	**WVBSS-12-N**
Sizes	1/2"
Connections	NPT
Body Material	Stainless Steel
PMO Max. Operating Pressure	**300 PSIG**
TMO Max. Operating Temperature	752°F
PMA Max. Allowable Pressure	300 PSIG up to 752°F
TMA Max. Allowable Temperature	752°F @ 300 PSIG

Typical Applications

The **WVBSS** Vacuum Breaker is used on heat exchangers, air coils, jacketed kettles, pressing machines, boiler feed water tanks, sparge systems, water lines, or anywhere else an unwanted vacuum may occur. The WVBSS allows air to enter the steam or liquid system in order to "break the vacuum" caused by the condensing of steam or draining of liquid from a system. The elimination of vacuum is necessary to allow proper drainage of liquid from process systems.

How It Works

The Vacuum Breaker functions like a simple check valve. Outside air is allowed to enter the system through the air inlet. However, when steam or water try to escape, the vacuum breaker closes off tightly.

Features

- All stainless steel construction
- Small and compact

Sample Specification

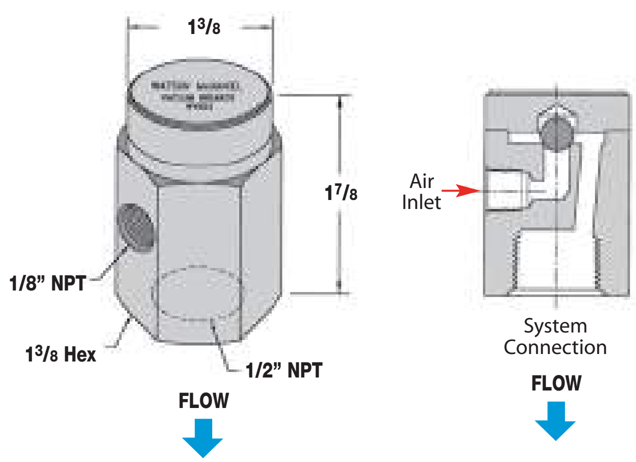
Vacuum Breaker shall be all stainless steel construction.

Installation

Unit must be installed in a vertical position and should be placed at the highest point in the system.

MATERIALS	
Body	Stainless Steel, Series 300
Ball	Hardened Stainless Steel
Nameplate	Stainless Steel, Series 300

DIMENSIONS – *inches*



CAPACITIES – *Air (SCFM)*

Size NPT	inches Hg Vacuum 2	4	6	8	10	12
1/2"	2.4	3.4	4.0	4.3	4.7	4.9

AVT125

Thermostatic Air Vent

Model	**AVT125**
Sizes	1/2", 3/4"
Connections	NPT
Body Material	Forged Brass
PMO Max. Operating Pressure	**125 PSIG**
TMO Max. Operating Temperature	353ºF
PMA Max. Allowable Pressure	125 PSIG up to 450ºF
TMA Max. Allowable Temperature	450ºF @ 125 PSIG

Air Vents are used for Removing Air from Steam Systems

Typical Applications

The **AVT125** is used on steam applications up to 125 PSIG for removal of air and non-condensable gases from process equipment, vessels and piping. The air vent should be located at a high point in the system or vessel and can be installed in any orientation.

How It Works

The thermostatic air vent contains a welded stainless steel thermal element that expands when heated and contracts when cooled. When air and non-condensable gases are present, the valve is in the open discharge position. When steam reaches the air vent, the element expands and closes the valve off tightly.

Features

- Simple design for easy maintenance
- All Stainless Steel Internals
- Thermal element is the only moving part

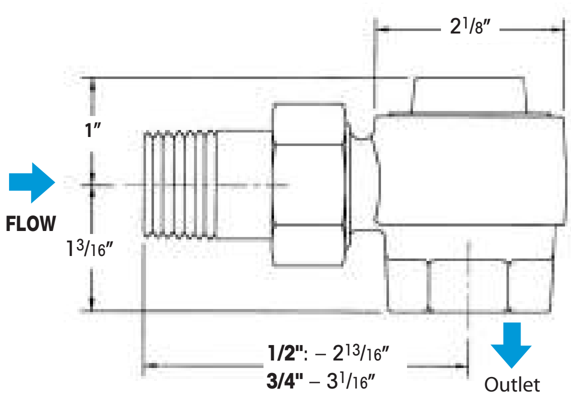
Sample Specification

Air vent shall have a stainless steel thermal element with forged brass construction, featuring a union nipple inlet connection. The valve and seat shall be stainless steel.

Installation & Maintenance

Air vents should be located at a high point in the system or vessel. The air vent can be installed in any orientation. An isolation valve should be installed to facilitate repair without system shut-down. Unit is in-line repairable. Repair kits are available.

Size/Connection NPT	Model Code	Orifice Size	PMO PSI	Weight lbs
1/2"	AVT125-12-N	1/4"	125	1.5
3/4"	AVT125-13-N	5/16"	125	1.5



MATERIALS	
Body & Cover	Forged Brass, CA 377
Element	Welded Stainless Steel, AISI 302
Spring	Stainless Steel, AISI 304
Seat	Stainless Steel, AISI 303
Gasket	Brass, ASTM B-21
Union Nipple	Brass, ASTM B-16
Union Nut	Brass, ASTM B-16

CAPACITIES – *Air (SCFM)*

Size	Orifice Size	Inlet Pressure (PSIG) 5	10	25	50	100	125
1/2"	1/4"	9	13	22	37	65	80
3/4"	5/16"	12	16	27	46	82	100

PIPELINE ACCESSORIES

Thermostatic Air Vent

Model	**AV2000 Series**
Sizes	**1/2", 3/4"**
Connections	**NPT**
Body Material	**Stainless Steel**
PMO Max. Operating Pressure	**650 PSIG**
TMO Max. Operating Temperature	**Saturated Steam Temp.**
PMA Max. Allowable Pressure	**1032 PSIG @ 100°F**
TMA Max. Allowable Temperature	**750°F @ 800 PSIG**

Air Vents are used for Removing Air from Steam Systems

Typical Applications

The **AV2000** air vent is used on industrial steam applications up to 650 PSIG for the removal of air and non-condensable gases from process equipment, vessels and piping. The air vent should be located at a high point in the system or vessel and can be installed in any orientation.

How It Works

The thermostatic air vent contains a welded stainless steel thermal element that expands when heated and contracts when cooled. When air and non-condensable gases are present, the valve is in the open discharge position. When steam reaches the air vent, the element expands and closes the valve off tightly.

Features

- Welded stainless steel thermal element
- Hardened stainless steel seat and valve plugs for extended service life
- Integral strainer to protect from contamination
- Steam pressures up to 650 PSIG
- Special Subcool Options Available

Sample Specification

Air vent shall have a thermal element with a seal-welded tamper-proof stainless steel construction. All internals shall be stainless steel, featuring an integral strainer and hardened seat and disc.

Installation

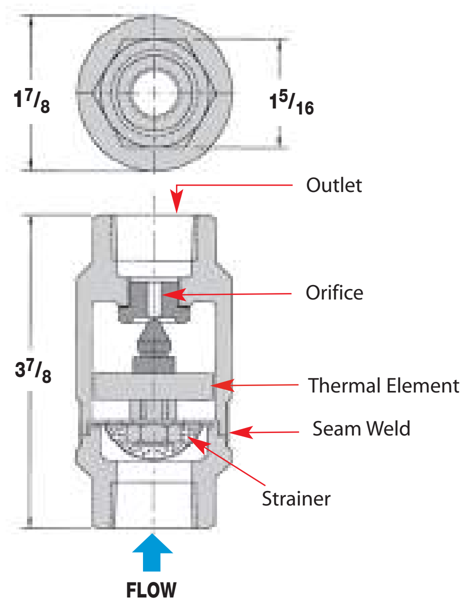
The air vent should be located at a high point in the system or vessel and can be installed in any orientation. An isolation valve should be installed to facilitate removal and replacement without system shut-down. Unit is seal-welded and non-repairable.

MATERIALS

Housing	Stainless Steel, ASTM A351-CF3
Thermal Element	Stainless Steel
Valve & Seat	Hardened Stainless Steel, 40 Rc
Strainer Screen .033" perf.	Stainless Steel

Size/Connection NPT	Model Code	Orifice Size	PMO PSI	Weight lbs
1/2"	**AV2001-12-N**	3/16"	650	1.25
1/2"	**AV2003-12-N**	5/16"	650	1.25
3/4"	**AV2001-13-N**	3/16"	650	1.25
3/4"	**AV2003-13-N**	5/16"	650	1.25

DIMENSIONS – *inches*



CAPACITIES – *Air (SCFM)*

Model	Orifice Size	PMO (PSIG)	Inlet Pressure (PSIG) 2	5	10	25	50	100	125	150	200	250	300	350	400	450	500	550	600	650
AV2001	3/16"	650	5.2	6.2	7.7	12.4	20.2	35.9	43.9	51.5	67.2	82.8	98.5	114	130	145	161	177	192	208
AV2003	5/16"	650	10.7	12.6	15.8	25.4	41.4	73.3	89.4	105	137	169	201	233	265	297	329	361	393	425

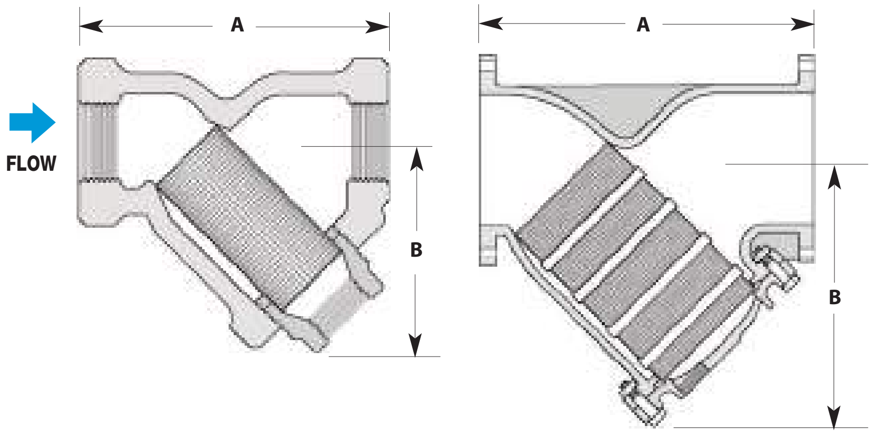
Y-Type Strainers • Cast Iron

Model	**CIY**
Sizes	**1/2", 3/4", 1", 1 1/4", 1 1/2", 2", 2 1/2", 3", 4"**
Connections	**NPT, FLG**
Body Material	**Cast Iron**

PRESSURE/TEMPERATURE RATINGS

NPT	**250 PSIG @ 406˚F**	**- Steam**
NPT	**400 PSIG @ 150˚F**	**- WOG**
125# FLG	**125 PSIG @ 450˚F**	**- Steam**
125# FLG	**200 PSIG @ 150˚F**	**- WOG**
250# FLG	**250 PSIG @ 450˚F**	**- Steam**
250# FLG	**500 PSIG @ 150˚F**	**- WOG**

Note: WOG = Water, Oil or Gas.



Typical Applications

The **CIY** Y-Strainer is used to strain dirt particles from fluid in pipelines and provide inexpensive protection for costly pumps, meters, valves, traps, turbines and compressors.

Features

- Machined seat assures perfect fit for screen
- Blowdown connection and easily removable stainless steel cylindrical screens for easy maintenance
- Durable cast iron body

Installation

The strainer should be installed in the flow direction as indicated on the body in either a vertical down or horizontal pipeline. The strainer must be accessible for periodic cleaning.

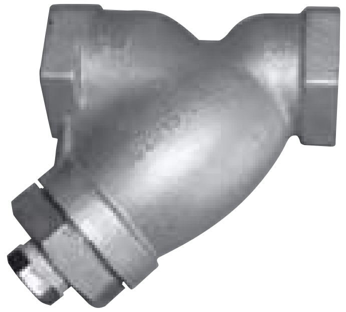
MATERIALS

Body	Cast Iron, A126 CLASS B
Plug	Cast Iron, A126 CLASS B
Cover	Cast Iron, A126 CLASS B
*Screen	Stainless Steel
*Gasket	Grafoil
*Gasket (Flg Cover)	Garlock 3000

DIMENSIONS & WEIGHTS – *inches*

Size/ Connection	Model Code	A	B	Blowdown NPT	Weight (lbs)	Screen Mesh
1/2" NPT	**CIY-12-N-020**	3 3/16	2 1/16	1/4	1.5	20
3/4" NPT	**CIY-13-N-020**	3 3/4	2 7/16	3/8	2.5	20
1" NPT	**CIY-14-N-020**	4	2 7/16	3/8	3.5	20
1 1/4" NPT	**CIY-15-N-020**	5	3 3/8	3/4	6	20
1 1/2" NPT	**CIY-16-N-020**	5 3/4	3 7/8	3/4	9	20
2" NPT	**CIY-17-N-020**	7	4 3/4	1	14	20
2" 125# FLG	**CIY-17-F125-045**	7 7/8	6	1/2	20	45
2" 250# FLG	**CIY-17-F250-045**	9 5/8	6 1/2	1/2	26	45
2 1/2" NPT	**CIY-18-N-045**	9 1/4	5 7/8	1 1/2	26	45
2 1/2" 125# FLG	**CIY-18-F125-045**	10	8	1	33	45
2 1/2" 250# FLG	**CIY-18-F250-045**	10 5/8	7	1	45	45
3" NPT	**CIY-19-N-045**	10	6	1 1/2	32	45
3" 125# FLG	**CIY-19-F125-045**	10 1/4	8 3/4	1	37	45
3" 250# FLG	**CIY-19-F250-045**	12	8	1	60	45
4" 125# FLG	**CIY-20-F125-045**	12 1/8	9 1/2	1 1/2	70	45
4" 250# FLG	**CIY-20-F250-045**	14 1/2	10 3/4	1 1/2	94	45

Y-Type Strainers • Carbon Steel / Stainless Steel



Model	CSY, SSY
Sizes	1/2", 3/4", 1", 1½", 2"
Connections	NPT, SW
Body Material	Carbon Steel (CSY) Stainless Steel (SSY)

PRESSURE/TEMPERATURE RATINGS

Carbon Steel	NPT	600 PSIG @ 489°F
Stainless Steel	NPT	600 PSIG @ 489°F

MATERIALS

	CSY Carbon Steel	SSY Stainless Steel
Body	Steel, A216 GR WCB	SS, A351 GR CF8M
Plug	Steel, A216 GR WCB	SS, A351 GR CF8M
Cover	Steel, A216 GR WCB	SS, A351 GR CF8M
Screen	Stainless	Stainless
Gasket	SS Spiral Wound	SS Spiral Wound

Typical Applications

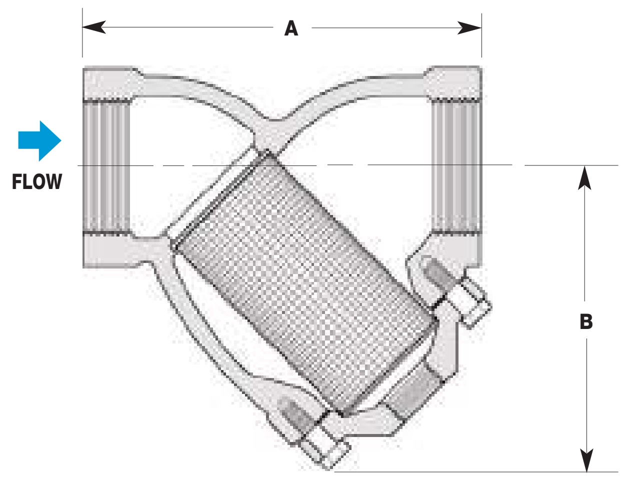
The **CSY/SSY** Y-Strainers are used to strain dirt particles from fluid in pipelines and provide inexpensive protection for costly pumps, meters, valves, traps, turbines and compressors.

Features

- Machined seat assures perfect fit for screen
- Blowdown connection and easily removable stainless steel cylindrical screens for easy maintenance
- Choice of carbon steel or stainless steel bodies

Installation

The strainer should be installed in the flow direction as indicated on the body in either a vertical down or horizontal pipeline. The strainer must be accessible for periodic cleaning.



HOW TO ORDER

Specify connection size and connection configuration (NPT or SW) that will meet application requirements.

DIMENSIONS & WEIGHTS – *inches*

Size	Connection	Model Code Carbon Steel	Model Code Stainless Steel	Screen Mesh Size	A	B	Blowdown NPT	Weight lbs
1/2"	NPT	CSY-12-N-020	SSY-12-N-020	20	3	2 7/16	1/4	1.5
	SW	CSY-12-SW-020	SSY-12-SW-020					
3/4"	NPT	CSY-13-N-020	SSY-13-N-020	20	3 3/4	2 15/16	3/8	2.5
	SW	CSY-13-SW-020	SSY-13-SW-020					
1"	NPT	CSY-14-N-020	SSY-14-N-020	20	4 5/8	3 3/4	3/8	5
	SW	CSY-14-SW-020	SSY-14-SW-020					
1½"	NPT	CSY-16-N-020	SSY-16-N-020	20	5 5/8	4 13/16	3/4	9
	SW	CSY-16-SW-020	SSY-16-SW-020					
2"	NPT	CSY-17-N-020	SSY-17-N-020	20	7	6 1/8	1	13
	SW	CSY-17-SW-020	SSY-17-SW-020					

For special mesh screens; Consult factory.
CS not recommended for prolonged use above 800°F.
SS not recommended for prolonged use above 1000°F.

Suction/Mixing Tee

Cast Iron, Bronze or Stainless Steel

Model	Suction Tee	
Sizes	1/2", 3/4", 1", 1 1/4", 1 1/2", 2", 2 1/2", 3"	
Connections	NPT	
Body Material	Cast Iron	125# & 250#
	Bronze	250#
	Stainless Steel	300#

PRESSURE/TEMPERATURE RATINGS

Cast Iron	**NPT**	**250 PSIG @ 406°F**
Bronze	**NPT**	**300 PSIG @ 422°F**
Stainless Steel	**NPT**	**450 PSIG @ 400°F**

Typical Applications

The Watson McDaniel Cast Iron, Bronze or Stainless Steel **Suction Tee** is a specialized type of pipe fitting used for blending, agitation, recirculation, mixing, aeration and heating.

How It Works

Heating by Direct Steam Injection: When using a Suction Tee for heating by direct steam injection, the Suction Tee must be completely submerged in the liquid being heated. When steam enters the primary inlet side of the Suction Tee, a low pressure condition is created inside the Suction Tee body. This causes the liquid inside the tank to circulate through the suction tee and intermix with the steam, causing the liquid to be heated.

Mixing: When liquid is pumped through the primary inlet of a Suction Tee, a low pressure region is created inside the Suction Tee body. When a Suction Tee is submerged, the liquid inside the tank will circulate through the secondary inlet of the Suction Tee causing a mixing action to occur. An alternate method when mixing two different liquids is to pump one liquid through the primary inlet and the other liquid through the secondary inlet of the Suction Tee.

Aeration: A tank or reservoir of liquid can be aerated by connecting the secondary inlet of the Suction Tee to an air or gas line under pressure while pumping liquid through the primary inlet.

Size/Connection NPT	Model Code	Material	PMO PSI	Weight (lbs)
1/2"	**SUCT-12-N-CI-125**	Cast Iron	125	1.25
	SUCT-12-N-B-250	Bronze	250	1.50
3/4"	**SUCT-13-N-CI-125**	Cast Iron	125	2.50
	SUCT-13-N-B-250	Bronze	250	3.50
1"	**SUCT-14-N-CI-125**	Cast Iron	125	4.50
	SUCT-14-N-CI-250	Cast Iron	250	6.00
	SUCT-14-N-B-250	Bronze	250	4.50
	SUCT-14-N-SS-300	316 SS	300	4.50
1 1/4"	**SUCT-15-N-CI-125**	Cast Iron	125	5.00
	SUCT-15-N-CI-250	Cast Iron	250	8.50
	SUCT-15-N-B-250	Bronze	250	5.50
1 1/2"	**SUCT-16-N-CI-125**	Cast Iron	125	6.00
	SUCT-16-N-CI-250	Cast Iron	250	9.50
	SUCT-16-N-B-250	Bronze	250	6.25
	SUCT-16-N-SS-300	316 SS	300	6.25
2"	**SUCT-17-N-CI-125**	Cast Iron	125	7.50
	SUCT-17-N-CI-250	Cast Iron	250	17.0
	SUCT-17-N-B-250	Bronze	250	9.75
	SUCT-17-N-SS-300	316 SS	300	9.25
2 1/2"	**SUCT-18-N-CI-125**	Cast Iron	125	11.0
3"	**SUCT-19-N-CI-125**	Cast Iron	125	21.5
	SUCT-19-N-CI-250	Cast Iron	250	38.0

Features

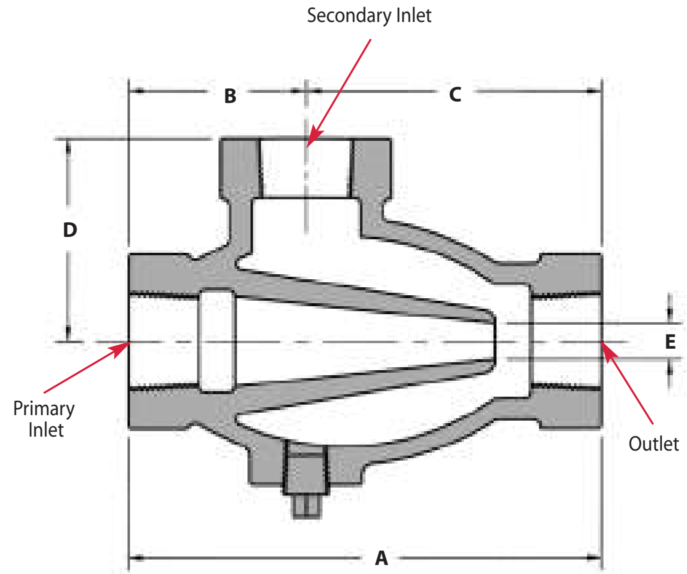
- Available in cast iron, bronze or stainless steel
- No moving parts
- Quiet operation
- Replaces mixing pumps, propellers and other mechanical devices

Suction/Mixing Tee

Cast Iron, Bronze or Stainless Steel

DIMENSIONS & WEIGHTS – *inches*

Pipe Size	A	B	C	D	E	Weight (lbs)
125# Cast Iron Body & Bronze 250#						
1/2"	3 3/4	1 1/2	2 1/4	1 3/4	1/4	1.5
3/4"	5	1 7/8	3 1/8	3 1/8	3/8	3.25
1"	5 5/8	2 3/16	3 7/16	2 1/2	5/8	4
1 1/4"	5 3/4	2 1/4	3 1/2	2 1/2	11/16	4.75
1 1/2"	6 1/16	2 7/16	3 5/8	2 7/8	7/8	5.50
2"	7	2 7/8	4 1/8	3	15/16	7
2 1/2"	8 3/8	3 1/2	4 7/8	3 5/16	1	11.75
3"	9 1/2	4 1/8	5 3/8	3 7/8	1 5/16	20.50
250# Cast Iron Body & Stainless Steel 300#						
1"	6 1/16	2 5/16	3 3/4	2 11/16	11/16	6.75
1 1/4"	6 3/16	2 3/8	3 13/16	2 13/16	11/16	8
1 1/2"	6 1/2	2 13/16	3 11/16	2 7/8	7/8	10.50
2"	7 3/8	3 1/16	4 5/16	3 1/4	15/16	16.50

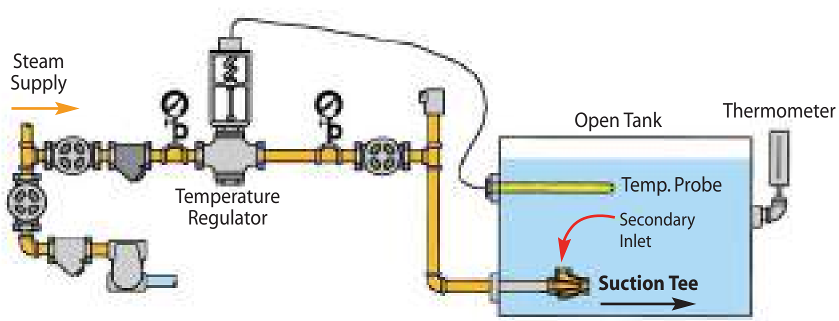


MATERIALS

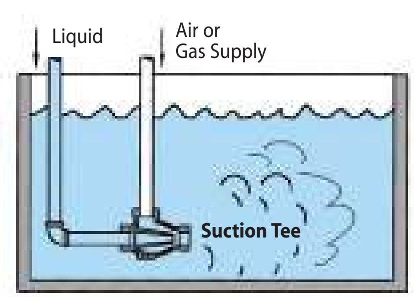
Cast Iron	
Body	Cast Iron, A126 CLASS 30
Plug	Cast Iron, A126 CLASS 30
Bronze	
Body	Bronze, ASTM B-62
Plug	Brass
Stainless Steel	
Body	Stainless Steel, A351 GR CF8M
Plug	Stainless Steel, A351 GR 316

CAPACITIES – *Steam (lbs/hr)*

Size	Supply Pressure (PSIG) 5	10	15	20	25	30	35	40	45	50	55	60	65	75	85	100	125	150
1/2"	66	96	114	135	156	165	174	207	240	258	276	294	312	354	396	456	552	630
3/4"	108	138	168	198	228	255	282	309	336	363	390	402	414	504	564	648	792	936
1"	312	390	468	549	630	711	792	882	972	1026	1080	1170	1260	1428	1584	1800	2232	2556
1 1/4"	444	558	672	783	894	1005	1116	1230	1344	1461	1578	1689	1800	2010	2232	2592	3168	3708
1 1/2"	612	756	900	1026	1152	1332	1512	1674	1836	1980	2124	2286	2448	2772	3060	3528	4320	5040
2"	798	1008	1206	1410	1614	1815	2016	2214	2412	2610	2808	3024	3240	3636	3996	4680	5652	6696
2 1/2"	912	1152	1368	1584	1800	2052	2304	2538	2772	2997	3222	3447	3672	4140	4608	5292	6480	7560
3"	1332	1656	1980	2304	2628	2970	3312	3636	3960	4302	4644	4986	5328	5976	6600	7620	9300	10800



Controlling temperature of large open tank by steam injection



Aeration or Agitation

EJECT, EJECT-ELL & EJECT-LM

Syphons, Eductors, Exhausters & Injectors

Model	**EJECT** **EJECT-ELL** **EJECT-LM**
Sizes	**1/2" – 2"**
Connections	**NPT**
Body Material	**Bronze (1/2" - 1 1/2")** **Cast Iron (2")**
PMO Max. Operating Pressure	**100 PSIG**
TMO Max. Operating Temperature	**130°F**
PMA Max. Allowable Pressure	**250 PSIG up to 450°F**
TMA Max. Allowable Temperature	**450°F @ 250 PSIG**

Note: Minimum Operating Pressure for EJECT-ELL & EJECT-LM is 20 PSIG.

Typical Applications

Watson McDaniel **Ejectors** perform a variety of functions depending upon the application and motive fluid (steam or water) used. See performance charts on the following pages. Applications include: exhausting, agitating, aerating, circulating, pumping and mixing.

How It Works

Using water, steam or air pressure as the motive force, ejectors operate on the principle that a high velocity flow through a nozzle will create a pressure drop in the area around the nozzle discharge. The resulting vacuum will induce flow into the secondary inlet of the ejector.

Features

- No moving parts
- Can be used with water or steam pressure
- Submersible
- Available in cast iron or bronze

Sample Specification

Ejectors shall be constructed from bronze or cast iron. Units shall be capable of using steam, water or air as a motive force.

Installation

See installation examples on following page.

MATERIALS	
Body (1/2" - 1 1/2")	Bronze
Body (2")	Cast Iron
Nozzles (all sizes)	Bronze

Note: ELECT-ELL & ELECT-LM for liquid motive service only.

Model **EJECT** can be used with Steam or Water as the Motive Inlet

EJECT

Size/Connection NPT	Model Code	Motive Fluid Used	Suction Fluid	Weight lbs
1/2"	**EJECT-12-N-S**	Steam	Water	0.75
	EJECT-12-N-W	Water	Water	0.75
/4"	**EJECT-13-N-S**	Steam	Water	0.75
	EJECT-13-N-W	Water	Water	0.75
1"	**EJECT-14-N-S**	Steam	Water	1.50
	EJECT-14-N-W	Water	Water	1.50
1 1/4"	**EJECT-15-N-S**	Steam	Water	3.75
	EJECT-15-N-W	Water	Water	3.75
1 1/2"	**EJECT-16-N-S**	Steam	Water	4.75
	EJECT-16-N-W	Water	Water	4.75
2"	**EJECT-17-N-S**	Steam	Water	7.50
	EJECT-17-N-W	Water	Water	7.50

EJECT-ELL

Motive Fluid is LIQUID

Size/Connection NPT	Model Code	Motive Fluid Used	Suction Fluid	Weight lbs
3/4"	**EJECT-ELL-13-N**	Water	Gases	4.00
1"	**EJECT-ELL-14-N**	Water	Gases	7.00
1 1/4"	**EJECT-ELL-15-N**	Water	Gases	8.00

EJECT-LM

Motive Fluid is LIQUID

Size/Connection NPT	Model Code	Motive Fluid Used	Suction Fluid	Weight lbs
3/4"	**EJECT-LM-13-N**	Water	Water	1.00
1"	**EJECT-LM-14-N**	Water	Water	2.25
1 1/4"	**EJECT-LM-15-N**	Water	Water	3.50

EJECT, EJECT-ELL & EJECT-LM

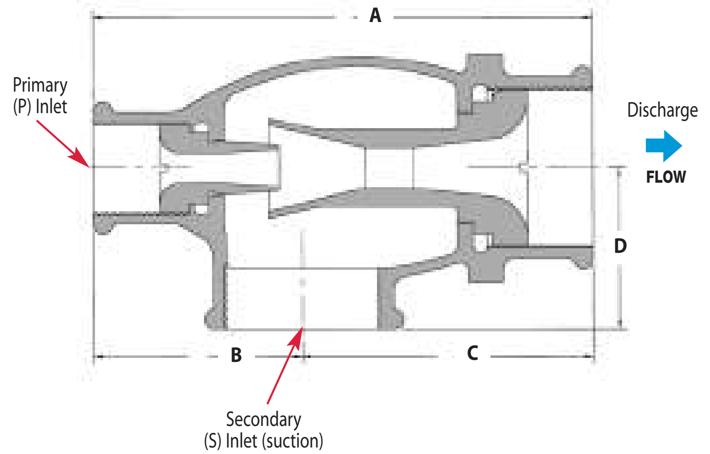
Syphons, Eductors, Exhausters & Injectors

EJECT

DIMENSIONS – *inches*

Size	Connection Sizes *			Dimensions			
	S. Inlet	Discharge	P. Inlet	A	B	C	D
Bronze Body & Nozzles							
1/2"	1/2	1/2	1/4	3 1/4	1 7/16	1 13/16	1 1/8
3/4"	3/4	3/4	3/8	4	1 1/2	2 1/2	1 3/8
1"	1	1	1/2	5 1/8	2 1/4	2 7/8	1 5/8
1 1/4"	1 1/4	1 1/4	3/4	5 7/8	2 7/16	3 7/16	1 13/16
1 1/2"	1 1/2	1 1/2	3/4	6 1/4	2 11/16	3 9/16	1 15/16
Cast Iron Body with Bronze Nozzles							
2"	2	2	1	7 1/4	3 1/8	4 1/8	2 3/8

* Connections are female NPT.



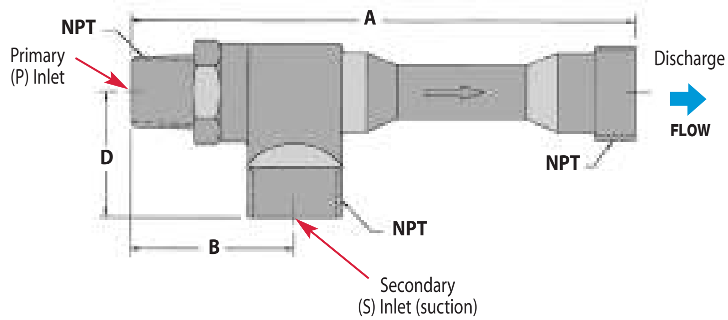
EJECT-ELL / EJECT-LM

Bronze Body & Nozzles

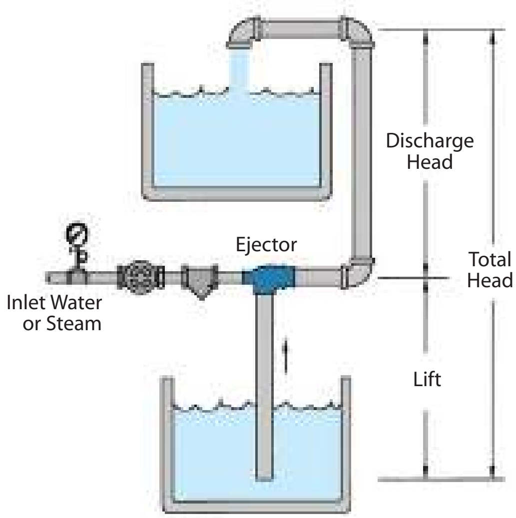
DIMENSIONS – *inches*

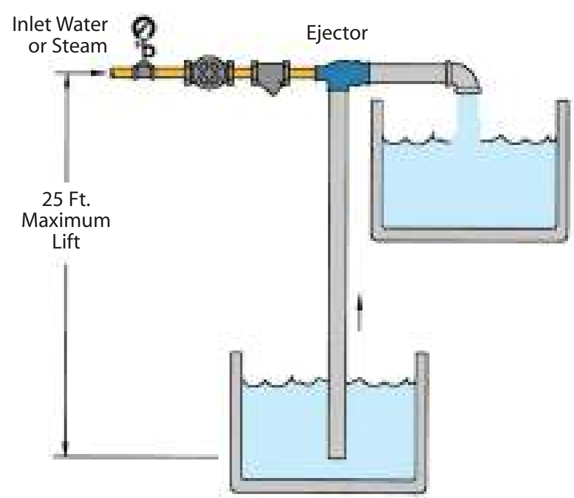
Size	Connection Sizes **			Dimensions		
	S. Inlet	Discharge	P. Inlet	A	B	D
3/4"	3/4	3/4	1/2	5 13/16	2	1 3/8
1"	1	1	3/4	7 1/8	2 5/16	1 3/4
1 1/4"	1 1/4	1 1/4	1	9	2 7/16	2 1/8

** Connections are male NPT.



Ejectors shown Pumping Liquid





It is always desirable to keep the Ejector as close to the actual liquid being pumped as possible. The maximum height the liquid can be pumped depends upon the pressure of the "motive" liquid or steam available. Please refer to the capacity graphs for maximum flow rates and maximum achievable heads.

The maximum height that water or any liquid with a specific gravity of 1 can be lifted is 25 feet. Increases in the temperature of the liquid being lifted will cause this maximum height to decrease. Pumping liquids in excess of 130°F is not recommended. Please consult factory with any specific application.

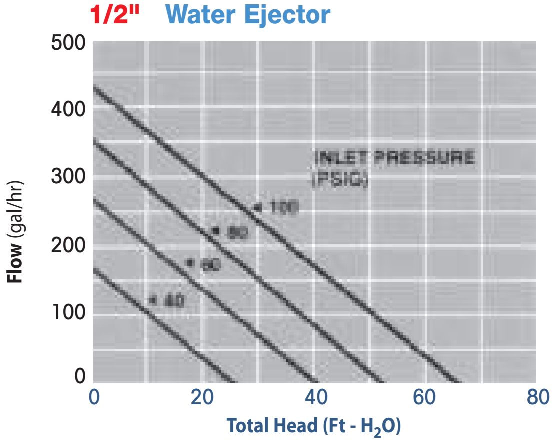
Ejector Sizing • EJECT Model

Example 1
A **#14 1" Ejector** using 60 lbs. of <u>water pressure</u> as a motive force will pump water to a maximum height of 40 ft. When pumping water to a height of 20 ft. using 60 lbs. of water pressure, the amount of water being pumped is 700 gal/hr.

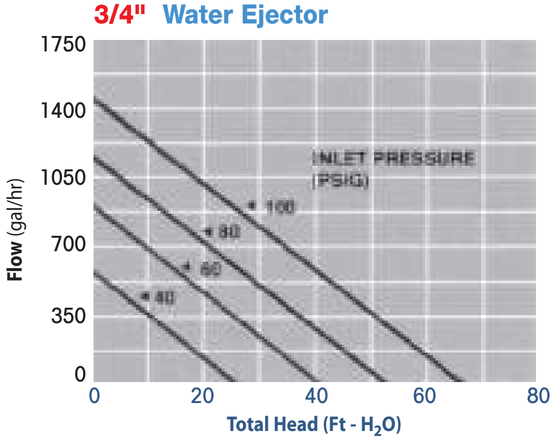
Example 2
A **#14 1" Ejector** using 60 lbs. of <u>steam pressure</u> as a motive force will pump water to a maximum height of 60 ft. When pumping water to a height of 53 ft. using 60 lbs. of steam pressure, the amount of water being pumped is 650 gal/hr.

for Model EJECT Only (Water)

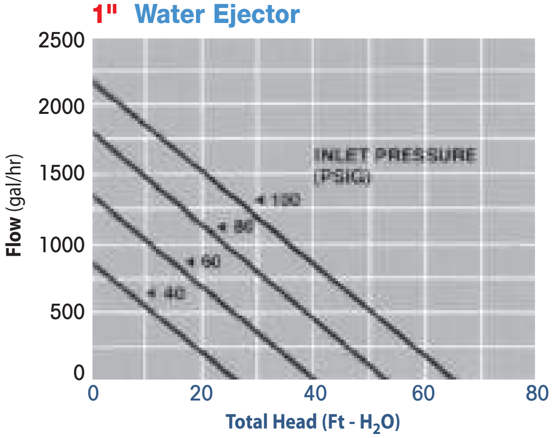
1/2" Water Ejector



3/4" Water Ejector

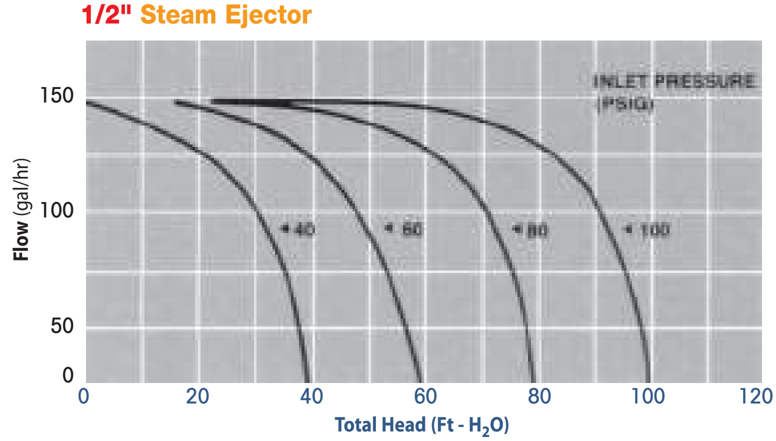


1" Water Ejector

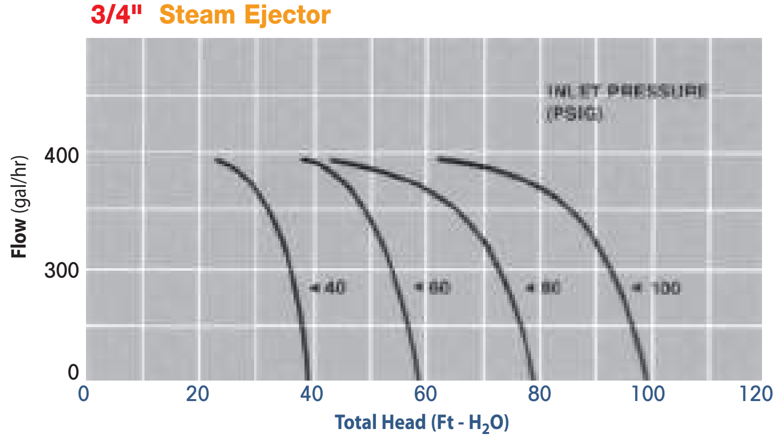


for Model EJECT Only (Steam)

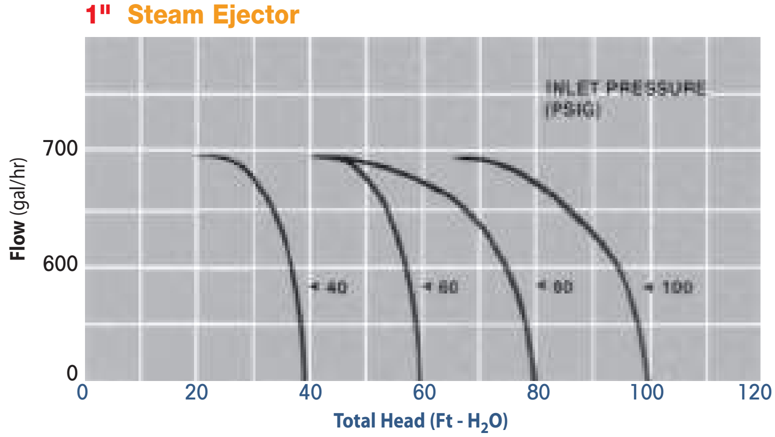
1/2" Steam Ejector



3/4" Steam Ejector



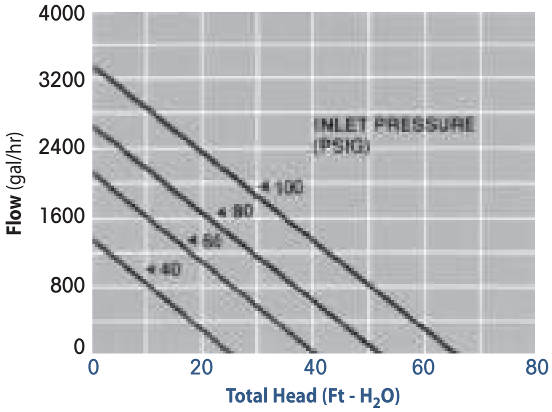
1" Steam Ejector



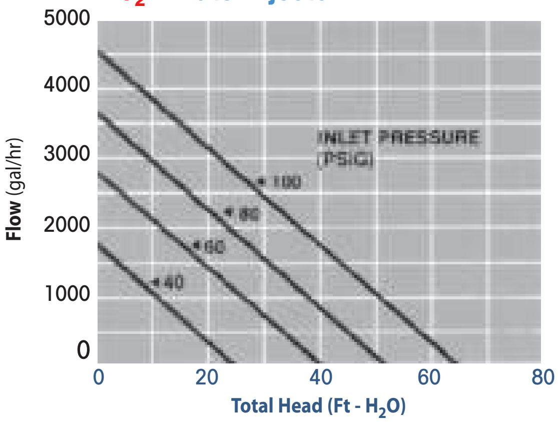
Ejector Sizing • EJECT Model

for Model EJECT Only (Water)

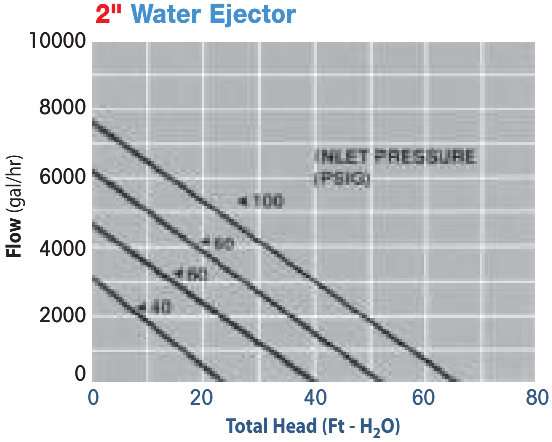
1 1/4" Water Ejector



1 1/2" Water Ejector

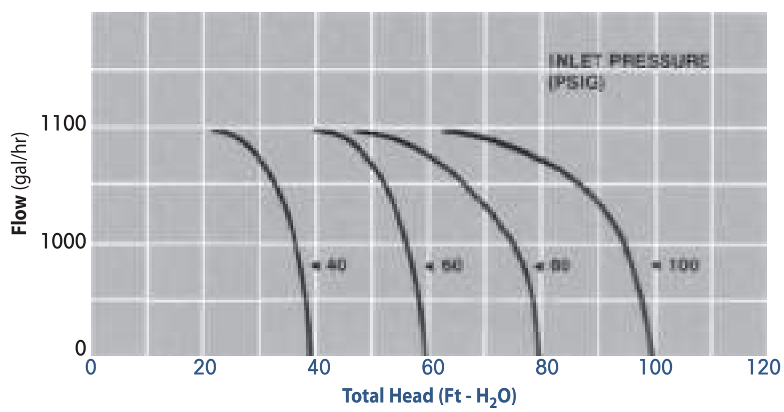


2" Water Ejector

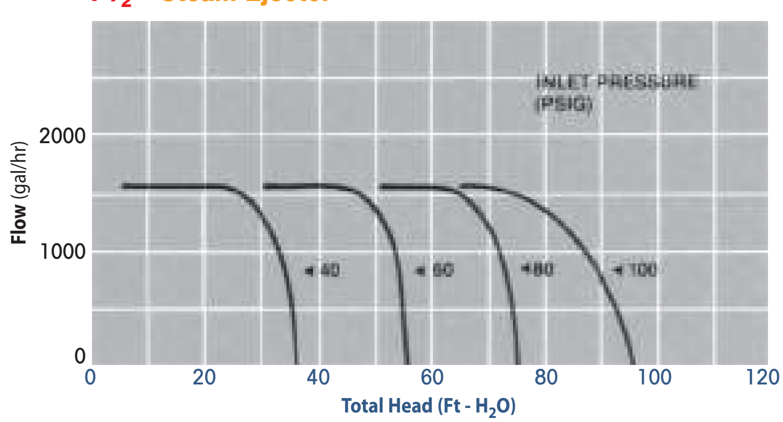


for Model EJECT Only (Steam)

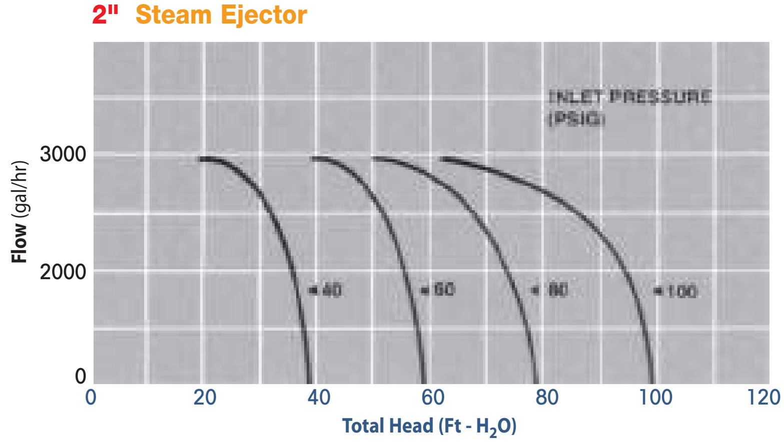
1 1/4" Steam Ejector



1 1/2" Steam Ejector



2" Steam Ejector



Model Code	**AV813-13-N** *
Sizes	3/4"
Connections	NPT
Body Material	Cast Iron
PMO Max. Operating Pressure	150 PSIG
TMO Max. Operating Temperature	300°F
PMA Max. Allowable Pressure	150 PSIG up to 350°F
TMA Max. Allowable Temperature	353°F @ 150 PSIG

* With Viton seat, use Model Code **AV813V-13-N**

Air Eliminators are used for Removing Air from Liquid Systems

Typical Applications

The **AV813** Air Eliminator is used for the removal of air and other gases from vessels or piping systems without allowing the contained liquid to escape.

How It Works

The valve and seat assembly inside the air eliminator is connected to a stainless steel float. When there is no liquid in the body of the air eliminator, the float will be in the down position, allowing air or other gases in the vessel or piping system to escape. When liquid enters the body, it will lift the float and the valve will be closed off before any liquid can escape.

Features

- Rugged cast iron housing
- Simple design for easy maintenance
- Stainless steel internals
- Optional Viton Valve Head for high temperatures and tight shut-off

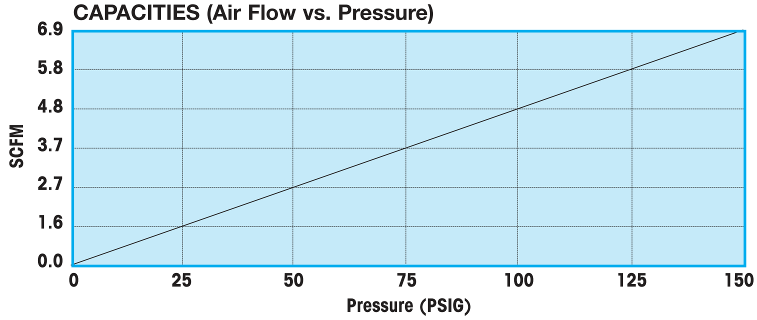
Sample Specification

Air Eliminator shall be of cast iron construction with stainless steel internals and soft EPDM seat for tight shut-off. Optional Viton seat is available for elevated temperatures and tight shut-off.

Installation & Maintenance

The AV813 should be located at a high point in the system or vessel. The unit must be installed level and upright with flow upward for the float mechanism to operate properly. Isolation valves should be installed for ease of maintenance.

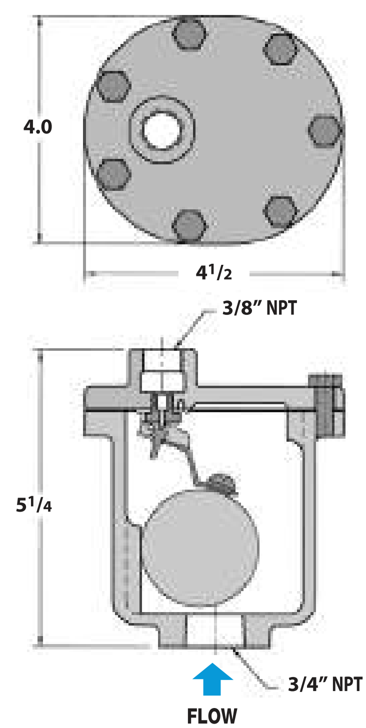
CAPACITIES (Air Flow vs. Pressure)



MATERIALS

Cover	Cast Iron, ASTM A-126, Class B
Body	Cast Iron, ASTM A-126, Class B
Gasket	Grafoil
Seat Yoke	Stainless Steel, Type 304
Valve Seat	Stainless Steel, Type 304
Pivot Pin	Stainless Steel, Type 304
Valve Head	EPDM (Viton optional)
Lever	Stainless Steel, Type 304
Float	Stainless Steel, Type 304
Washer	Stainless Steel, Type 304
Screw & Washer	Stainless Steel, Type 304

DIMENSIONS – *inches*



AE1800 & AE1800R Series

Stainless Steel

Repairable & Non-Repairable

Model	**AE1800, AE1800R**
Sizes	**1/2”, 3/4”**
Connections	**NPT**
Body Material	**Stainless Steel**
PMO Max. Operating Pressure	**400 PSIG**
TMO Max. Operating Temperature	**500°F**
PMA Max. Allowable Pressure	**400 PSIG up to 500°F**
TMA Max. Allowable Temperature	**500°F @ 400 PSIG**

AE1800 (Non-Repairable) **AE1800R** (Repairable)

Air Eliminators are used for Removing Air from Liquid Systems

Typical Applications

The **AE1800** Air Eliminator is used for the removal of air and other gases from vessels or piping systems without allowing the contained liquid to escape.

How It Works

The valve and seat assembly inside the air eliminator is connected to a stainless steel float. When there is no liquid in the body of the air eliminator, the float will be in the down position, allowing air or other gases in the vessel or piping system to escape. When liquid enters the body, it will lift the float and the valve will be closed off before any liquid can escape.

Features

- All stainless steel body and internals
- Hardened SS seat (55 Rc) for longer service life
- Repairable units available (AE1800R Series)

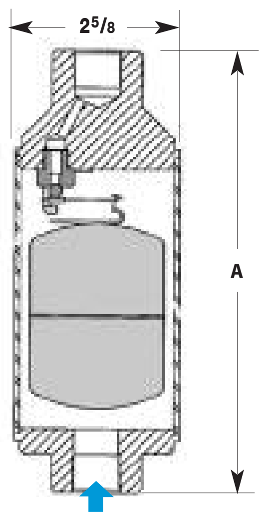
Installation & Maintenance

The AE1800 should be located at a high point in the system or vessel. The unit must be installed level and upright with flow upward for the float mechanism to operate properly. Isolation valves should be installed for ease of maintenance.

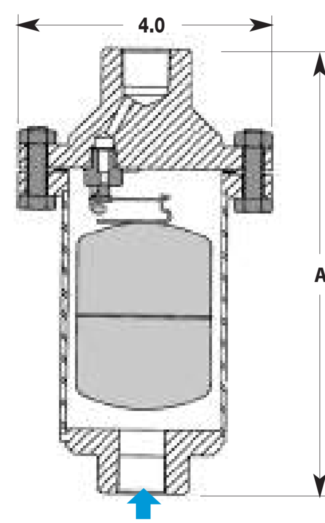
MATERIALS

Body & Shell	Stainless Steel, AISI 304
Float Assembly	Stainless Steel, AISI 304
Valve & Lever Assembly	Hardened Stainless Steel, 55 Rc
Seat	Stainless Steel, AISI 420
Washer, Seat	302 SS
*Gasket	Grafoil
*Bolt, Hex, HD	Stainless Steel, AISI 316
*Nut	Stainless Steel, 18-8

* *AE1800R Repairable models only.*



AE1800 (Non-Repairable)



AE1800R (Repairable)

DIMENSIONS – *inches /pounds*

Model Code & Orifice Size .078”	.101”	.125”	Size NPT (Inlet x Outlet)	Height A	Weight (lbs)
AE1811-N	AE1821-N	AE1831-N	3/4” x 1/2”	7.5	4
AE1811R-N	AE1821R-N	AE1831R-N		7.9	5
AE1812-N	AE1822-N	AE1832-N	3/4” x 3/4”	7.5	4
AE1812R-N	AE1822R-N	AE1832R-N		7.9	5
AE1813-N	AE1823-N	AE1833-N	1/2” x 1/2”	7.5	4
AE1813R-N	AE1823R-N	AE1833R-N		7.9	5

CAPACITIES – *Air (SCFM)*

Series	Orifice Size	PMO* (PSIG)	Inlet Pressure (PSIG) 5	7	9	12	15	20	25	30	40	50	60	70	80	90	100	110	120	125	150	180	265	300	400
AE1810	.078”	400	1.0	1.1	1.3	1.5	1.7	1.9	2.2	2.5	3.1	3.4	3.7	4.2	5.4	6.0	6.8	7.2	7.5	7.9	9.4	11.2	16.3	18.4	24.4
AE1820	.101”	265	1.7	1.9	2.1	2.4	2.6	3.1	3.5	4.0	4.8	5.3	5.7	6.6	8.4	9.3	10.2	11.1	12	12.4	14.5	17.3	24.8	-	-
AE1830	.125”	180	2.5	3.0	3.4	3.9	4.3	5.1	5.8	6.5	8.0	8.7	9.5	10.9	13.9	15.4	16.9	18.4	19.9	20.5	24.4	29.6	-	-	-

Note: Specify Model Number when ordering. Example: **AE1812R-N** (.078” Orifice, 3/4” x 3/4” NPT, 400 PSIG max, Repairable unit)

* PMO based on liquids with specific gravity of 1. Consult factory for PMO for liquids of other specific gravity values.

Cast Iron or Carbon Steel

Model	WDS	
Body Material	Cast Iron	Carbon Steel
Sizes	3/4" thru 4"	1" thru 12"
Connections	NPT, 125# Flanged	NPT, SW, 150# & 300# Flanged
PMO Max. Operating Pressure	250 PSIG	300 PSIG (NPT & SW)
Pressure/ Temperature Rating	NPT: 250 PSIG @ 450°F 125# FLG: 150 PSIG @ 450°F	NPT, SW: 1000 PSIG @ 650°F 150# FLG:150 PSIG @ 450°F 300# FLG: 500 PSIG @ 650°F

WDS
Carbon Steel
(Flanged)

WDS
Cast Iron
(NPT)

Typical Applications

The **WDS Series** Separators are used for the removal of entrained liquid or solids from steam or air. Effective in applications where the system has an entrained liquid flow rate of up to 40% by weight of the unit's flow capacity.

How It Works

Wet steam enters the inlet of the separator where it is deflected in a centrifugal downward motion. The entrained moisture is separated out by reduction in velocity. Separated liquid then falls below the Vortex Containment Plate where it cannot be re-entrained. Dry steam or air then flows upward and exits through the outlet of the separator.

Features

- Removes 99% of all particles ≥ 10 microns in size
- Minimum pressure drop
- Gauge ports on 3" & 4" cast iron units
- Standard gauge ports on 2½"–12" carbon steel units
- ASME Code constructed

Sample Specification

Steam Moisture Separator shall be "T" style for horizontal piping installations. Separator to be code constructed in cast iron or carbon steel and available in FNPT and flanged connections.

Installation

The WDS Air/Steam Moisture Separator must be installed in a horizontal run of pipe. Exercise standard piping and structural practices when installing this unit. Proper drainage of the separator utilizing a float & thermostatic steam trap or liquid drainer (for air applications) is essential for proper operation.

MATERIALS	
WDS Cast Iron Model	Cast Iron
WDS Carbon Steel Model	Fabricated Carbon Steel

CAPACITIES – *Steam (lbs/hr)*

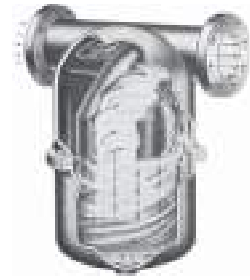
	Operating Pressure (PSIG)											
Size	5	10	25	50	100	150	200	250	300	400*	450*	500*
3/4", 1"	192	219	289	384	536	661	772	872	964	1132	1210	1284
1¼"	305	348	459	609	851	1050	1225	1384	1531	1797	1921	2038
1½"	434	495	653	868	1211	1495	1744	1970	2179	2559	2734	2902
2"	769	877	1156	1536	2143	2646	3087	3487	3857	4529	4839	5136
2½"	1220	1391	1834	2437	3401	4199	4900	5535	6121	7188	7680	8151
3"	1912	2181	2876	3821	5333	6583	7682	8677	9597	11269	12041	12779
4"	3183	3632	4787	6362	8878	10959	12788	14446	15977	18760	20046	21274
5"	4823	5501	7252	9637	13449	16603	19373	21884	24203	28420	30367	32229
6"	7465	8516	11226	14917	20818	25699	29988	33874	37464	43992	47006	49887
8"	12444	14196	18713	24867	34704	42840	49989	56468	62452	73334	78359	83161
10"	19376	22104	29137	38720	54036	66705	77836	87924	97241	114186	122009	129487
12"	28560	32580	42947	57071	79648	98320	114728	129597	143331	168306	179836	190859

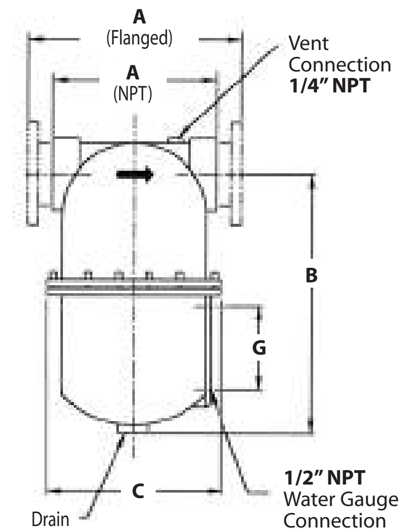
* Not to be used for steam service at these pressures. For air service only.

Air/Steam Moisture Separator

WDS Series

Cast Iron or Carbon Steel





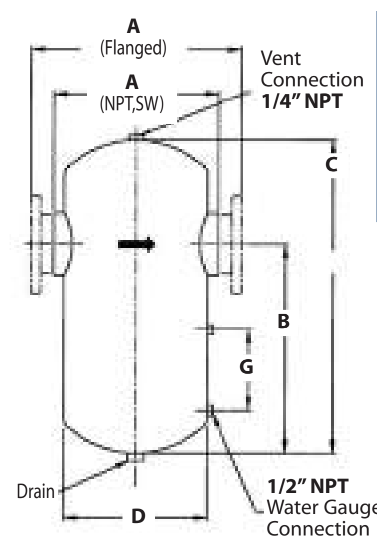
WDS (Cast Iron)

WDS CAST IRON NPT DIMENSIONS – *inches*

Size (NPT)	A	B	C	Vent NPT	Drain NPT	Gauge Centers G	Weight (lbs)
3/4"	5 1/2	10 1/8	5 3/4	1/4	3/4	N/A	23
1"	6	10 1/8	6 3/4	1/4	1	N/A	26
1 1/4"	6	10 3/8	7	1/4	1	N/A	30
1 1/2"	7 1/4	13 1/8	8 1/8	1/4	1	N/A	45
2"	8 1/8	15 5/8	8 1/2	1/4	1	N/A	50
2 1/2"	12	18 1/4	11 3/8	1/4	1 1/4	N/A	95
3"	11	18 1/4	11 3/8	1/4	1 1/4	3 1/2	90

WDS CAST IRON FLANGED DIMENSIONS – *inches*

Size (Flanged)	A	B	C	Vent NPT	Drain NPT	Gauge Centers G	Weight (lbs)
2"	10 1/2	13 3/4	8 1/2	1/4	1	N/A	50
3"	14	16	11 3/8	1/4	1 1/4	4 3/4	95
4"	15 7/8	19 3/8	14	1/4	1 1/4	5 3/4	195



WDS (Carbon Steel)

WDS CARBON STEEL DIMENSIONS – *inches*

Size	NPT & SW A	150# & 300# FLG A	B	C	D	Gauge Centers G	NPT Drain Std.	NPT Drain Opt.	Weight (lbs) NPT & SW	Weight (lbs) 150# FLG	Weight (lbs) 300# FLG
1"	6 3/8	10 1/2	10 1/2	12	5 9/16	Opt.	1	1 1/2	29	33	35
1 1/4"	6 3/8	10 1/2	10 1/2	12	5 9/16	Opt.	1	1 1/2	30	35	37
1 1/2"	7 5/8	11 1/2	12 1/2	14	6 5/8	Opt.	1	2	55	50	56
2"	7 7/8	11 1/2	12 1/2	14	6 5/8	Opt.	1	2	57	55	59
2 1/2"	–	16	15	22	8 5/8	5 3/4	1	2	–	100	110
3"	–	18	18	26	10 3/4	5 3/4	1 1/2	2 1/2	–	140	150
4"	–	20	22	31	12 3/4	5 3/4	1 1/2	2 1/2	–	195	220
5"	–	22	26	36	14	7 7/8	1 1/2	2 1/2	–	230	290
*6"	–	*24	30	41	16	7 7/8	1 1/2	2 1/2	–	350	380
*8"	–	*28	37	50	18	7 7/8	2	3	–	475	610
*10"	–	*34	55	70	24	7 7/8	2	3	–	780	1180
*12"	–	*38	58	75	28	7 7/8	2 1/2	4	–	940	1510

Note: 1" - 2" units are Cast Steel; 2 1/2" and up are Fabricated Steel.

*** Contact Factory for certified drawings on 6" through 12" models.**

Air/Steam Moisture Separator

Cast Iron

Model	WCIS1	WCIS3
Sizes	3/4” – 2”	2 1/2” – 4”
Connections	NPT	ANSI 150#/300#
Body Material	Cast Iron	Cast Iron
PMO Max. Operating Pressure	360 PSIG	360 PSIG
TMO Max. Operating Temperature	662ºF	662ºF
PMA Max. Allowable Pressure	232 PSIG @ 248ºF 160 PSIG @ 572ºF	232 PSIG @ 248ºF 188 PSIG @ 428ºF
TMA Max. Allowable Temperature	572ºF @ 160 PSIG	428ºF @ 188 PSIG

WCIS1
Cast Iron

WCIS3
Cast Iron

Typical Applications

- On steam mains, as a drip station ahead of steam pressure reducing or temperature control valves
- On the steam inlet to laundry presses and other process equipment which require dry saturated steam
- On the compressed air supply to sensitive instruments and before filters

How It Works

When a vapor entrained with moisture enters the steam separator, a series of baffles change its flow direction several times. During the process, the baffles in the housing collect impinged water droplets that are carried in the vapor. Gravity causes the accumulated water droplets and other foreign particles to fall to the drain and exit through an external trap. This allows clean, dry vapor to exit at the outlet of the separator.

Features

- Removes 99% of all particles ≥ 10 microns in size
- Optimal gravity discharge
- Long-lasting cast iron construction

Sample Specification

Moisture Separator shall be of the high efficiency impingement type having a pressure drop that does not exceed an equivalent length of pipe. Body shall be iron with threaded or flanged connections. A threaded bottom drain shall be provided for the installation of a trap to discharge any accumulated liquid.

Installation

Install in a horizontal pipeline with the drain directly below the line. Recommended trap is a continuous draining float operated type.

Maintenance

The trap at the separator drain should be serviced periodically according to the manufacturer’s instructions. The separator itself requires no maintenance.

MATERIALS

WCIS1 Body & Cover WCIS3 Body	Cast Iron ASTM A 126 GR CLB
WCIS1 Gasket	Semi-rigid Graphite Laminate
WCIS3 Gasket	Reinforced Exfoliated Graphite
Bolts	Steel UNF, BS 1766 Gr 5
Bushing	Malleable Iron
Plug	Malleable Iron

Air Capacities in SCFM (standard cubic feet per minute)

	Operating Pressure (PSIG)						
Size	20	40	60	80	100	145	200
3/4”	31	51	67	87	102	148	194
1”	51	82	108	138	169	245	322
1 1/2”	123	190	262	334	406	587	
2”	206	437	437	556	674	968	
2 1/2”	288	623	623	793	957	1380	
3”	370	803	803	1019	1236	1776	
4”	643	1385	1385	1756	2132	3059	

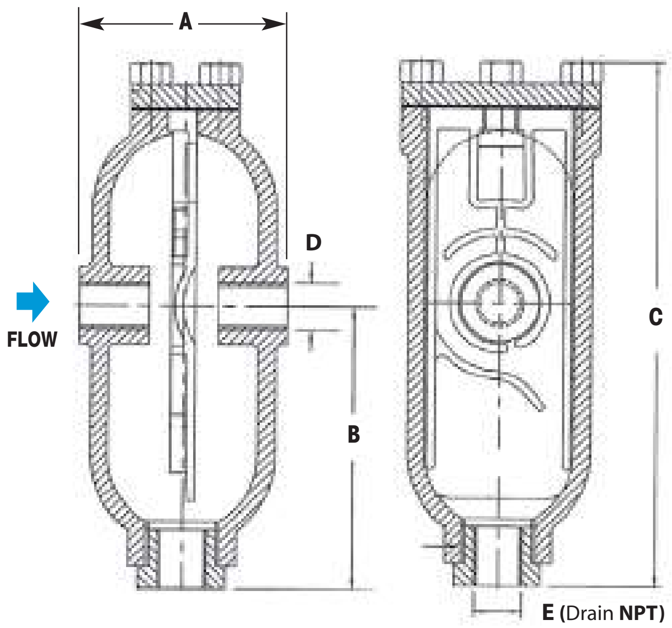
Saturated Steam Capacities in lbs/hr

	Operating Pressure (PSIG)						
Size	5	10	25	50	100	145	200
3/4”	68	82	128	203	349	496	635
1”	110	133	208	330	567	804	1030
1 1/2”	260	317	494	783	1347	1845	
2”	429	523	814	1292	3220	3041	
2 1/2”	612	746	1162	1844	3168	4340	
3”	946	1153	1795	2848	4893	6702	
4”	1630	1985	3092	4906	8427	11542	

WCIS Series

Cast Iron

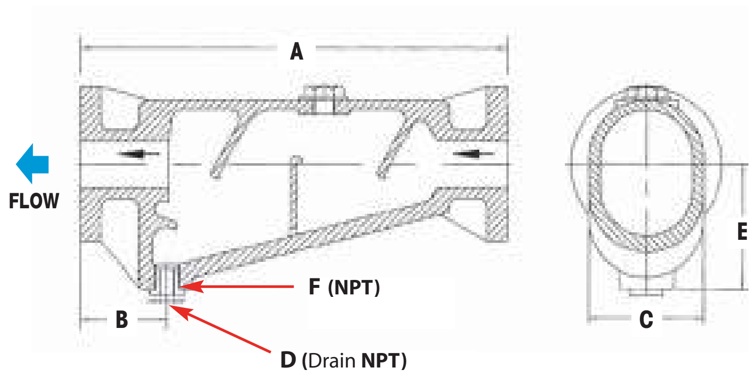
WCIS1 (Cast Iron)



Size	A	B	C	D	E	Weight
3/4"	4.75	6.69	14	3/4"	3/4"	24 lb
1"	4.75	6.69	14	1"	3/4"	24 lb
1 1/2"	9.0	9.06	18.35	1 1/2"	1"	80 lb
2"	9.96	9.65	20.55	2"	1"	80 lb

WCIS1 DIMENSIONS (nominal) - inches/*mm*

WCIS3 (Cast Iron)



WCIS3 DIMENSIONS – Flanged connections (in./*mm*)

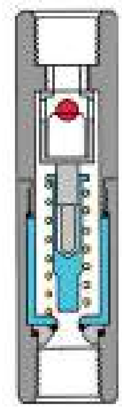
Size	A	B	C	D	E	F	Weight
2 1/2"	15.94	4.13	5.71	3/4"	6.89	1 1/2"	67 lb
3"	18.90	4.53	5.91	1"	6.50	1 1/2	87 lbs
4"	27.17	4.92	7.87	1"	8.27	1 1/2	148 lbs

PIPELINE ACCESSORIES

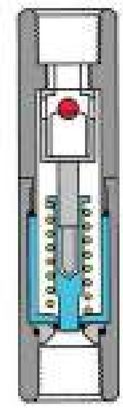
Freeze Protection Valve

Stainless Steel

Model Code	**WFPV-12-N**
Sizes	**1/2”**
Connections	**NPT**
Body Material	**Stainless Steel**
PMO Max. Operating Pressure	**200 PSIG**
TMO Max. Operating Temperature	**300ºF**



Valve OPEN (<40˚F)



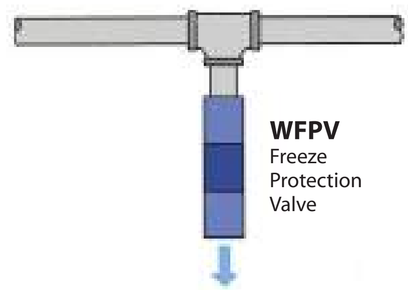
Valve CLOSED (≥40˚F)

Typical Applications

The **WFPV** is used for freeze protection on pipes, valves, fittings, pumps, condensate systems, safety showers, fire lines, spray nozzles, freeze sensitive equipment or as backup protection on steam tracing lines.

How It Works

A thermostatic element senses water temperature in the valve. If the temperature falls below 35ºF, the valve will modulate open allowing water to drain from the system. The valve will remain open as long as the water flowing by the sensing element is less than 40ºF. When the water temperature rises above 40ºF, the valve will close.

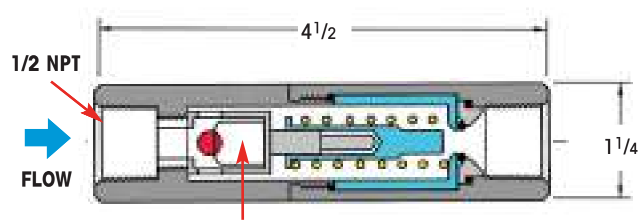


Features

- Corrosion resistant stainless steel body
- Long service life
- Narrow temperature band
- System pressures will not affect opening temperature

Sample Specification

The freeze protection valve shall have a stainless steel body and be actuated by a thermostatic element that senses water temperature. The unit shall feature a ram-type plug for a tight and reliable shut-off.



Weight: 0.9 lbs.

Installation

Unit should be installed in a vertical orientation with flow direction downward. For full details, see Installation and Maintenance Manual.

MATERIALS	
Body	Stainless Steel, 303
O-Ring	EPDM
Plug	Stainless Steel
Spring	Stainless Steel, 302
Thermal Actuator	Stainless Steel

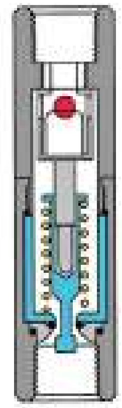
CAPACITIES – *Water (lbs/hr)*

Inlet Pressure (PSIG)	Capacity (lbs/hr)
50	2475
75	3031
100	3500
125	3913
150	4287
175	4630
200	4950

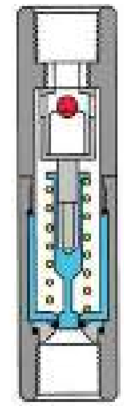
WSPV Series

Stainless Steel

Model Code	1/2″	**WSPV-12-N**
	3/4″	**WSPV-13-N**
Sizes		**1/2″, 3/4″**
Connections		**NPT**
Body Material		**Stainless Steel**
PMO Max. Operating Pressure		**200 PSIG**
TMO Max. Operating Temperature		**300ºF**



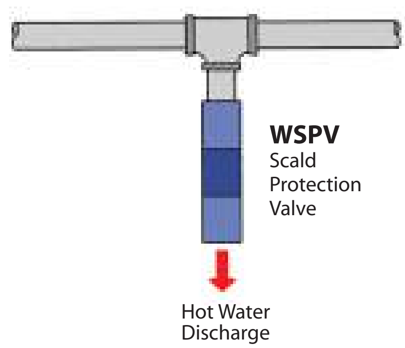
Valve
OPEN
(>95˚F)



Valve
CLOSED
(≤95˚F)

Typical Applications

The **WSPV** is used to protect personnel from accidental scalding by over-heated water or other liquids. Installations such as eye-wash stations and safety showers can become over-heated by piping exposed to solar radiation or a heat exchanger malfunction.



How It Works

When water temperature rises above 95ºF, the thermal actuator modulates the valve open. If the water exceeds 105ºF, the valve will go to full open position in order to discharge the over-heated water. When the water temperature returns to 95ºF, the thermal actuator modulates the valve to close.

Features

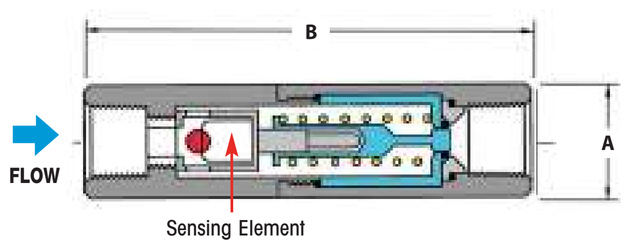
- Corrosion resistant stainless steel body
- Long service life
- Narrow temperature band
- System pressures will not affect opening temperature

DIMENSIONS & WEIGHTS – *inches / pounds*

Size NPT	A	B	Weight (lbs)
1/2"	1 1/4	4 1/2	0.9
3/4"	1 1/2	5 1/2	1.4

Sample Specification

The scald protection valve shall have a stainless steel body and be actuated by a thermal element that senses water temperature. The unit shall feature a ram-type plug for reliable and tight shut-off.



Installation

Unit should be installed in a vertical orientation with flow direction downward. For full details, see Installation and Maintenance Manual.

MATERIALS

Body	Stainless Steel, 303
Seat Seal	PTFE
Plug	Stainless Steel
Spring	Stainless Steel, 302
Thermal Actuator	Stainless Steel

CAPACITIES – *Water (lbs/hr)*

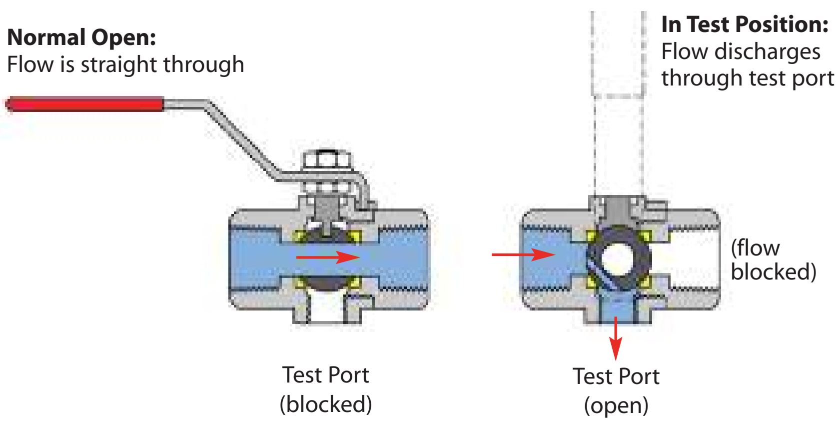
Inlet Pressure (PSIG)	Capacity (lbs/hr)	
	1/2″	3/4″
50	5,300	7,070
75	6,495	8,660
100	7,500	10,000
125	8,385	11,180
150	9,180	12,240
200	10,600	14,140

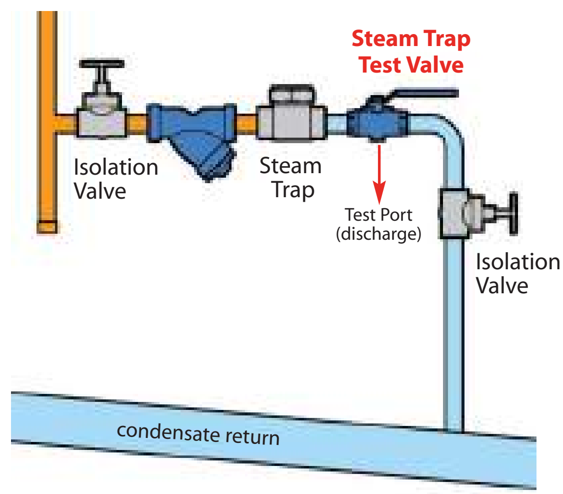
PIPELINE ACCESSORIES

Stainless Steel

Model	WSTTV	Stainless Steel
Sizes & Model Code	1/2"	WSTTV-12-N-SS
	3/4"	WSTTV-13-N-SS
	1"	WSTTV-14-N-SS
Connections	NPT	
Body Material		Stainless Steel
Pressure Ratings		150 PSIG WSP

WSP = Working Steam Pressure





Application & How It Works

The **WSTTV** Steam Trap Test Valve offers simple, immediate, and visible diagnosis of any steam trap. Turning the handle 90˚ to the "Test" position will direct flow of steam trap out the test port for visual evaluation of discharge.

With the **WSTTV** Steam Trap Test Valve installed downstream of the trap and in the open position, the steam trap discharges normally. A quarter-turn of the handle repositions the specially designed ball and diverts the trap discharge through a port on the bottom of the valve. Discharge can then be observed and assessments made regarding the operation of the steam trap.

Features

- Seal welded construction
- Full stainless steel construction
- Fully compliant with ASME B16.34 & API 608
- NACE MR-01-75 compliant
- Standard locking stainless steel handles
- Single reduced bore/full porting (depending on size)

Installation

Test Valve to be mounted on the outlet side of the steam trap. Care should be taken to ensure that the discharge port will be positioned in such a manner so as to avoid danger to personnel. NOT AN ISOLATION OR STOP VALVE.

MATERIALS (Stainless Steel)

Description	150 PSI Rating
Body	CF8M
Ball	ASTM A276 Gr. 316 SS
Stem	ASTM A276 Gr. 316 SS
Seats (2)	R-TFM (Hostaflon)
Stem Packing	Graphite
Handle Assembly	300 Series SS

Heat Miser
Instantaneous Steam to Water Heaters
for Domestic and Process Water Heating Applications

Watson McDaniel

The Heat Miser is an Instantaneous Steam to Water Heater which produces hot water from steam. The Watson McDaniel fully-assembled Heat Miser eliminates the need for large hot water storage tanks and saves significant energy which is required for large standing tanks of hot water.

Common Applications: Hospitals, Schools & Universities, Hotels, Process Washdown Stations, Residential Apartment Buildings or any other facility with an existing steam boiler.

Old Hot Water System Negatives

- Takes up excessive floor space
- Stagnating hot water
- Danger of Legionella Growth
- Corrosion of tanks
- Significant radiant heat loss

New Heat Miser System

- Small footprint (typical floor space of 14ft^2)
- Efficient plate & frame heat exchanger maximizes turbulent flow for instantaneous hot water on demand
- Stainless Steel waterside components
- Simple maintenance and reduced overall costs

System Benefits

- Meets the rigorous demands of domestic water heating
- Accommodates extreme load fluctuations without the need or storage tanks
- Accurate control of outlet water temperature for many systems to +/- 2°F, and +/- 8°F for wide and sudden load fluctuations
- High-efficiency Plate & Frame Heat Exchanger optimized for use with low pressure steam and offers typical flow rates up to 300 GPM, with higher flow rate designs available
- Integral Control Panel included for ease of operation and system feedback
- Electric and Pneumatic Control Valves available for precise steam control
- Excellent for washdown stations

The Watson McDaniel Difference

- ASME qualified welders and certifications
- ASME U and UM Stamp availability on appropriate components
- Complete assembly and pressure testing prior to shipment
- Better control of design, cost and quality by avoiding 3rd party fabricators
- Unparalleled turn-around and deliveries with many units available for shipment within days

Standard Auxiliary Items

- Steam and Condensate Inlet Y-Strainers
- Stainless Steel Recirculation Pump
- Over-temperature Protection – Solenoid-actuated Cold Water Injection
- Steam Inlet Pressure Gauge
- Stainless Steel RTD Electronic Temperature Sensor
- Stainless Steel Waterside Piping with Safety Valve

Heat Exchanger

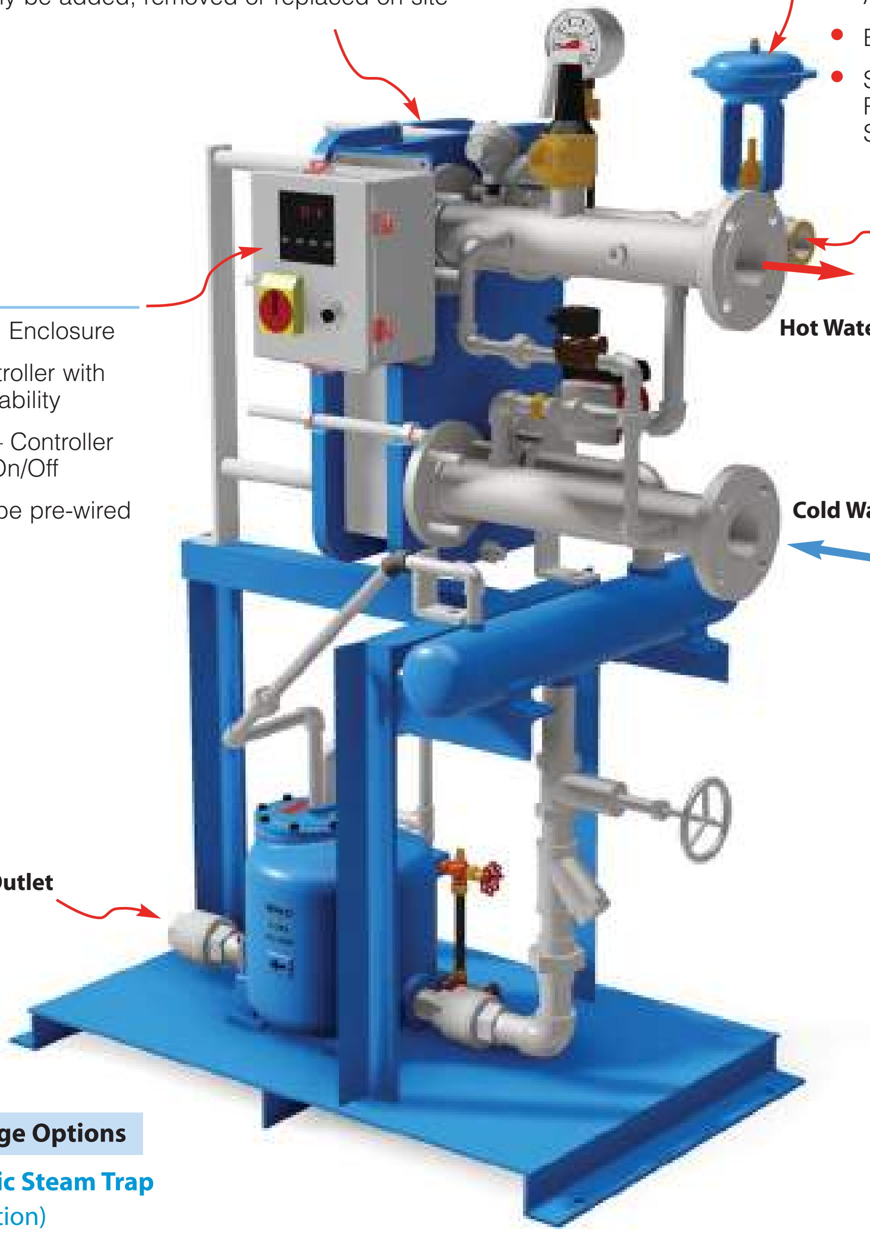
- High-efficiency Plate & Frame Counterflow Type
- Single or Double Wall 316 Stainless Steel Plates
- Steam-rated EPDM gaskets
- Plates may easily be added, removed or replaced on site

Control Valve

- Cast Iron, Bronze or Steel Globe Body
- Fail Closed Pneumatic Actuator
- Electro-Pneumatic Positioner
- Single Seat, Equal Percentage, Stainless Steel Trim

Control Panel

- NEMA 4X Electrical Enclosure
- Electronic PID Controller with Full Auto-Tune Capability
- Selector Switches – Controller On/Off and Pump On/Off
- All components to be pre-wired for 120V service



Condensate Drainage Options

Float & Thermostatic Steam Trap
(gravity drainage option)

- All Stainless Steel Internals
- Body Material options include Ductile Iron, Carbon Steel and Stainless Steel

Pump-Trap Combination (pumped drainage option)

- Patented Snap-Assure mechanism with stainless steel wear parts
- Ductile Iron Tank
- Gauge Glass
- Motive PRV, Drip Trap, and Motive and Vent Piping

Common Optional Items

- High-limit Steam Isolation Package including dedicated sensor and actuated ball valve
- HDP Pressure Reducing Valve for reducing inlet steam supply pressure to the control valve

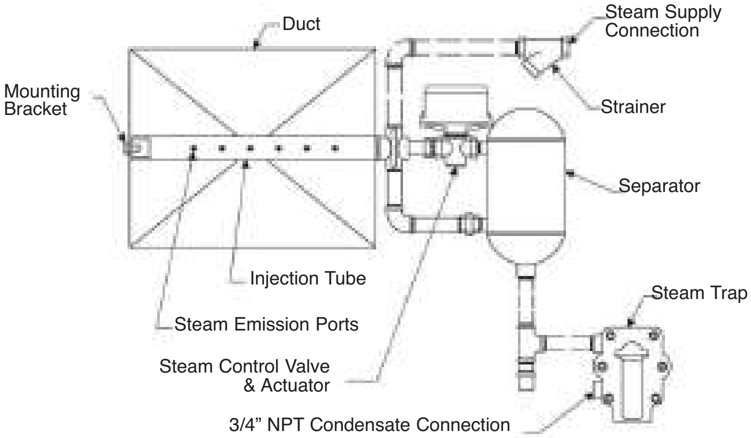
Watson McDaniel offers five standard packages, or you can customize your own Heat Miser.

3 Standard Frame Sizes

1P **2P** **3P**

Model	WATER		STEAM			Footprint Dimensions (in)		
	Inlet & Outlet	GPM	Steam Inlet	Condensate Outlet	Steam Load (lbs/hr) @ 100˚F Temp Rise	Length	Width	Height
1P10	3″	20	1 1/2″	1 1/2″	1,030	46	30	67
1P20	3″	40	2″	1 1/2″	2,061	46	30	67
2P28	3″	60	2 1/2″	2″	3,091	46	30	73
3P20	3″	80	3″	2″	4,122	54	34	92
3P28	3″	100	3″	2″	5,152	54	34	92

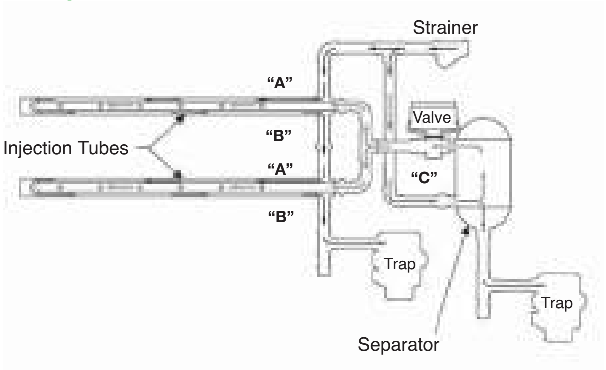
Single Tube Humidifier



Single Tube (WSI)

- **For direct injection of steam humidification into air stream**
- **Many tube length options to accommodate various duct widths**
- **Recommended for relatively small duct heights where dissipation distance is not critical**

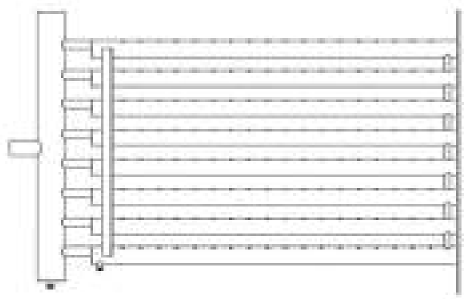
Multiple Tube Humidifier



Multiple Tube (WSI)

- **Used for improved dissipation distances in duct heights above 20"**
- **Number of tubes can be selected to optimize performance**
- **Many tube length options to accommodate various duct widths**

Insty-Pac Manifold-Style Humidifier



Insty-Pac (WIP)

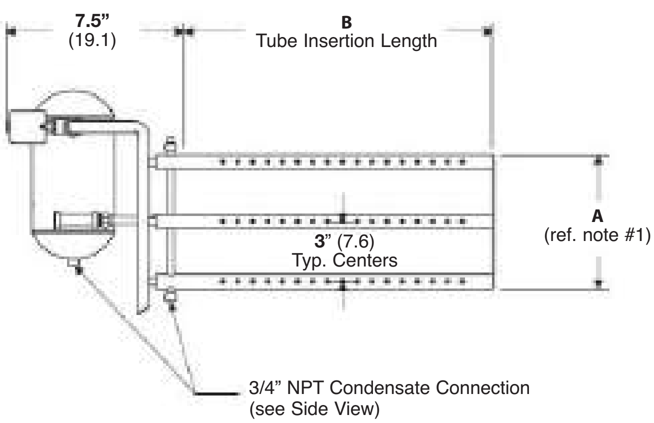
- **Custom-engineered manifold design for job-specific requirements**
- **Used when dissipation distances are critical for optimum air stream humidification**
- **Number of tubes properly selected to achieve design requirements**

Humidification Overview

Steam Heat Exchanger (WSX)

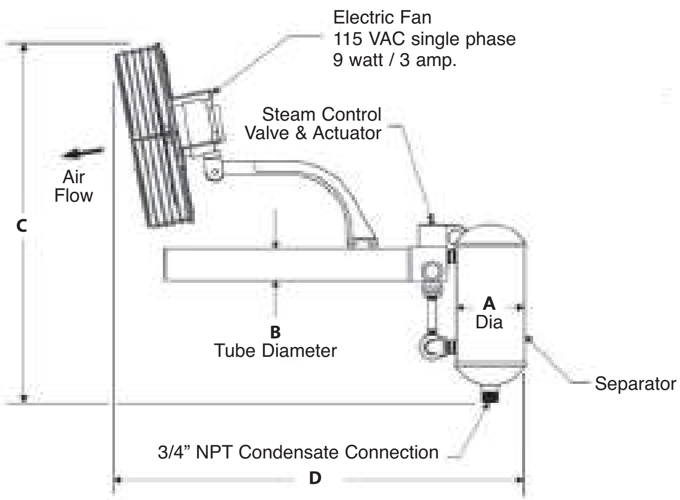
- Provides humidification for today's stringent indoor air quality requirements
- Utilizes boiler steam to heat tap water providing injection steam free from chemical or mineral carry-over
- Ideal for use where electric humidifiers would be cost-prohibitive

Mini-Mult Front View



Mini-Mult

- Designed for applications that require small humidification loads in a small duct size
- Ideal for any high humidity job where fast steam dissipation in cool air in a short-run duct is essential
- Number of tubes can be specified per duct size and job requirements



Area Type

- Designed for applications that require humidification without the use of duct work
- Ideal for area humidity control in paper, textile or wood manufacturing applications as well as printing plants and storage areas

Series "**WSI**"
Steam Injection
Humidifiers

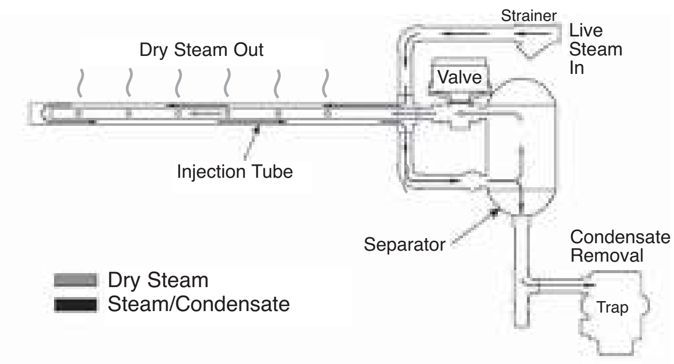
Series "**WIP**"
INSTY-PAC
Steam Injection
Humidifiers

Typical Applications

A Steam Injection Humidifier supplies precise humidity control from the facility steam boiler into the air stream. Typically used in manufacturing plants, printing plants, commercial offices, hospitals and any other facilities which require a critical balance between temperature and humidity control.

How It Works

The Steam Injection Humidifier receives steam directly from the boiler (live steam), removes the condensate and injects the dry steam into the duct work or an air stream. Live steam enters a steam jacket to preheat the injection tube. Steam then flows into the separator where condensate is removed. Dry steam is then discharged through the injection tube for circulation into the air stream.



MATERIALS	
Separator	304 SS
Dispersion Tube	304 SST

Features

- Provides accurate humidity control
- Simple and cost efficient system to meet high humidity requirements
- Available for regular or purified boiler steam
- Available for single or multiple tube applications
- Capacities up to 2900 lbs/hr
- Pressure ranges from 2-60 PSIG
- Available for pneumatic or electric controls
- All stainless steel distributors and nozzles ensure permanent bond
- Separator and Steam Jacket included to provide highest quality steam

Installation

Distributor must be mounted level in a straight section of duct, with steam outlets facing into the air stream. A steam trap should be installed on the separator outlet, allowing for proper condensate removal. Also include a strainer upstream of humidifier inlet.

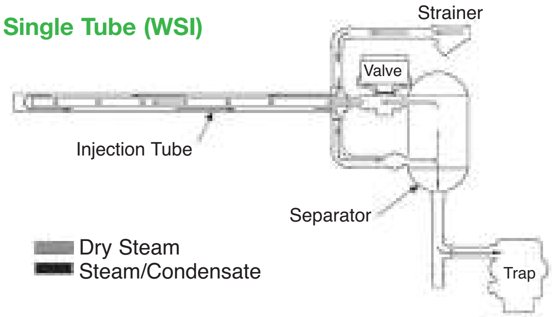
Maintenance

The strainer should be cleaned periodically. The valve, actuator, steam trap and temperature switch should be inspected annually to confirm proper operation. For full maintenance details, see installation and maintenance manual.

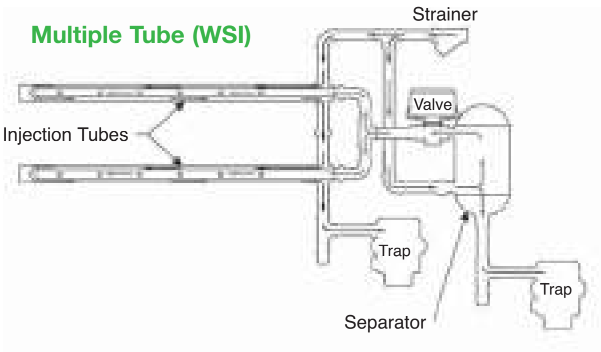
HOW TO ORDER

Consult factory for sizing and selection. Provide required humidification load, steam pressure at humidifier inlet, duct dimensions, actuator type and any accessories.

Single Tube (WSI)



Multiple Tube (WSI)

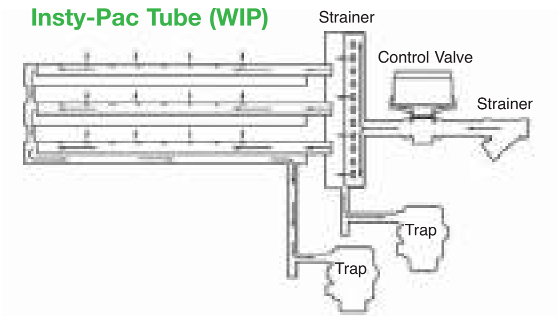


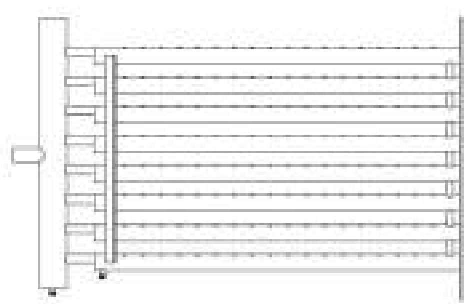
To prevent condensation on in-duct objects, such as dampeners, coils, filters or turning vanes, it is very important that the dissipation distance be shorter than the distance from the humidifier to the in-duct object. The following recommendations should be used when designing a multiple injection tube system:

Duct Height	Recommended Qty. of Tubes †
Up to 36″	2
37″ – 48″	3
49″ – 72″	4
73″ – 96″	5
Above 96″	6

† Final duct relative humidity, air velocity and available dissipation distance will affect the quantity of tubes required.

Insty-Pac Tube (WIP)





MODEL NUMBERS				Steam Pressure to Humidifier Supply Connection (PSIG)																						
Insty Pac	Single Tube	Multi Tube	Valve Cv / Size NPT	2	3	4	5	6	7	8	9	10	11	12	13	14	15	20	25	30	35	40	45	50	55	60
			.10 (1/2″)	1.6	1.9	2.3	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.3	4.4	5.1	5.7	6.3	6.8	7.3	7.7	8.1	8.5	8.9
			.22 (1/2″)	3.5	4.2	5.0	5.6	6.5	6.6	7.1	7.6	8	8	9	9	10	10	11	13	14	15	16	17	18	19	20
			.40 (1/2″)	6.4	7.6	9.1	10	11	12	13	14	15	15	16	16	17	18	20	23	25	27	29	31	33	34	36
			.75 (1/2″)	12	14	17	19	21	23	24	26	27	28	30	31	32	33	38	43	47	50	54	57	60	63	66
			.95 (1/2″)	15	18	21	24	27	29	31	33	34	36	38	39	40	42	48	54	59	64	68	72	76	80	84
BP-1	50-10	50	1.30 (1/2″)	21	24	29	33	36	39	42	44	47	49	51	53	55	57	66	74	80	87	93	99	104	109	114
			1.75 (1/2″)	28	33	40	44	49	52	55	60	63	66	69	72	74	76	88	99	107	116	124	132	139	146	153
			2.20 (1/2″)	35	41	50	55	61	66	71	75	79	82	86	90	93	95	111	123	134	146	156	165	174	183	192
			2.80 (1/2″)	45	53	64	70	78	84	90	96	100	104	109	114	118	121	141	157	171	186	199	210	221	233	244
			3.25 (1/2″)	52	61	73	82	90	96	104	110	116	121	127	132	137	140	163	181	198	214	229	244	257	270	282
			4.40 (1/2″)	70	83	98	110	121	130	141	149	157	163	172	178	185	190	221	244	256	290	310	328	345	363	381
			5.50 (3/4″)	85	104	123	138	150	161	176	186	196	204	213	222	231	235	275	305	333	360	385	408	430	451	471
BP-2	60-20	60	6.20 (3/4″)	96	117	138	155	169	182	198	210	220	230	240	250	259	265	310	343	372	403	434	459	485	508	529
			7.50 (3/4″)	116	142	166	186	204	220	238	253	265	277	289	302	312	320	373	412	450	487	525	555	585	614	640
			8.20 (1″)	123	155	180	204	223	240	261	275	290	303	313	328	341	349	407	443	488	529	570	603	635	668	703
BP-3	70-20	70	10.0 (1″)	150	189	220	248	272	293	317	335	354	370	380	400	414	423	497	540	595	645	695	735	770	810	850
			12.0 (1″)	180	228	264	296	326	351	378	402	422	441	456	465	492	505	595	648	714	774	828	876	-	-	-
BP-4	80-30	80	20.0 (1-1/4″)	300	375	440	494	540	582	630	666	702	736	750	772	814	834	990	1060	1180	1280	1376	1460	-	-	-
			28.0 (1-1/4″)	420	511	612	686	756	812	873	927	980	1024	1044	1075	1128	1165	1383	1484	1638	1778	1912	2044	-	-	-
BP-5	N/A	90	40.0 (2″)	300	375	440	494	540	582	630	666	702	736	750	772	814	834	990	1060	1180	1280	1376	1460	-	-	-

Typical Applications

Steam Heat Exchanger Humidifiers can be used for humidification applications where steam injection is to be used, but chemically treated boiler steam is not allowable. They provide humidification to meet stringent indoor air quality requirements and are ideal for use where electric humidifiers would be cost-prohibitive.

How It Works

The **WSX Steam Heat Exchanger Humidifier** works by utilizing existing boiler steam to heat tap water, providing injection steam free from chemical or mineral carry-over. Several steam injection dispersion methods are available to suit the application requirements.

Features

- Single unit capacity up to 2,035 lbs/hr
- 304 Stainless Steel reservoir construction
- Stainless Steel heat exchanger
- Unique side-entry heat exchanger provides a large clean out access section without disturbing the cover or injection tube system's steam supply piping
- Pneumatic modulating steam control valve
- Tri-Probe level controller
- Adjustable surface water flusher
- Motorized drain valve with brass body
- User-adjustable automatic drain system
- Float & Thermostatic steam trap(s)
- Inlet "Y" strainer(s)

Options

- **INTAC microprocessor controller**
- **Electric modulating actuator**
- **Factory-mounted control panel**
- **NEMA 4 weather-tight control panel**
- **Control panel door lock**
- **Seasonal End-of-Use drain system**
- **Door interlock safety switch**
- **Factory-insulated reservoir**
- **Support legs**
- **Wall brackets**
- **Freeze protection**
- **Stand-by water temperature sensing**
- **Blower Pack for area humidification**
- **Variable air volume control**
- **Outdoor air temperature sensing**
- **Drain tempering kit**
- **Remote INTAC microprocessor controller**
- **Outdoor enclosure**

Humidifier Capacity – *lbs/hr (kg/hr)* †

Model	Steam Pressure in at the control valve – PSIG (kPa)			
	5 (34.5)	10 (69.0)	13 (89.6)	15 (103.4)
SX-1R	32 (14.5)	76 (34.5)	100 (45.3)	122 (55.3)
SX-2R	52 (23.6)	108 (48.9)	140 (63.5)	169 (76.7)
SX-3R	102 (46.3)	228 (103.4)	292 (132.5)	348 (157.8)
SX-4R	192 (87.1)	484 (219.5)	655 (297.1)	753 (341.7)
SX-8R	370 (167.8)	840 (381.0)	1200 (544.3)	1350 (612.4)
SX-12R	560 (254.0)	1265 (573.8)	1810 (821.0)	2035 (923.1)

† Actual humidifier capacity may vary due to the heat loss from the humidifier reservoir. The ambient air temperature, air velocity and injection tube system will affect the rate of the heat loss from the reservoir.

The capacities shown are based on a non-insulated humidifier reservoir tested in a 70°F environment.

Watson McDaniel

Replacement Parts & Repair Kits

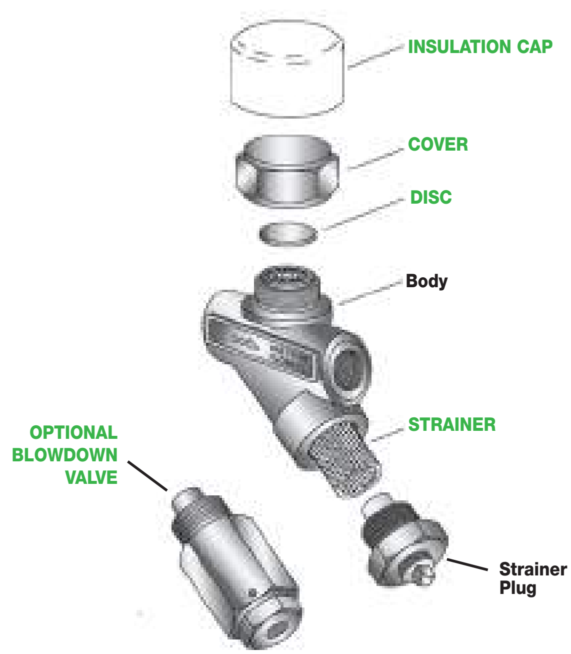
Table of Contents

TD600 Series — Thermodynamic Steam Trap Parts & Kits

Size	For Models	Item	Order #
3/8" / 1/2"	TD600 / TD600L	Disc	**1495500**
		Cover	**1495600**
		Insul-cap	**W-INSUL-CAP-11**
1/2" / 3/4"	TD600 / TD600L	Disc	**1495800**
		Cover	**1495900**
		Insul-cap	**W-INSUL-CAP-12**
3/4"	TD600	Disc	**1496100**
		Cover	**1496200**
		Insul-cap	**W-INSUL-CAP-13**
1"	TD600	Disc	**1496400**
		Cover	**1496500**
		Insul-cap	**W-INSUL-CAP-14**

TD600S Series — Thermodynamic Steam Trap Parts & Kits

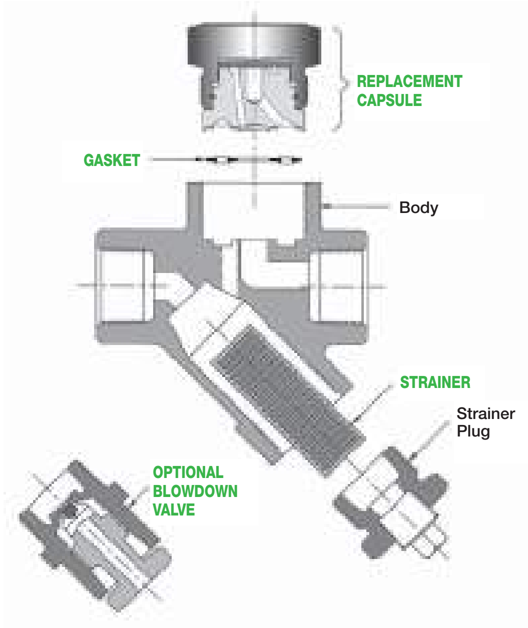
Size	For Models	Item	Order #
1/2" / 1"	TD600LS/LSB / TD600LS/LSB	Disc	**1495500**
		Cover	**1495600**
		Insul-cap	**W-INSUL-CAP-11**
1/2" / 3/4"	TD600S/SB / TD600LS/LSB	Disc	**1495800**
		Cover	**1495900**
		Insul-cap	**W-INSUL-CAP-12**
3/4"	TD600S/SB	Disc	**1496100**
		Cover	**1496200**
		Insul-cap	**W-INSUL-CAP-13**
All TD600S Series		Screen	**1532002**
All TD600SB/LSB		Blowdown Valve Assembly	**WBLDNVLV-TRAPS**



TD700S Series Thermodynamic Steam Trap Parts & Kits

Size	For Models	Items	Order #
1/2", 3/4",1"	TD700S/SB	Repair Kit: (1) trap capsule (1) capsule gasket	W-KIT-WD700
1/2", 3/4", 1"	TD700HS/HSB	Repair Kit: (1) trap capsule (1) capsule gasket	W-KIT-WD700H
1/2", 3/4", 1"	TD700S Series TD700SB/HSB	(1) Strainer Screen	1532002
		(1) Blowdown Valve Assembly	WBLDNVLV-TRAPS

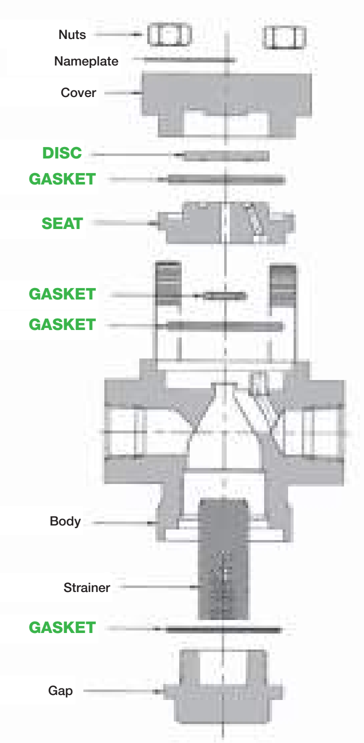
Cross Reference: **Yarway Replacement Capsule 721/721H**



TD900S Series Thermodynamic Steam Trap Parts & Kits

Size	For Models	Items	Order #
1/2", 3/4",1"	TD900S	Insulation Cap	W-INSUL-WD900S
		Seat & Disc Assembly Kit	W-KIT-900-SDA
1/2", 3/4",1"	TD900LS	Insulation Cap	W-INSUL-WD900S
		Seat & Disc Assembly Kit	W-KIT-900L-SDA

Seat & Disc Assembly Kit consists of:
(1) disc
(1) seat
(4) gaskets



TD3600 Series High-pressure Thermodynamic Steam Trap Parts & Kits

Size	For Model	Repair Kit	Kit Order #
1/2", 3/4",1"	TD3600	Seat, Disc, Screen, Gaskets	W-KIT-3600

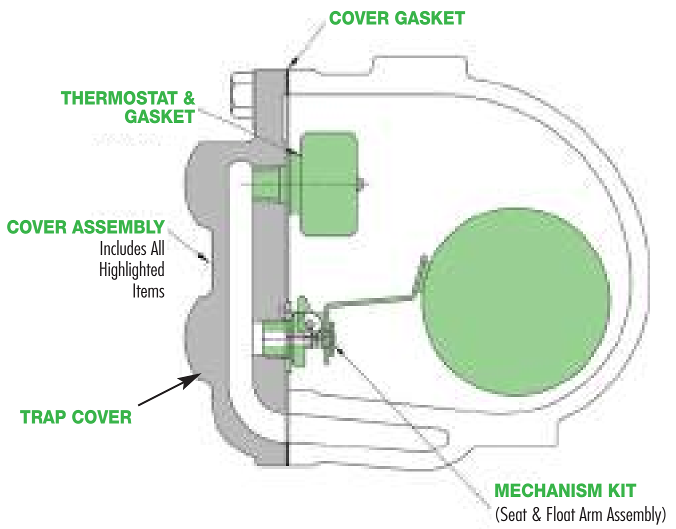
WFT Series Float & Thermostatic Steam Trap Parts & Kits

Thermostat Kit:
(1) welded stainless steel thermostat
(1) thermostat gasket.

Mechanism Kit: (does not include thermostat & cover gasket)
(1) seat & float arm assembly

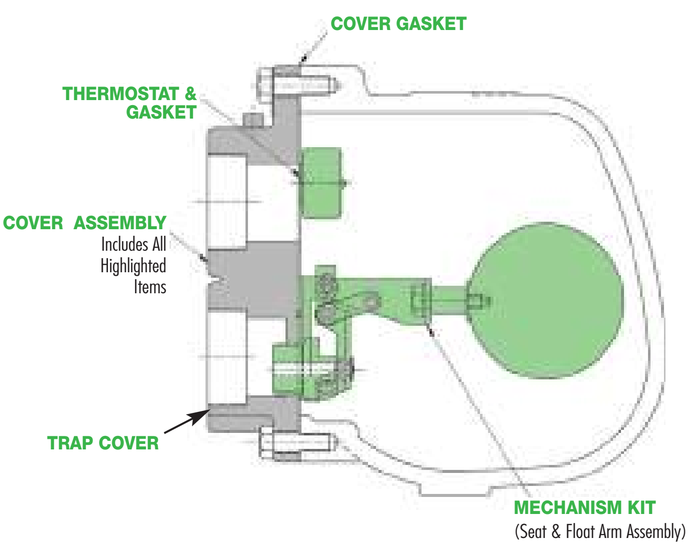
Cover Assembly Kit: (consists of all internal components below, assembled to trap cover)
(1) mechanism kit
(1) thermostat kit
(1) cover gasket

*The repair parts for the WFT Series F&T Traps are also used in the **WLD1900 Liquid Drainer.** Note: No thermostat required in the WLD1900.



* Repair Parts for WLD1900 Liquid Drainer – 15 PSIG (PMO)

Model	Size #	Order	Item
WFT-015 • 15 PSI	3/4"	W-KIT-3-32	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-57	Mechanism Kit
		W-KIT-7-30	Cover Assembly Kit
	1"	W-KIT-3-32	Cover Gasket Kit
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-57	Mechanism Kit
		W-KIT-7-30	Cover Assembly Kit
	1 1/4"	W-KIT-3-32	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-58	Mechanism Kit
		W-KIT-7-30-15	Cover Assembly Kit
	1 1/2"	W-KIT-3-22	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-59	Mechanism Kit
		W-KIT-7-31	Cover Assembly Kit
	2"	W-KIT-3-18	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-60	Mechanism Kit
		W-KIT-7-32	Cover Assembly Kit



* Repair Parts for WLD1900 Liquid Drainer – 30 PSIG (PMO)

Model	Size #	Order	Item
WFT-030 • 30 PSI	3/4"	W-KIT-3-32	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-61	Mechanism Kit
		W-KIT-7-33	Cover Assembly Kit
	1"	W-KIT-3-32	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-61	Mechanism Kit
		W-KIT-7-33	Cover Assembly Kit
	1 1/4"	W-KIT-3-32	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-61	Mechanism Kit
		W-KIT-7-33	Cover Assembly Kit
	1 1/2"	W-KIT-3-22	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-62	Mechanism Kit
		W-KIT-7-34	Cover Assembly Kit
	2"	W-KIT-3-18	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-63	Mechanism Kit
		W-KIT-7-35	Cover Assembly Kit

WFT Series (continued)

* Repair Parts for WLD1900 Liquid Drainer – 90 PSIG (PMO)

Model	Size	Order #	Item
WFT-075 • 75 PSI	3/4″	W-KIT-3-32	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-64	Mechanism Kit
		W-KIT-7-36	Cover Assembly Kit
	1″	W-KIT-3-32	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-64	Mechanism Kit
		W-KIT-7-36	Cover Assembly Kit
	1 1/4″	W-KIT-3-22	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-65	Mechanism Kit
		W-KIT-7-37-15	Cover Assembly Kit
	1 1/2″	W-KIT-3-22	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-65	Mechanism Kit
		W-KIT-7-37	Cover Assembly Kit
	2″	W-KIT-3-18	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-66	Mechanism Kit
		W-KIT-7-38	Cover Assembly Kit

* Repair Parts for WLD1900 Liquid Drainer – 200 PSIG (PMO)

Model	Size	Order #	Item
WFT-175 • 175 PSI	3/4″	W-KIT-3-22-1	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-70	Mechanism Kit
		W-KIT-7-42	Cover Assembly Kit
	1″	W-KIT-3-22-1	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-70	Mechanism Kit
		W-KIT-7-43	Cover Assembly Kit
	1 1/4″	W-KIT-3-22-1	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-71	Mechanism Kit
		W-KIT-7-44	Cover Assembly Kit
	1 1/2″	W-KIT-3-22-1	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-71	Mechanism Kit
		W-KIT-7-45	Cover Assembly Kit
	2″	W-KIT-3-18	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-72	Mechanism Kit
		W-KIT-7-46	Cover Assembly Kit

* Repair Parts for WLD1900 Liquid Drainer – 150 PSIG (PMO)

WFT-125 • 125 PSI	3/4″	W-KIT-3-32	Cover Gasket
		W-KIT-4-12-125	Thermostat Kit
		W-KIT-6-67	Mechanism Kit
		W-KIT-7-39	Cover Assembly Kit
	1″	W-KIT-3-32	Cover Gasket
		W-KIT-4-12-125	Thermostat Kit
		W-KIT-6-67	Mechanism Kit
		W-KIT-7-39	Cover Assembly Kit
	1 1/4″	W-KIT-3-22	Cover Gasket
		W-KIT-4-12-125	Thermostat Kit
		W-KIT-6-68	Mechanism Kit
		W-KIT-7-40-15	Cover Assembly Kit
	1 1/2″	W-KIT-3-22	Cover Gasket
		W-KIT-4-12-125	Thermostat Kit
		W-KIT-6-68	Mechanism Kit
		W-KIT-7-40	Cover Assembly Kit
	2″	W-KIT-3-18	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-69	Mechanism Kit
		W-KIT-7-41	Cover Assembly Kit

* Repair Parts for WLD1900 Liquid Drainer – 250 PSIG (PMO)

WFT-250 • 250 PSI	3/4″	W-KIT-3-22-1	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-73	Mechanism Kit
		W-KIT-7-47	Cover Assembly Kit
	1″	W-KIT-3-22-1	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-73	Mechanism Kit
		W-KIT-7-48	Cover Assembly Kit
	1 1/4″	W-KIT-3-22-1	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-74	Mechanism Kit
		W-KIT-7-49	Cover Assembly Kit
	1 1/2″	W-KIT-3-22-1	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-75	Mechanism Kit
		W-KIT-7-50	Cover Assembly Kit
	2″	W-KIT-3-18	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-76	Mechanism Kit
		W-KIT-7-51	Cover Assembly Kit

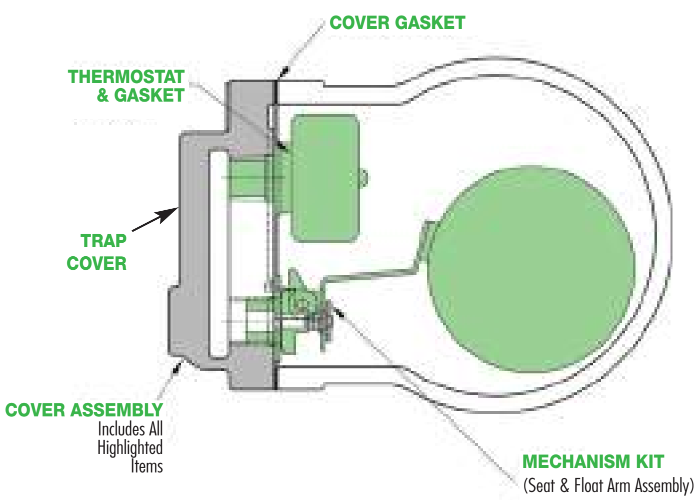
*The repair parts for the FTT Series F&T Traps are also used in the **WLD1400 Liquid Drainer.** Note: No thermostat required in the WLD1400.

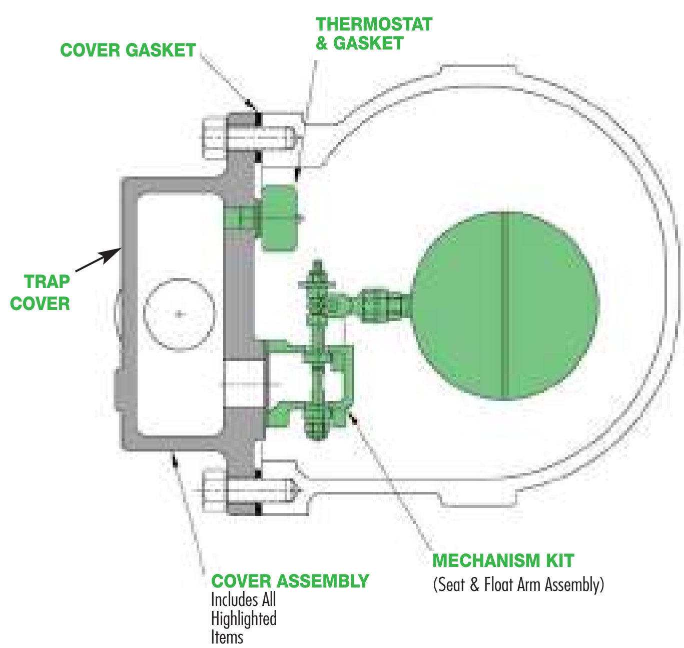
FTT Series — Float & Thermostatic Steam Trap Parts & Kits

Thermostat Kit:
(1) welded stainless steel thermostat
(1) thermostat gasket

Mechanism Kit: (does not include thermostat & cover gasket)
(1) seat & float arm assembly

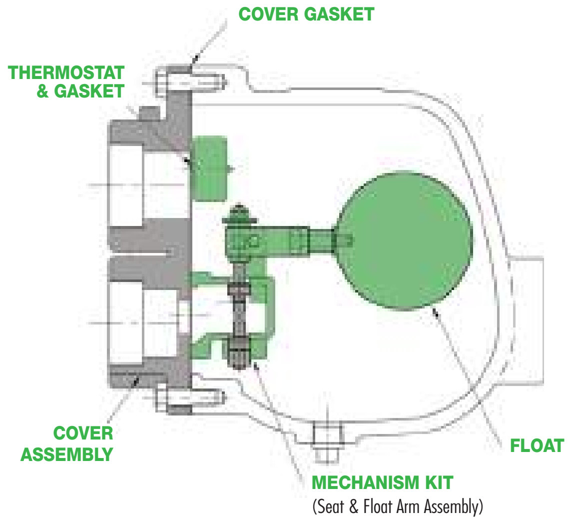
Cover Assembly Kit:
(consists of All internal components below, assembled to trap cover)
(1) mechanism kit
(1) thermostat kit
(1) cover gasket

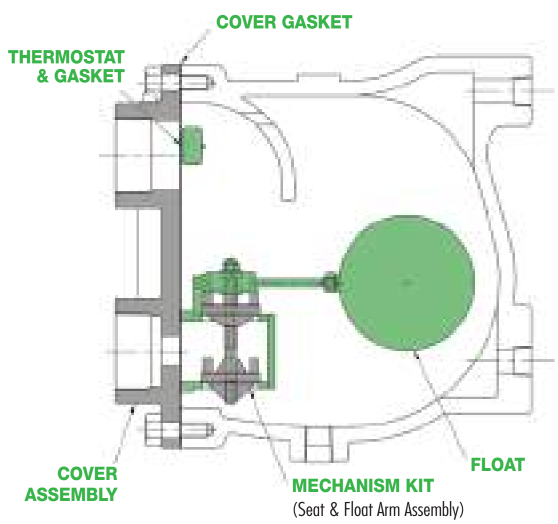


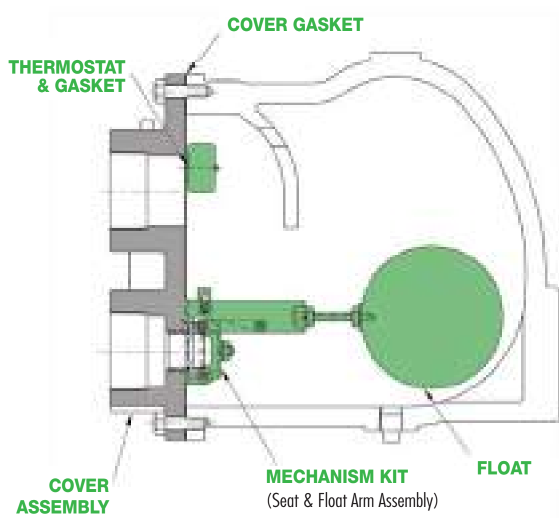


Model	Size	Order #	Description
FTT-065 • 65 PSI	1/2" 3/4"	W-KIT-3-33	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-55-065	Mechanism Kit
		W-KIT-7-21-065	Cover Assembly Kit
	1"	W-KIT-3-31	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-56-065	Mechanism Kit
		W-KIT-7-22-065	Cover Assembly Kit
	1 1/2"	W-KIT-3-34	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-57-065	Mechanism Kit
		W-KIT-7-52-065	Cover Assembly Kit
	2"	W-KIT-3-34	Cover Gasket
		W-KIT-4-12	Thermostat Kit
		W-KIT-6-58-065	Mechanism Kit
		W-KIT-7-53-065	Cover Assembly Kit
FTT-145 • 145 PSI	1/2" 3/4"	W-KIT-3-33	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-55-145	Mechanism Kit
		W-KIT-7-21-145	Cover Assembly Kit
	1"	W-KIT-3-31	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-56-145	Mechanism Kit
		W-KIT-7-22-145	Cover Assembly Kit
	1 1/2"	W-KIT-3-34	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-57-145	Mechanism Kit
		W-KIT-7-52-145	Cover Assembly Kit
	2"	W-KIT-3-34	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-58-145	Mechanism Kit
		W-KIT-7-53-145	Cover Assembly Kit
FTT-225 • 225 PSI	1/2" 3/4"	W-KIT-3-33	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-55-225	Mechanism Kit
		W-KIT-7-21-225	Cover Assembly Kit
	1"	W-KIT-3-31	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-56-225	Mechanism Kit
		W-KIT-7-22-225	Cover Assembly Kit
FTT-250 • 250 PSI	1 1/2"	W-KIT-3-34	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-57-250	Mechanism Kit
		W-KIT-7-52-250	Cover Assembly Kit
	2"	W-KIT-3-34	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-58-250	Mechanism Kit
		W-KIT-7-53-250	Cover Assembly Kit
FTT-300	1"	W-KIT-3-31	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-6-56-300	Mechanism Kit
		W-KIT-7-22-300	Cover Assembly Kit

FTE/FTES Series Float & Thermostatic Steam Trap Parts & Kits







Size	Model	Order #	Description
2"	FTE-20	**W-KIT-3-18**	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-5-18	Float
		W-KIT-6-28	Mechanism Kit
		W-KIT-7-24	Cover Assembly Kit
	FTE-50	**W-KIT-3-19**	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-5-19	Float
		W-KIT-6-29	Mechanism Kit
		W-KIT-7-25	Cover Assembly Kit
2 1/2"	FTE-50	**W-KIT-3-19**	Cover Gasket
	FTES-50*	**W-KIT-4-18**	Thermostat Kit
		W-KIT-5-20	Float
		W-KIT-6-30	Mechanism Kit
		W-KIT-7-26	Cover Assembly Kit
	FTE-125	**W-KIT-3-19**	Cover Gasket
	FTES-125*	**W-KIT-4-18**	Thermostat Kit
		W-KIT-5-21	Float
		W-KIT-6-24	Mechanism Kit
		W-KIT-7-27	Cover Assembly Kit
1 1/2"	FTE-200	**W-KIT-3-22-1**	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-5-22	Float
		W-KIT-6-26	Mechanism Kit
		W-KIT-7-28	Cover Assembly Kit
2"	FTE-200	**W-KIT-3-18**	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-5-23	Float
		W-KIT-6-27	Mechanism Kit
		W-KIT-7-29	Cover Assembly Kit
2 1/2"	FTE-200	**W-KIT-3-19**	Cover Gasket
	FTES-200	**W-KIT-4-18**	Thermostat Kit
	FTES-300*	**W-KIT-5-24**	Float
		W-KIT-6-25	Mechanism Kit
		W-KIT-7-23	Cover Assembly Kit

Thermostat Kit:
(1) welded stainless steel thermostat
(1) thermostat gasket

Mechanism Kit: (does not include float, thermostat & cover gasket)
(1) seat & float arm assembly

Cover Assembly Kit: (consists of all internal components below, assembled to trap cover)
(1) mechanism kit
(1) thermostat kit
(1) cover gasket

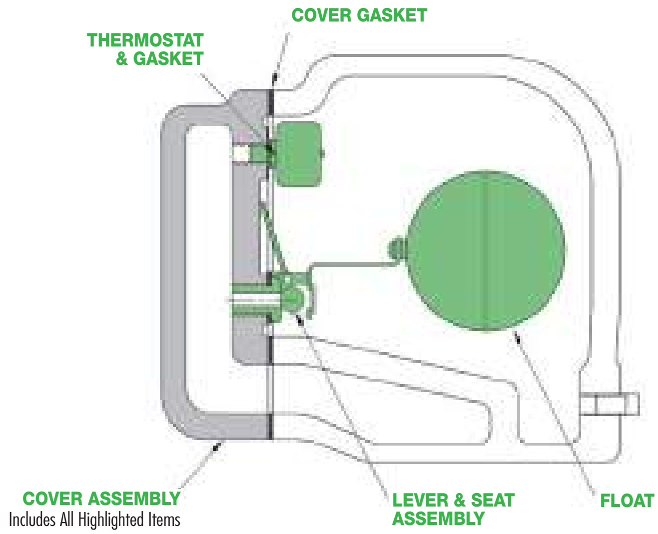
* Contact Factory for any FTES Cover Assembly.

FT Series Float & Thermostatic Steam Trap Parts & Kits

Thermostat Kit:
(1) welded stainless steel thermostat
(1) thermostat gasket.

Lever & Seat Assembly: (does not include float)
(1) lever
(1) seat
(1) disc
(1) seat gasket

Cover Assembly Kit:
(consists of all items below assembled to trap cover)
(1) trap cover
(1) lever & seat assembly
(1) float & screw
(1) thermostat kit
(1) cover gasket



15 PSI

Model	Order #	Item
FT3-015-13-N (3/4″ FT-15)	W-KIT-3-01	Cover Gasket
	W-KIT-4-12	Thermostat Kit
	W-KIT-5-02	Float & Screw
	W-KIT-6-02	Lever & Seat Assembly
	W-KIT-7-02	Cover Assembly Kit
FT4-015-14-N (1″ FT-15)	W-KIT-3-01	Cover Gasket
	W-KIT-4-12	Thermostat Kit
	W-KIT-5-02	Float & Screw
	W-KIT-6-02	Lever & Seat Assembly
	W-KIT-7-02	Cover Assembly Kit
FT6-015-15-N (1 1/4″ FT-15)	W-KIT-3-02	Cover Gasket
	W-KIT-4-12	Thermostat Kit
	W-KIT-5-03	Float & Screw
	W-KIT-6-03	Lever & Seat Assembly
	W-KIT-7-03	Cover Assembly Kit
FT7-015-16-N (1 1/2″ FT-15)	W-KIT-3-03	Cover Gasket
	W-KIT-4-12	Thermostat Kit
	W-KIT-5-04	Float & Screw
	W-KIT-6-04	Lever & Seat Assembly
	W-KIT-7-04	Cover Assembly Kit
FT8-015-17-N (2″ FT-15)	W-KIT-3-04	Cover Gasket
	W-KIT-4-12	Thermostat Kit
	W-KIT-5-05	Float & Screw
	W-KIT-6-05	Lever & Seat Assembly
	W-KIT-7-05	Cover Assembly Kit
FTS8-015-17-N (2″ FTS-15)	W-KIT-3-04	Cover Gasket
	W-KIT-4-12	Thermostat Kit
	W-KIT-5-17	Float & Screw
	W-KIT-6-21	Lever & Seat Assembly
	W-KIT-7-18	Cover Assembly Kit

30 PSI

Model	Order #	Item
FT33-030-13-N (3/4″ FT-30)	W-KIT-3-01	Cover Gasket
	W-KIT-4-12	Thermostat Kit
FT34-030-14-N (1″ FT-30)	W-KIT-5-02	Float & Screw
	W-KIT-6-06	Lever & Seat Assembly
	W-KIT-7-06	Cover Assembly Kit
FT35-030-14-N (1″ FT-30)	W-KIT-3-02	Cover Gasket
	W-KIT-4-12	Thermostat Kit
	W-KIT-5-03	Float & Screw
	W-KIT-6-07	Lever & Seat Assembly
	W-KIT-7-07	Cover Assembly Kit
FT36-030-15-N (1 1/4″ FT-30)	W-KIT-3-02	Cover Gasket
	W-KIT-4-12	Thermostat Kit
	W-KIT-5-03	Float & Screw
	W-KIT-6-07	Lever & Seat Assembly
	W-KIT-7-07	Cover Assembly Kit
FT37L-030-16-N (1 1/2″ FT-30)	W-KIT-3-03	Cover Gasket
	W-KIT-4-12	Thermostat Kit
	W-KIT-5-04	Float & Screw
	W-KIT-6-15	Lever & Seat Assembly
	W-KIT-7-15	Cover Assembly Kit
FT37-030-16-N (1 1/2″ FT-30)	W-KIT-3-04	Cover Gasket
	W-KIT-4-12	Thermostat Kit
FT38-030-17-N (2″ FT-30)	W-KIT-5-05	Float & Screw
	W-KIT-6-08	Lever & Seat Assembly
	W-KIT-7-08	Cover Assembly Kit

FT Series (continued)

75 PSI		
Model	Order #	Item
FT73-075-13-N (3/4" FT-75)	W-KIT-3-01	Cover Gasket
	W-KIT-4-12	Thermostat Kit
FT74-075-14-N (1" FT-75)	W-KIT-5-02	Float & Screw
	W-KIT-6-09	Lever & Seat Assembly
	W-KIT-7-09	Cover Assembly Kit
FT75-075-14-N (1" FT-75)	W-KIT-3-02	Cover Gasket
	W-KIT-4-12	Thermostat Kit
	W-KIT-5-03	Float & Screw
	W-KIT-6-10	Lever & Seat Assembly
	W-KIT-7-10	Cover Assembly Kit
FT76-075-15-N (1 1/4" FT-75)	W-KIT-3-02	Cover Gasket
	W-KIT-4-12	Thermostat Kit
	W-KIT-5-03	Float & Screw
	W-KIT-6-10	Lever & Seat Assembly
	W-KIT-7-10	Cover Assembly Kit
FT77L-075-16-N (1 1/2" FT-75)	W-KIT-3-03	Cover Gasket
	W-KIT-4-12	Thermostat Kit
	W-KIT-5-04	Float & Screw
	W-KIT-6-16	Lever & Seat Assembly
	W-KIT-7-16	Cover Assembly Kit
FT77-075-16-N (1 1/2" FT-75)	W-KIT-3-04	Cover Gasket
	W-KIT-4-12	Thermostat Kit
FT78-075-17-N (2" FT-75)	W-KIT-5-05	Float & Screw
	W-KIT-6-11	Lever & Seat Assembly
	W-KIT-7-11	Cover Assembly Kit
FTS8-075-17-N (2" FTS-75)	W-KIT-3-04	Cover Gasket
	W-KIT-4-12	Thermostat Kit
	W-KIT-5-17	Float & Screw
	W-KIT-6-22	Lever & Seat Assembly
	W-KIT-7-19	Cover Assembly Kit

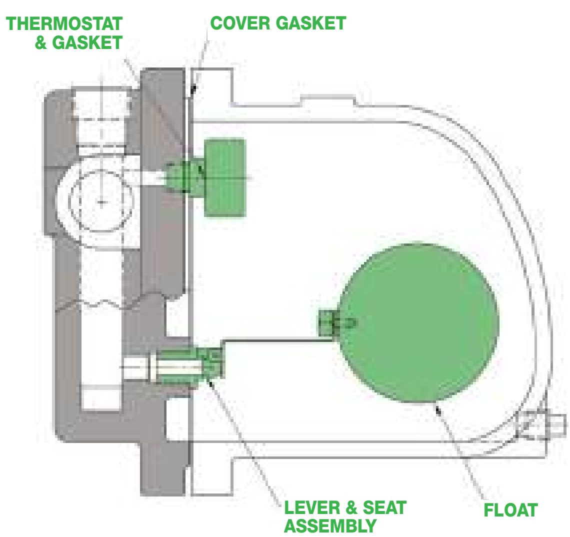
125 PSI		
Model	Order #	Item
FT123	W-KIT-3-01	Cover Gasket
	W-KIT-4-12-125	Thermostat Kit
FT124	W-KIT-5-02	Float & Screw
	W-KIT-6-12	Lever & Seat Assembly
	W-KIT-7-12	Cover Assembly Kit
FT125	W-KIT-3-02	Cover Gasket
	W-KIT-4-12-125	Thermostat Kit
	W-KIT-5-03	Float & Screw
	W-KIT-6-13	Lever & Seat Assembly
	W-KIT-7-13	Cover Assembly Kit
FT126	W-KIT-3-03	Cover Gasket
	W-KIT-4-12-125	Thermostat Kit
	W-KIT-5-04	Float & Screw
	W-KIT-6-13	Lever & Seat Assembly
	W-KIT-7-13	Cover Assembly Kit
FT127L	W-KIT-3-03	Cover Gasket
	W-KIT-4-12-125	Thermostat Kit
	W-KIT-5-04	Float & Screw
	W-KIT-6-17	Lever & Seat Assembly
	W-KIT-7-17	Cover Assembly Kit
FT127	W-KIT-3-04	Cover Gasket
	W-KIT-4-12-125	Thermostat Kit
FT128	W-KIT-5-05	Float & Screw
	W-KIT-6-14	Lever & Seat Assembly
	W-KIT-7-14	Cover Assembly Kit
FTS8-125	W-KIT-3-04	Cover Gasket
	W-KIT-4-12-125	Thermostat Kit
	W-KIT-5-05	Float & Screw
	W-KIT-6-23	Lever & Seat Assembly
	W-KIT-7-20	Cover Assembly Kit

FT600/FT601 Series — Float & Thermostatic Steam Trap Parts & Kits

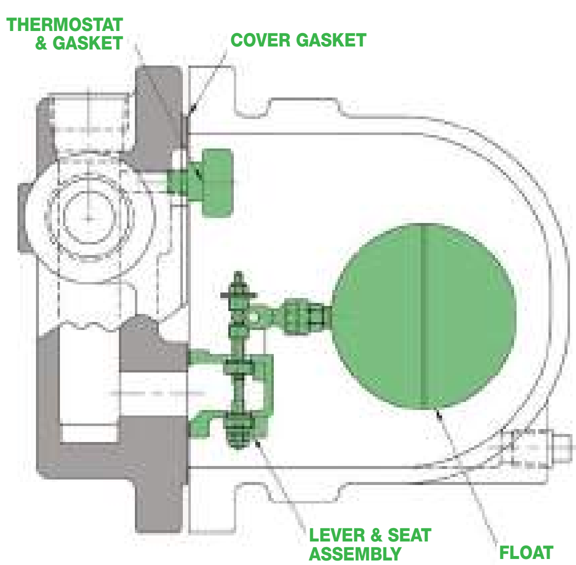
Thermostat Kit:
(1) welded stainless steel thermostat
(1) thermostat gasket.

Lever & Seat Assembly: (does not include float)
(1) lever
(1) seat
(1) disc
(1) seat gasket

3/4" & 1" FT600



1 1/2" & 2" FT600



Size	Model	Order #	Item
3/4"	FT600-65 FT601-65	**W-KIT-3-23**	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-5-25	Float & Screw
		W-KIT-6-31	Lever & Seat Assembly
	FT600-145 FT601-145	**W-KIT-3-23**	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-5-25	Float & Screw
		W-KIT-6-32	Lever & Seat Assembly
	FT600-200 FT601-200	**W-KIT-3-23**	Cover Gasket
		W-KIT-4-18	Thermostat Kit
		W-KIT-5-25	Float & Screw
		W-KIT-6-33	Lever & Seat Assembly
	FT600-300 FT601-300	**W-KIT-3-23**	Cover Gasket
		W-KIT-4-15	Thermostat Kit
		W-KIT-5-25	Float & Screw
		W-KIT-6-34	Lever & Seat Assembly
	FT600-450 FT601-450	**W-KIT-3-23**	Cover Gasket
		W-KIT-4-16	Thermostat Kit
		W-KIT-5-25	Float & Screw
		W-KIT-6-35	Lever & Seat Assembly

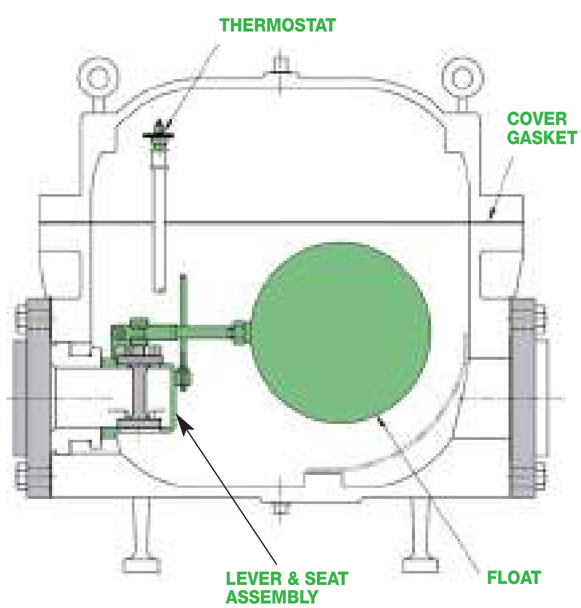
Size	Model	Order #	Item
1"	FT600-65 FT601-65	**W-KIT-3-24**	Cover Gasket
		W-KIT-4-15	Thermostat Kit
		W-KIT-5-26	Float & Screw
		W-KIT-6-36	Lever & Seat Assembly
	FT600-145 FT601-145	**W-KIT-3-24**	Cover Gasket
		W-KIT-4-15	Thermostat Kit
		W-KIT-5-26	Float & Screw
		W-KIT-6-37	Lever & Seat Assembly
	FT600-200 FT601-200	**W-KIT-3-24**	Cover Gasket
		W-KIT-4-15	Thermostat Kit
		W-KIT-5-26	Float & Screw
		W-KIT-6-38	Lever & Seat Assembly
	FT600-300 FT601-300	**W-KIT-3-24**	Cover Gasket
		W-KIT-4-15	Thermostat Kit
		W-KIT-5-26	Float & Screw
		W-KIT-6-39	Lever & Seat Assembly
	FT600-450 FT601-450	**W-KIT-3-24**	Cover Gasket
		W-KIT-4-16	Thermostat Kit
		W-KIT-5-26	Float & Screw
		W-KIT-6-40	Lever & Seat Assembly

FT600/FT601 Series (continued)

Size	Model	Order #	Item
1 1/2"	FT600-65 FT601-65	**W-KIT-3-25**	Cover Gasket
		W-KIT-4-15	Thermostat Kit
		W-KIT-5-27-1	Float & Screw
		W-KIT-6-41	Lever & Seat Assembly
	FT600-145 FT601-145	**W-KIT-3-25**	Cover Gasket
		W-KIT-4-15	Thermostat Kit
		W-KIT-5-27-1	Float & Screw
		W-KIT-6-42	Lever & Seat Assembly
	FT600-200 FT601-200	**W-KIT-3-25**	Cover Gasket
		W-KIT-4-15	Thermostat Kit
		W-KIT-5-27-2	Float & Screw
		W-KIT-6-43	Lever & Seat Assembly
	FT600-300 FT601-300	**W-KIT-3-25**	Cover Gasket
		W-KIT-4-15	Thermostat Kit
		W-KIT-5-27-2	Float & Screw
		W-KIT-6-44	Lever & Seat Assembly
	FT600-450 FT601-450	**W-KIT-3-25**	Cover Gasket
		W-KIT-4-16	Thermostat Kit
		W-KIT-5-27-2	Float & Screw
		W-KIT-6-45	Lever & Seat Assembly

Size	Model	Order #	Item
2"	FT600-65 FT601-65	**W-KIT-3-26**	Cover Gasket
		W-KIT-4-15	Thermostat Kit
		W-KIT-5-28-1	Float & Screw
		W-KIT-6-52	Lever & Seat Assembly
	FT600-145 FT601-145	**W-KIT-3-26**	Cover Gasket
		W-KIT-4-15	Thermostat Kit
		W-KIT-5-28-1	Float & Screw
		W-KIT-6-53	Lever & Seat Assembly
	FT600-200 FT601-200	**W-KIT-3-26**	Cover Gasket
		W-KIT-4-15	Thermostat Kit
		W-KIT-5-28-2	Float & Screw
		W-KIT-6-54	Lever & Seat Assembly
	FT600-300 FT601-300	**W-KIT-3-26**	Cover Gasket
		W-KIT-4-15	Thermostat Kit
		W-KIT-5-28-2	Float & Screw
		W-KIT-6-49	Lever & Seat Assembly
	FT600-450 FT601-450	**W-KIT-3-26**	Cover Gasket
		W-KIT-4-16	Thermostat Kit
		W-KIT-5-28-2	Float & Screw
		W-KIT-6-50	Lever & Seat Assembly

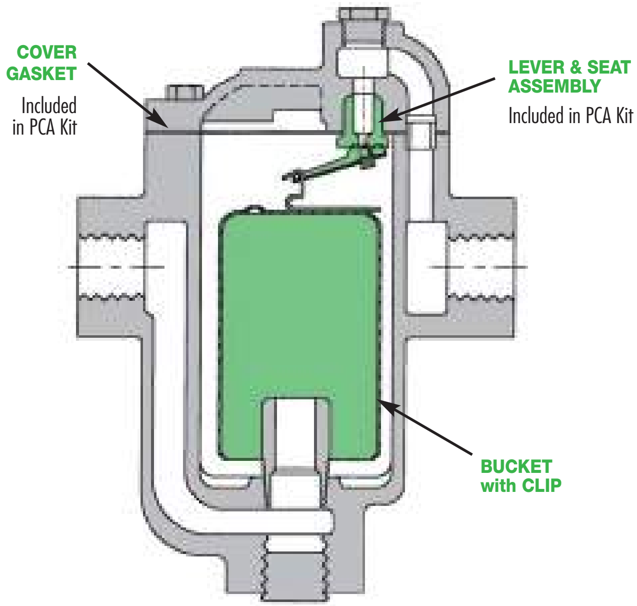
3" & 4" FT600



Size	Model	Order #	Item
3" & 4"	FT600-450 FT601-450	**W-KIT-3-27**	Cover Gasket
		W-KIT-4-16	Thermostat Kit
		W-KIT-5-29	Float & Screw
		W-KIT-6-51	Lever & Seat Assembly

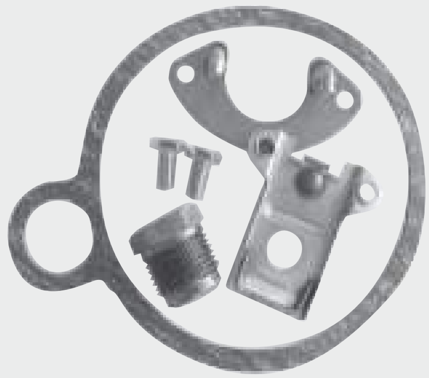
IB Series — Inverted Bucket Steam Trap Parts & Kits

Inverted Bucket Trap
1031, 1032, 1033, 1034

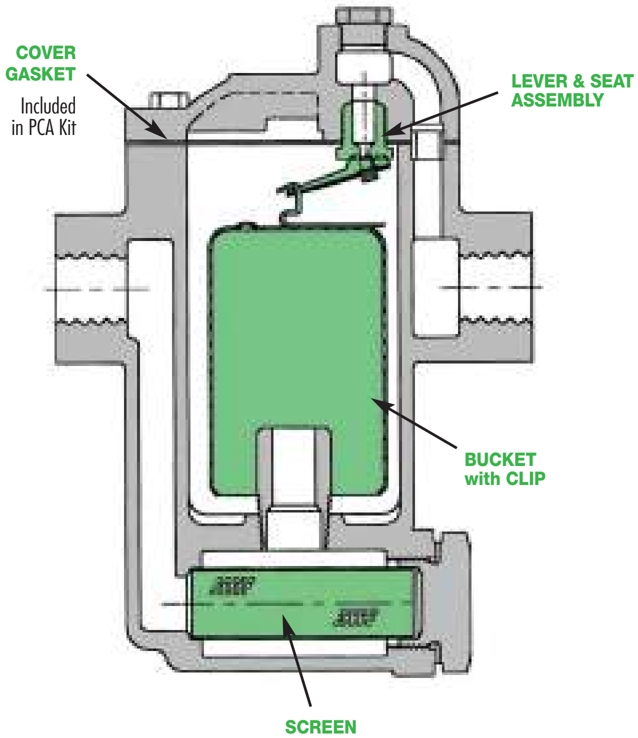


***PCA Kit-Pressure Change Assembly**

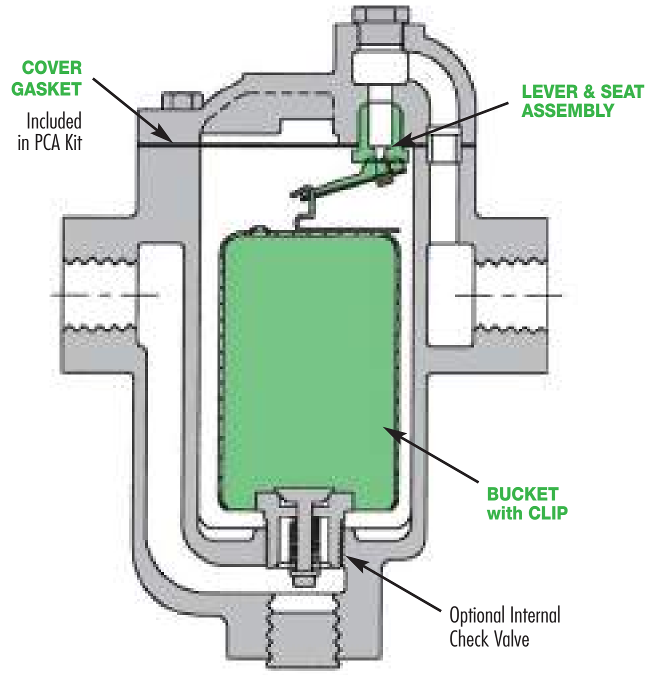
The PCA Kit consists of all items to rebuild the Bucket Trap except the bucket & clip. This includes the lever & seat assembly with cover gasket.



Inverted Bucket Trap
1041, 1042, 1044, 1038S



Inverted Bucket Trap
1032 shown with Check Valve



PCA Kit # is dependent upon orifice size or maximum working pressure of the steam trap.
Consult factory for other parts if required.

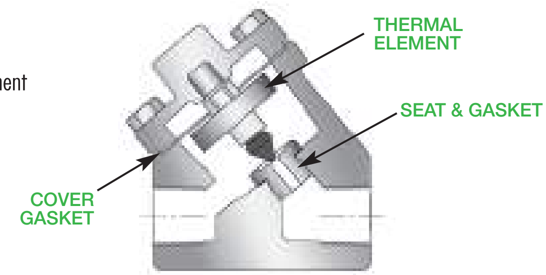
PCA Kit: (Lever & Seat Assembly with Cover Gasket)

Connection	For Model	Max Pressure	Orifice Size	PCA Kit* #	Screen #	Cover Gasket #	Bucket with clip #
1/2" 3/4"	IB1031-20 IB1041-20	20	3/16	W-KIT-5-09-020	9-01 (For Model IB1041 Only)	3-07	4-06
	IB1031-80 IB1041-80	80	1/8	W-KIT-5-09-080			
	IB1031-125 IB1041-125 IB1031S-125	125	7/64	W-KIT-5-09-125			
	IB1031-150 IB1041-150	150	#38	W-KIT-5-09-150			
1/2" 3/4" 1"	IB1032-15 IB1042-15	15	1/4	W-KIT-5-10-015	9-02 (For Model IB1042 Only)	3-07	4-07
	IB1032-30 IB1042-30	30	3/16	W-KIT-5-10-030			
	IB1032-70 IB1042-70	70	5/32	W-KIT-5-10-070			
	IB1032-125 IB1042-125	125	1/8	W-KIT-5-10-125			
	IB1032-200 IB1042-200	200	7/64	W-KIT-5-10-200			
	IB1032-250 IB1042-250	250	#38	W-KIT-5-10-250			
1/2" 3/4"	IB1033-15	15	5/16	W-KIT-5-15-015	No Screen required	3-12	4-14
	IB1033-30	30	1/4	W-KIT-5-15-030			
	IB1033-70	70	3/16	W-KIT-5-15-070			
	IB1033-125	125	5/32	W-KIT-5-15-125			
	IB1033-200	200	1/8	W-KIT-5-15-200			
	IB1033-250	250	7/64	W-KIT-5-15-250			
3/4" 1"	IB1034-15 IB1044-15	15	1/2	W-KIT-5-11-015	9-03 (For Model IB1044 Only)	3-08	4-08
	IB1034-30 IB1044-30	30	3/8	W-KIT-5-11-030			
	IB1034-60 IB1044-60	60	5/16	W-KIT-5-11-060			
	IB1034-80 IB1044-80	80	9/32	W-KIT-5-11-080			
	IB1034-125 IB1044-125	125	1/4	W-KIT-5-11-125			
	IB1034-180 IB1044-180	180	7/32	W-KIT-5-11-180			
	IB1034-250 IB1044-250	250	3/16	W-KIT-5-11-250			
1 1/4" 1 1/2"	IB1038S-15	15	1/2	W-KIT-5-12S-015	9-03S	3-09S	4-09S
	IB1038S-30	30	3/8	W-KIT-5-12S-030			
	IB1038S-60	60	5/16	W-KIT-5-12S-060			
	IB1038S-80	80	9/32	W-KIT-5-12S-080			
	IB1038S-125	125	1/4	W-KIT-5-12S-125			
	IB1038S-180	180	7/32	W-KIT-5-12S-180			
	IB1038S-250	250	3/16	W-KIT-5-12S-250			

WT2500 Series — Thermostatic Steam Trap Kits

Size	Seat Material	Orifice Size	Kit Order #
1/2" & 3/4"	Stainless Steel	3/16"	**W-KIT-2501**
	Stainless Steel	5/16"	**W-KIT-2503**

Kit consists of:
- (1) seat
- (1) thermal element
- (1) cover gasket
- (1) seat gasket



WT3000 & WT4000 Series — Thermostatic Steam Trap Parts & Kits

Size	For Models	Orifice Size	Kit Order #
1/2" & 3/4"	WT3001/3001S/3001SB	3/16"	**W-KIT-400-51**
1/2" & 3/4"	WT3003/3003S/3003SB	5/16"	**W-KIT-400-53**
3/4" & 1"	WT4001/4001S/4001SB	5/16"	**W-KIT-400-60**
3/4" & 1"	WT4003/4003S/4003SB	7/16"	**W-KIT-400-62**

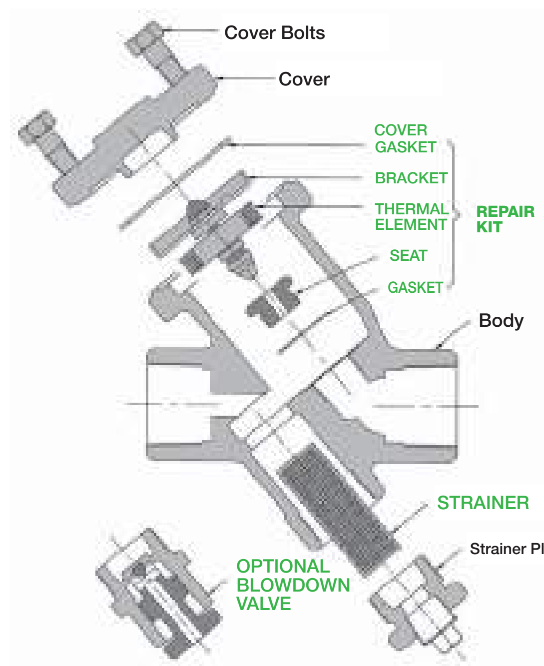
Kit consists of:
- (1) bracket (bellows cup)
- (1) thermal element
- (1) valve seat
- (1) cover gasket
- (1) valve seat gasket

Cover Gasket

Size	For Models	Kit Order #
All	WT3000 Series	**W-KIT-410-50**
All	WT4000 Series	**W-KIT-410-51**

Blowdown Valve & Strainer

Size	For Models	Item	Order #
All	WT3000SB WT4000SB UC450SB	Blowdown Valve Assembly	**WBLDNVLV-TRAPS**
All	WT3000SB WT4000SB UC450SB	Strainer Screen	**1532002**

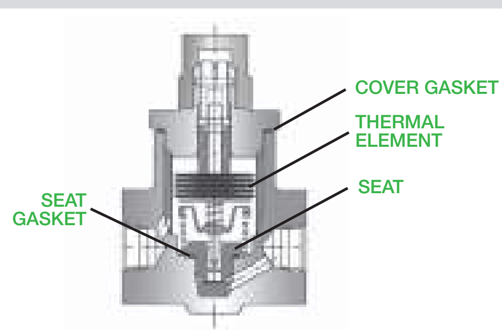


WT5000 Series — Externally Adjustable Bi-Metallic Steam Trap Kits

Size	For Models	PMO PSI	Kit Order #
1/2", 3/4" & 1"	WT5000	650	**W-KIT-WT5000**

Cross Reference: TLV **Model LEX3N-TZ**

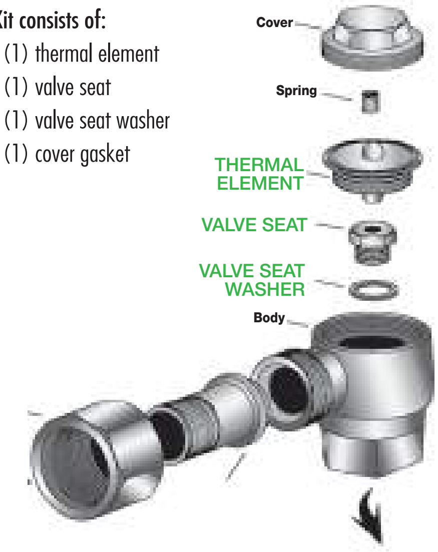
Kit consists of:
- (1) thermal element
- (1) valve seat
- (1) cover gasket
- (1) valve seat gasket
- (1) screen



TA25B & TA125 Series — Radiator Thermostatic Steam Trap Kits

Size	For Models	Seat Material	PMO PSI	Kit Order #
1/2	TA25B-12-N	Brass	25	**W-KIT-TT-12-025**
	TA125-12-N	Stainless steel	125	**W-KIT-TT-12-125**
3/4"	TA25B-13-N	Brass	25	**W-KIT-TT-13-025**
	TA125-13-N	Stainless steel	125	**W-KIT-TT-13-125**

Kit consists of:
(1) thermal element
(1) valve seat
(1) valve seat washer
(1) cover gasket

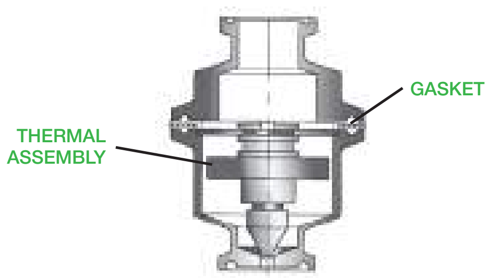


TS25B & TS125 Series — Radiator Thermostatic Steam Trap Kits

Size	For Models	Seat Material	PMO PSI	Kit Order #
1/2	TS25B-12-N	Brass	25	**W-KIT-TT-12-025**
	TS125-12-N	Stainless steel	125	**W-KIT-TT-12-125**
3/4"	TS25B-13-N	Brass	25	**W-KIT-TT-13-025**
	TS125-13-N	Stainless steel	125	**W-KIT-TT-13-125**

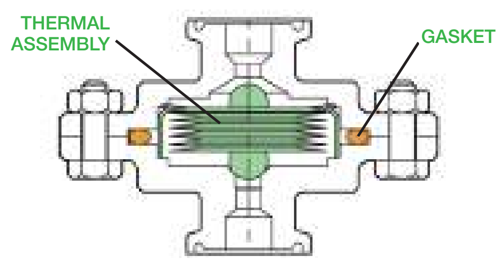
FDA300, FDA400 & FDA500 Series — Clean Steam Trap Parts

For Models	Kit Order #	Product Description
FDA300	**W-KIT-300-01**	Gasket
FDA300	**W-KIT-300-02**	Thermal Assembly
FDA400/410 & FDA500/510	**W-KIT-500-01**	Gasket
FDA400/410 & FDA500/510	**W-KIT-500-02**	Thermal Assembly



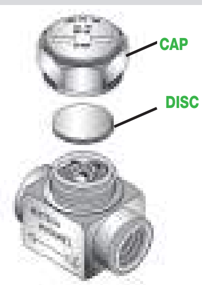
FDA600 Series — Clean Steam Trap Parts

For Model	Kit Order #	Product Description
FDA600	**W-KIT-600-01**	Gasket
FDA600	**W-KIT-600-02**	Thermal Assembly



FDA800 Series — Clean Steam Trap Parts

For Model	Kit Order #	Product Description $
FDA800	**W-KIT-800-01**	Disc
FDA800	**W-KIT-800-02**	Cap



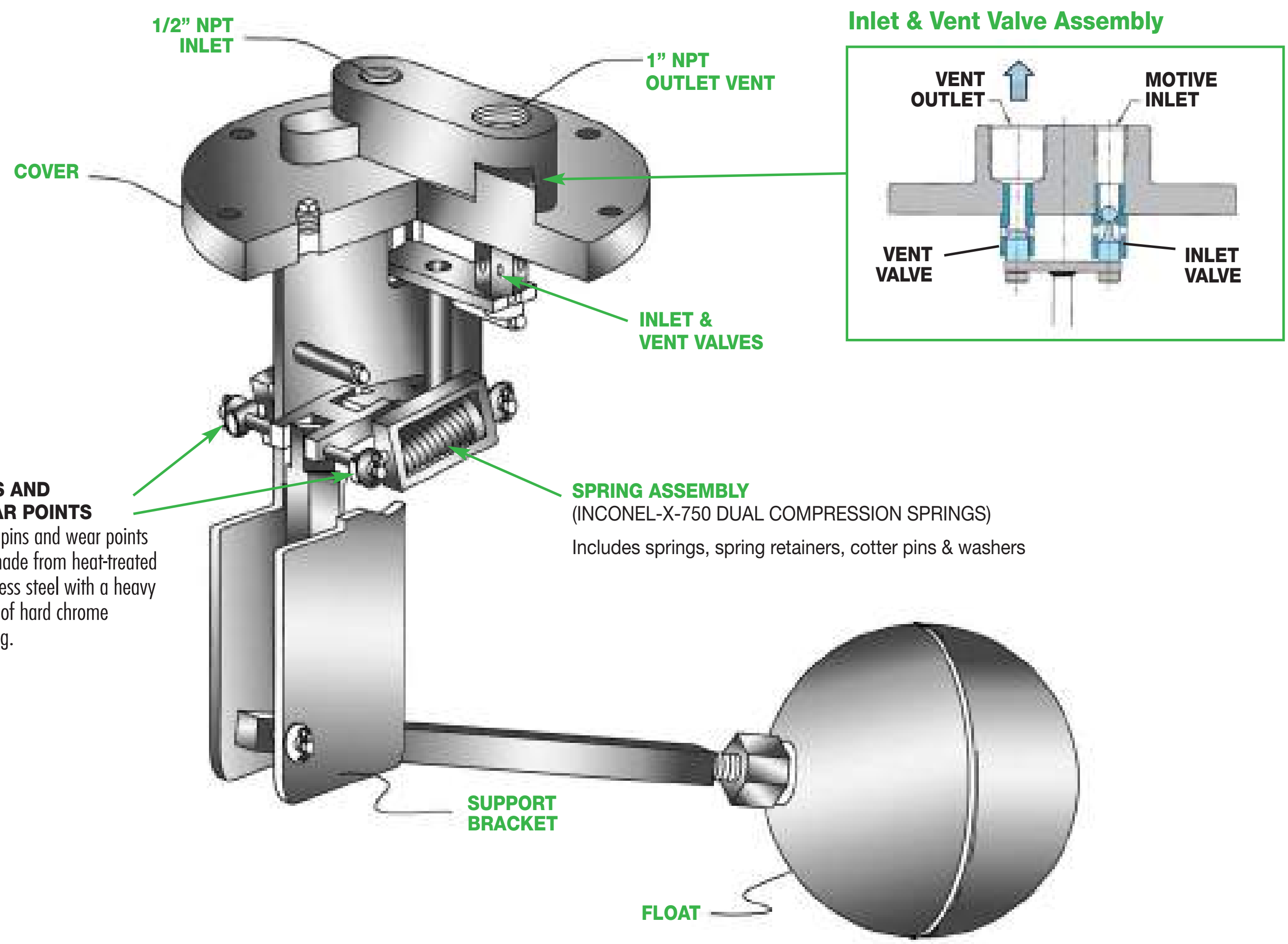
PMP Series — Pressure Motive Pump Mechanism Assembly Parts & Kits

Rebuilt Mechanism Assemblies

For Model (All Sizes)	Kit Order #	Description	Weight lbs
PMPF	**W-KIT-900-03R**	Rebuilt mechanism assembly for PMPF	30
PMPC & PMPLS	**W-KIT-910-03R**	Rebuilt mechanism assembly for PMPC & PMPLS	30
PMPT & PMPNT	**W-KIT-912-03R**	Rebuilt mechanism assembly for PMPT & PMPNT	15

Note: The exchange program is for mechanisms within **two years of service or less. The old mechanism must be returned along with the order** for the rebuilt mechanism. Orders without old mechanisms will be invoiced at the new mechanism price. **One time rebuild** of each mechanism only.

Pressure Motive Pump Mechanism Assembly



PINS AND WEAR POINTS
Pivot pins and wear points are made from heat-treated stainless steel with a heavy layer of hard chrome plating.

New Assemblies & Parts for Pressure Motive Pumps

For Model (All Sizes)	Kit Order #	Description	Weight lbs
PMPM	**W-KIT-901-04**	Cover gasket for PMPM	3
	W-KIT-901-06	Float & cover gasket for PMPM	3
	W-KIT-901-05	Inlet & vent valve assembly for PMPM	5
	W-KIT-901-08	Spring assembly for PMPM	5
	W-KIT-916-03	Complete mechanism assembly for PMPM less cover	5
	W-KIT-911-03	Complete mechanism assembly for PMPM	95
PMPF, PMPC & PMPLS All Sizes	**W-KIT-900-03**	New mechanism assembly for PMPF & PMPSP	30
	W-KIT-910-03	New mechanism assembly for PMPC & PMPLS	30
	W-KIT-900-04	Cover gasket for PMPF, PMPC & PMPLS	3
	W-KIT-900-05	Inlet & vent valve assembly for PMPF, PMPC & PMPLS	5
	W-KIT-900-06	Float & cover gasket for PMPF, PMPC & PMPLS	10
	W-KIT-900-08	Spring assembly for PMPF, PMPC & PMPLS	5
	W-KIT-904-03	PMP Head Assembly, Johnson LMV Complete	28
PMPBP 4″ x 4″	**W-KIT-900-01**	New mechanism assembly for PMPBP & SSI	110
	W-KIT-910-14	Cover gasket for PMPBP	7
	W-KIT-900-15	Inlet & vent valve assembly for PMPBP	12
	W-KIT-900-16	Float & cover gasket for PMPBP	20
	W-KIT-900-18	Spring set for PMPBP	10
	W-KIT-900-02	New mechanism assembly for PMPBP, 150# FLG.	110
	W-KIT-900-07	New mechanism assembly for PMPBP, 300# FLG.	110

Note: For purchasing Stainless Steel Check Valves 1/2″ - 3″ NPT – See Check Valves Model WSSCV, in Pipeline Accessories Section.

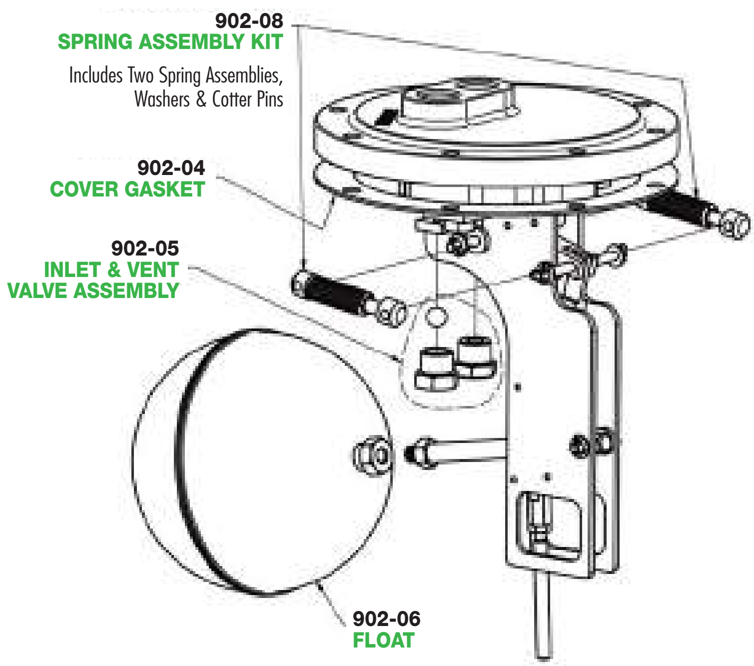
Cross Reference

Kit Order #	Spirax Sarco	Johnson	Armstrong	Gestra	Hoffman	Spence
W-KIT-900-03	PTF	LMV	PT-400	FPS Series	PCC	P3
W-KIT-910-03	PTC	LMV	N/A	FPS Series	PCS	P3
W-KIT-900-01	PPF-P	N/A	PT-516	FPS33L	N/A	N/A

PMPT & PMPNT — Pressure Motive Pump & Trap Combination Parts & Kits

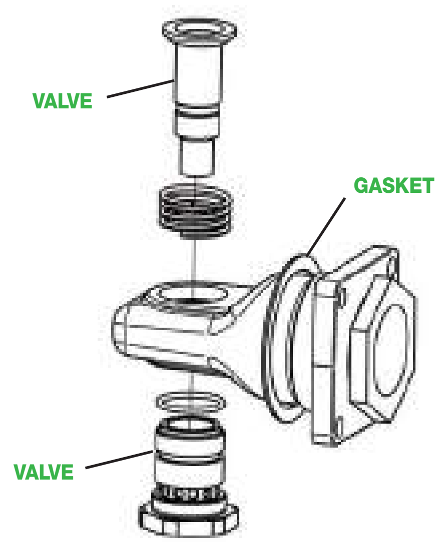
For Model (All Sizes)	Kit Order #	Description	Weight lbs
PMPT & PMPNT	**W-KIT-902-04**	Cover Gasket	0.5
	W-KIT-902-05	Inlet & Vent Valve Assembly	4.0
	W-KIT-902-06	Float & Cover Gasket	0.5
	W-KIT-902-08	Spring Assembly	0.8
	W-KIT-912-03	Complete Pump Mechanism Assembly & Gasket PMPT	15.0
	W-KIT-912-03-SS	Complete Pump Mechanism Assembly & Gasket PMPTSS	15.0
	W-KIT-914-03	Complete Pump Mechanism Assembly & Gasket PMPNT	0.8
	W-KIT-914-03-SS	Complete Pump Mechanism Assembly & Gasket PMPNTSS	0.8
	W-KIT-917-03	Internal Trap Assembly Mechanism & Gasket for PMPT only	10.0

Notes: 1) For purchasing Stainless Steel Check Valves 1/2" - 3" NPT – See Check Valves Model WSSCV, in Pipeline Accessories Section.



912-03
Complete Pump Mechanism for PMPT

914-03
Complete Pump Mechanism for PMPNT



917-03
Internal Trap Assembly Mechanism for PMPT

Ductile Iron Regulator

HD Series Pilot-Operated Regulator Kits & Parts

Size	Maintenance Kit[1] Order #	Complete Rebuild Kit [2] Order #
1/2" & 3/4 "	**W-KIT-800-13**	**W-KIT-801-13**
1"	**W-KIT-800-14**	**W-KIT-801-14**
1 1/4"	**W-KIT-800-15**	**W-KIT-801-15**
1 1/2"	**W-KIT-800-16**	**W-KIT-801-16**
2"	**W-KIT-800-17**	**W-KIT-801-17**
2 1/2"	**W-KIT-800-18**	**W-KIT-801-18**
3"	**W-KIT-800-19**	**W-KIT-801-19**
4"	**W-KIT-800-20**	**W-KIT-801-20**
6"	**W-KIT-800-22**	**W-KIT-801-22**

Note: **For Low Pressure Main Valve (LP)**
Add **LP** to the end of the above part number to include Peroxide cured EPDM Diaphragm. Example: **W-KIT-800-13-LP**

[1] **HD Maintenance Kit (800 Series) Consists of :**
(1) bottom cover gasket
(2) diaphragm gaskets
(2) diaphragms
(1) pilot adapter gasket
(1) strainer screen

[2] **Complete Rebuild Kit (801 Series) Consists of:**
(1) HD Maintenance Kit (800 Series; above)
(1) seat
(1) disc & stem assembly

Additional Options:

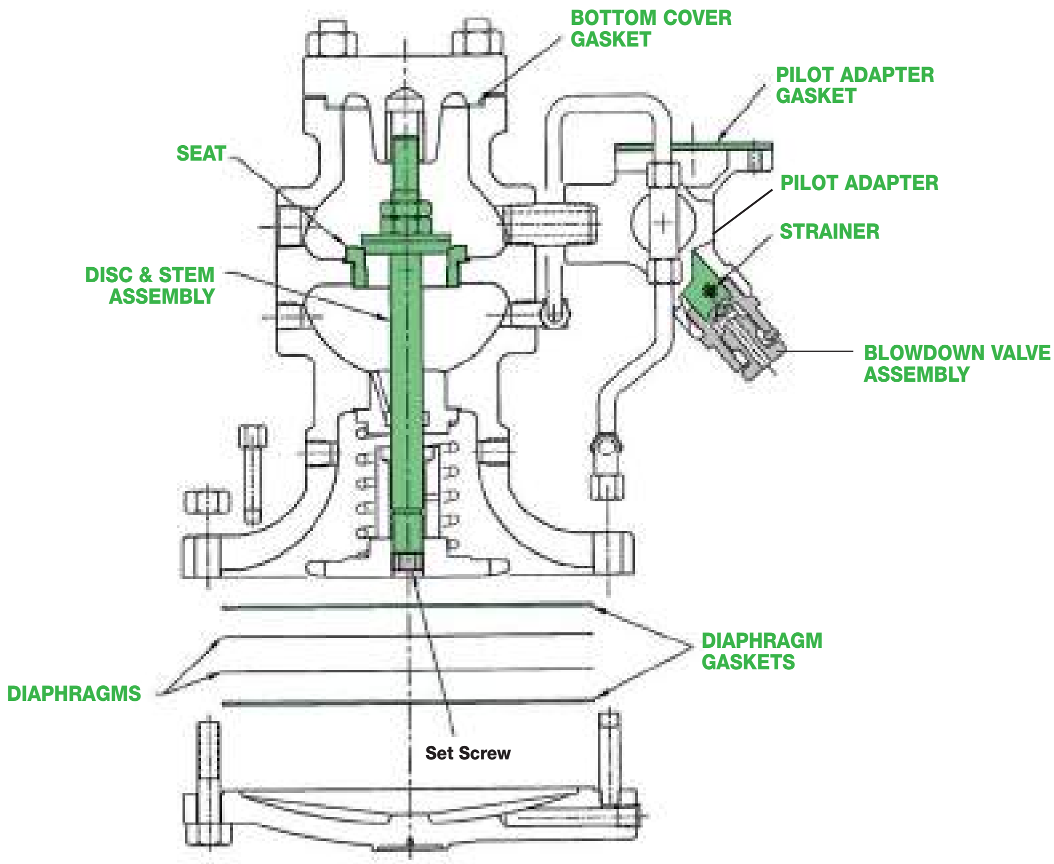
a) Blowdown Valve Assembly:
Order #: **KIT-800-11**

b) Gasket for Pilot Adapter:
Order #: **1762900**

c) Reduced Port Kits; Contact Factory

d) Replacement Pilot Adapter:
Order #: **ZBHD-18-19-20**

HD Regulator Repair Parts



Replacement Parts & Kits for Pilots used with HD Regulator

PP & PP5 Pressure Pilots — Repair Kits

Kit Order #	Description
W-KIT-802-01	Series PP Pressure Pilot Kit
W-KIT-802-02	Series PP - 2 Diaphragms & bottom spring button only
W-KIT-854-04	Series PP5 Pressure Pilot Kit

PP & PP5 Pressure Pilot Kit Consists of:
- (2) diaphragms
- (1) head & seat assembly
- (1) seat gasket
- (1) pilot adapter gasket
- (1) diaphragm gasket (PP5 only)

PBP Back Pressure Pilot — Repair Kits

Kit Order #	Description
W-KIT-803-01	PBP Back Pressure Pilot Kit

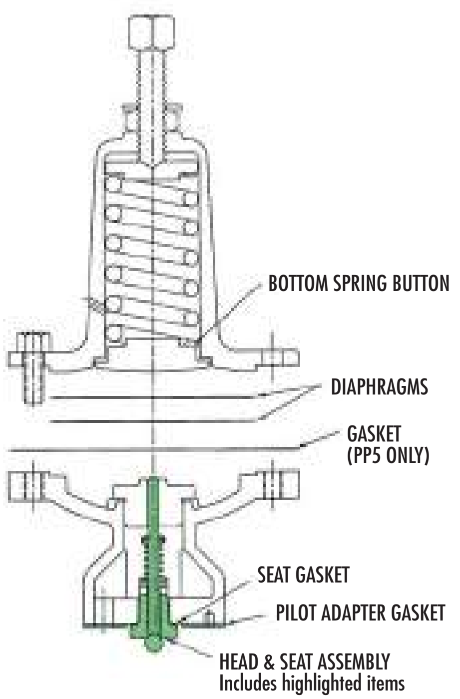
PBP Back Pressure Pilot Kit Consists of:
- (2) diaphragms
- (1) head & seat assembly
- (1) seat gasket
- (1) pilot adapter gasket

PDP Differential Pilot — Repair Kits

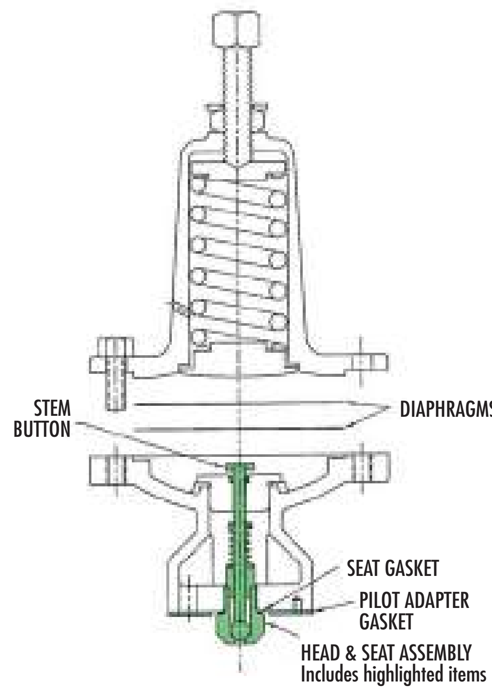
Kit Order #	Description
W-KIT-806-01	PDP Differential Pressure Pilot Kit

PDP Differential Pilot Kit Consists of:
- (2) diaphragms
- (1) head & seat assembly
- (1) cap gasket
- (1) seat gasket
- (1) pilot adapter gasket

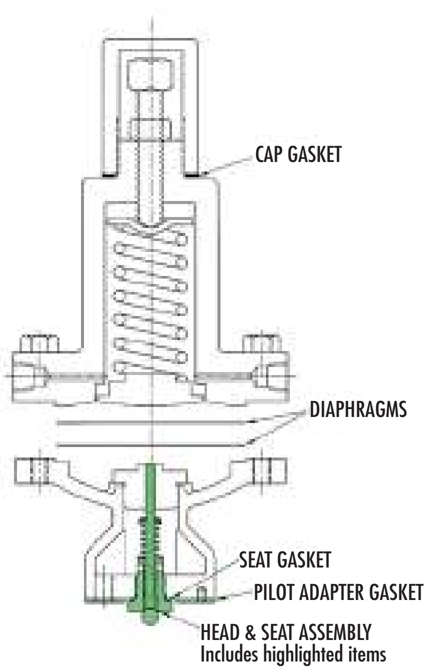
PP & PP5
Pressure Pilot Repair Kit



PBP
Back Pressure Pilot Repair Kit



PDP
Differential Pilot Repair Kit

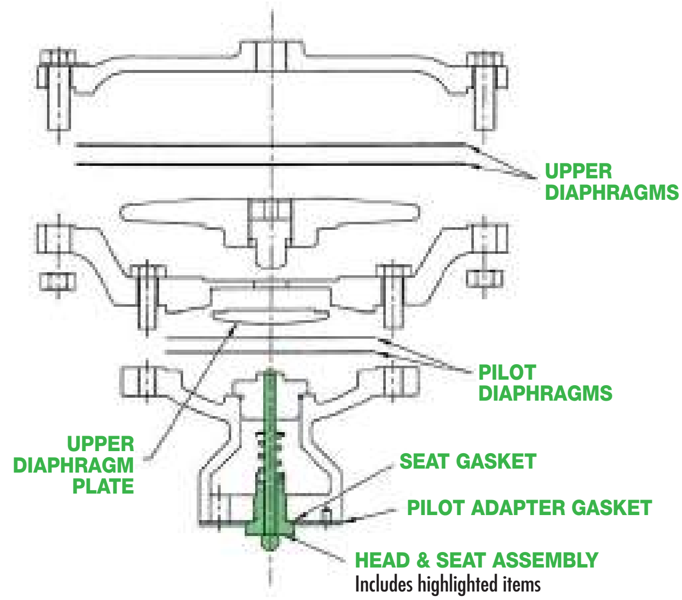


PA Series Air Pilots — Repair Kits

Kit Order #	Description
W-KIT-804-01	PA1 (1:1) Air Pilot Kit
W-KIT-804-04	PA4 (4:1) Air Pilot Kit
W-KIT-804-06	PA6 (6:1) Air Pilot Kit

Kit Consists of:
- (2) upper diaphragms
- (2) pilot diaphragms
- (1) head & seat assembly
- (1) seat gasket
- (1) pilot adapter gasket

PA Air Pilot Repair Kit

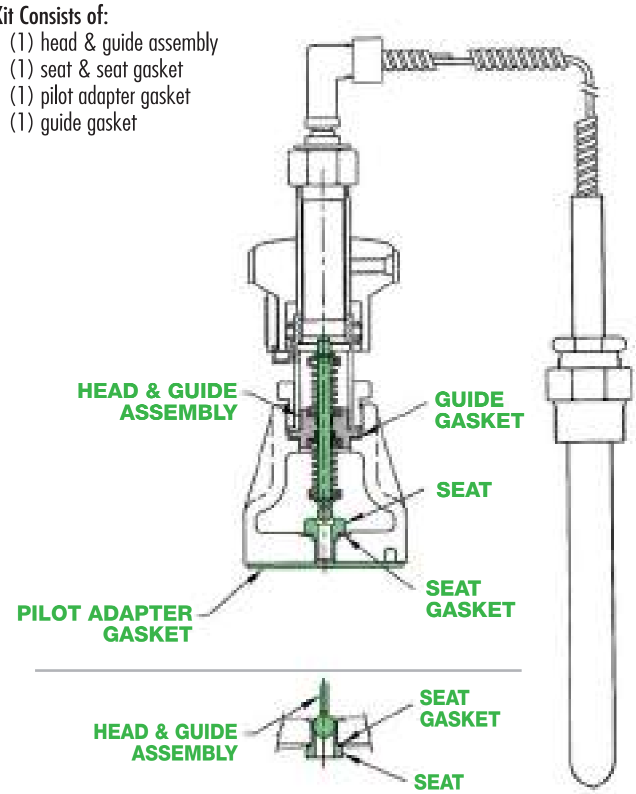


PT & PTU Temperature Pilots — Repair Kits

Kit Order #	Description
W-KIT-805-01	PT & PTU Pilot Kit
W-KIT-805-02	PT & PTU Low Pressure Pilot Kit

Kit Consists of:
- (1) head & guide assembly
- (1) seat & seat gasket
- (1) pilot adapter gasket
- (1) guide gasket

PT & PTU Temperature Pilot Repair Kit



Low Pressure Pilot

Cast Steel Regulator

HSP Series — Pilot-Operated Pressure Regulator Repair Parts & Kits

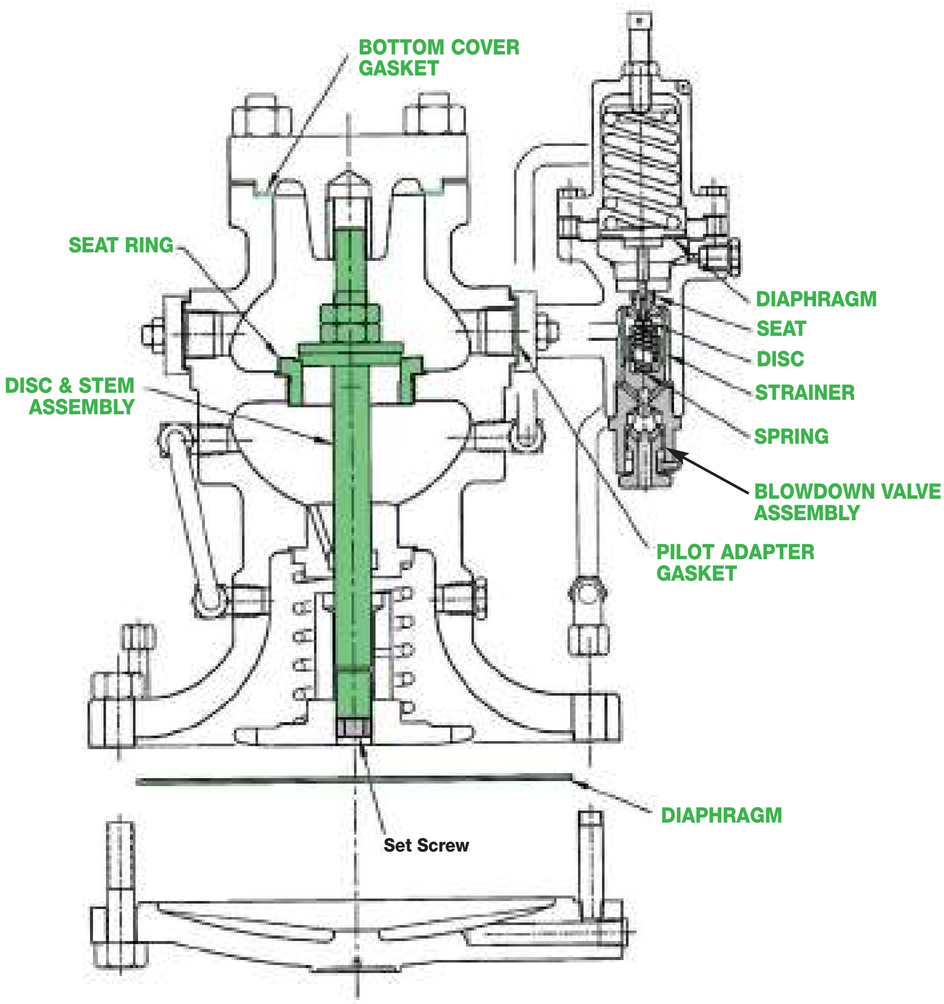
Size	Maintenance Kit [1] Order #	Complete Rebuild Kit [2] Order #
1"	W-KIT-810-14	W-KIT-811-14
1 1/2"	W-KIT-810-16	W-KIT-811-16
2"	W-KIT-810-17	W-KIT-811-17
3"	W-KIT-810-19	W-KIT-811-19
4"	W-KIT-810-20	W-KIT-811-20

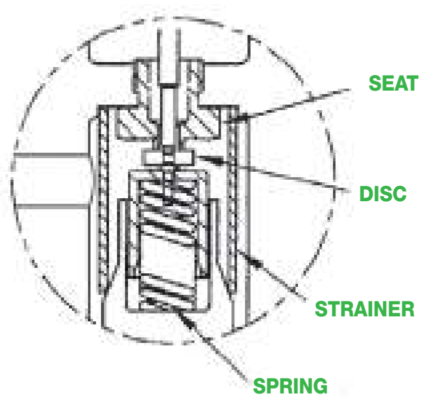
[1] HSP Maintenance Kit (810 Series) Consists of:
(1) bottom cover gasket
(1) diaphragm
(1) pilot adapter gasket
(1) strainer screen

[2] Complete Rebuild Kit for HSP Consists of:
(1) 810 Series Maintenance Kit
(1) seat
(1) disc & stem assembly

Additional Options:
a) Blowdown Valve Assembly for HSP:
Order #: **Kit-800-11-HSP**
b) **Reduced Port Kits** - Contact Factory

HSP Regulator Repair Parts





PHSP Series Pilots — Replacement Pressure Pilots & Repair Kit

Kit Order #	Description
PHSP-Y	HSP Pressure Pilot, 10-40 PSI (Yellow)
PHSP-B	HSP Pressure Pilot, 25-100 PSI (Blue)
PHSP-R	HSP Pressure Pilot, 75-300 PSI (Red)
W-KIT-812-01	HSP Pressure Pilot Kit

PHSP Pressure Pilot Kit Consists of:
(1) diaphragm
(1) seat
(1) stem & cup
(1) disc
(1) spring

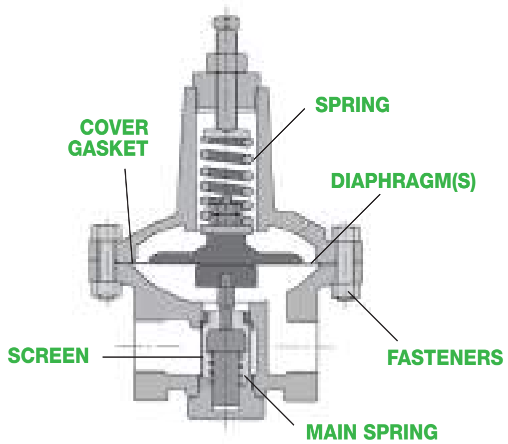
"O" Series Pressure Regulator Kits

Size	Kit Order #	Diaphragm Material	Kit Order #	Diaphragm Material
3/8", 1/2", 3/4"	**W-KIT-80-11**	Bronze	**W-KIT-81-11V**	Viton
3/4" HC	**W-KIT-82-12**	Bronze	**W-KIT-83-12V**	Viton
1", 1 1/4"	**W-KIT-82-14**	Bronze	**W-KIT-83-14V**	Viton
1 1/2", 2"	**W-KIT-82-15**	Bronze	**W-KIT-83-15V**	Viton

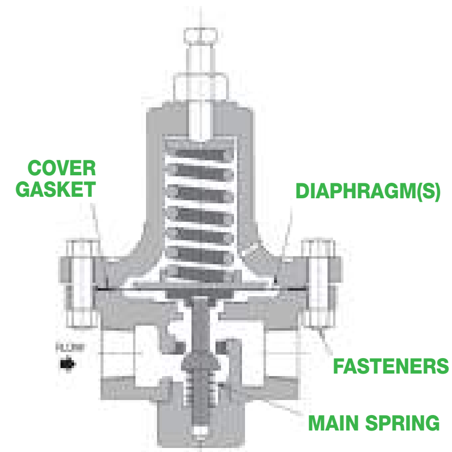
Kits for 3/8", 1/2" & 3/4" Sizes Consist of:
(1) cover gasket
(2) bronze or (1) Viton diaphragm
(1) set of diaphragm cover fasteners
(1) main spring

Kits for 3/4" HC Thru 2" Sizes also include:
(1) screen

3/4" HC & 1" – 2" Sizes



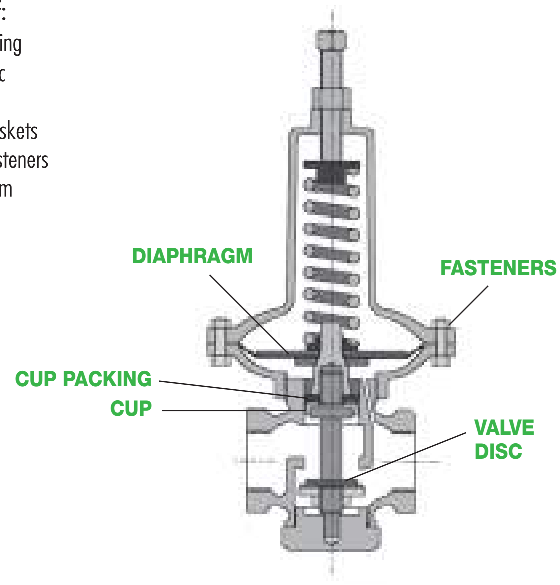
3/8", 1/2" & 3/4" Sizes



"B" Series Pressure Regulator Kits

Size	Viton Kit Order #
1/2", 3/4"	**W-KIT-200-01V**
1"	**W-KIT-200-03V**
1 1/4"	**W-KIT-200-04V**
1 1/2"	**W-KIT-200-05V**
2"	**W-KIT-200-06V**
2 1/2"	**W-KIT-200-07V**
3"	**W-KIT-200-08V**
4"	**W-KIT-200-09V**

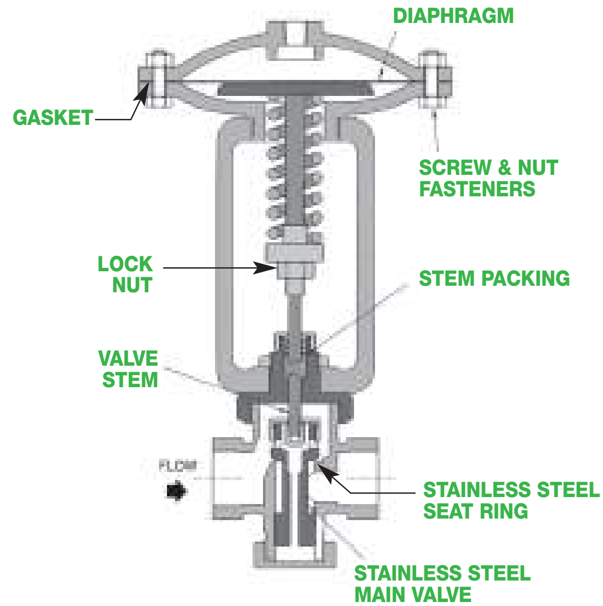
Kits Consist of:
(1) cup packing
(1) valve disc
(1) cup
(1) set of gaskets
(1) set of fasteners
(1) diaphragm



455 Series — Pressure Regulator Kits & Parts

Size	Case Size	Kit Order #
1/2", 3/4"	5"	W-KIT-402-01
	6"	W-KIT-406-01
1"	5"	W-KIT-402-03
	6"	W-KIT-406-03
1 1/4"	5"	W-KIT-402-04
	6"	W-KIT-406-04
1 1/2"	5"	W-KIT-402-05
	6"	W-KIT-406-05
2"	7"	W-KIT-414-06
	9"	W-KIT-417-06
	13"	W-KIT-427-06
2 1/2"	7"	W-KIT-414-07
	9"	W-KIT-417-07
	13"	W-KIT-427-07
3"	7"	W-KIT-414-08
	9"	W-KIT-417-08
	13"	W-KIT-427-08
4"	7"	W-KIT-414-09
	9"	W-KIT-417-09
	13"	W-KIT-427-09

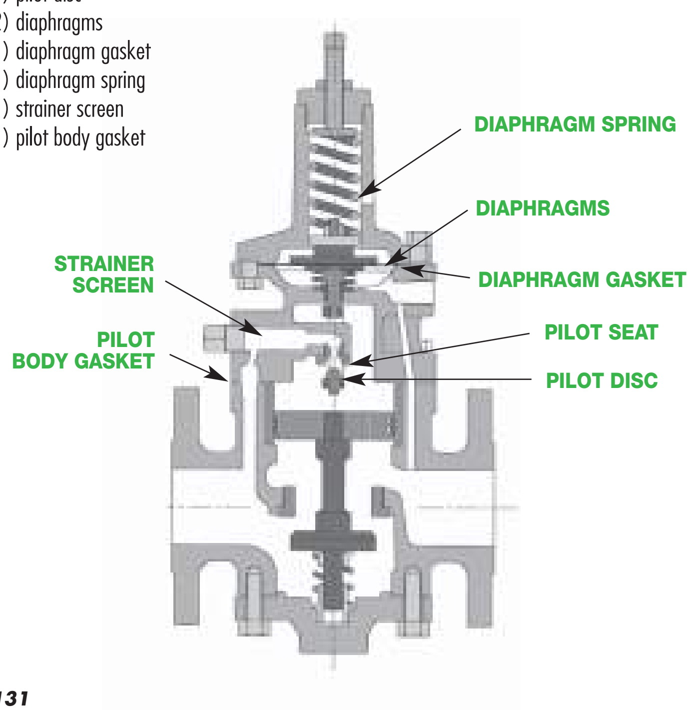
Kits consist of:
- (1) stainless steel main valve
- (1) set of stem packing
- (1) locknut
- (1) set of diaphragm case fasteners
- (1) stainless steel seat ring
- (1) pilot stem
- (1) gasket
- (1) diaphragm



402 & 403 Series — Pressure Regulator Kits

Size	Kit Order # 402 or 403 eries
1/2", 3/4", 1"	W-KIT-450-01
1 1/4", 1 1/2"	W-KIT-450-04
2"	W-KIT-450-06
2 1/2"	W-KIT-450-07
3"	W-KIT-450-08
4"	W-KIT-450-09

Kits consist of:
- (1) pilot seat
- (1) pilot disc
- (2) diaphragms
- (1) diaphragm gasket
- (1) diaphragm spring
- (1) strainer screen
- (1) pilot body gasket

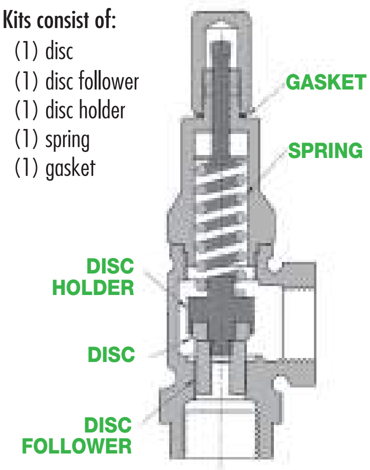


10691 Series — Back Pressure / Relief Valve Kits

Size	Pressure Range PSI	Kit Order #
1/2"	75-300	W-KIT-40-1
	25-100	W-KIT-40-2
	5-35	W-KIT-40-3
3/4"	75-300	W-KIT-41-1
	25-100	W-KIT-41-2
	5-35	W-KIT-41-3
1"	75-300	W-KIT-42-1
	25-100	W-KIT-42-2
	5-35	W-KIT-42-3

For Viton or Teflon Disc, Add **V** or **T** to part number.
Example for Viton: **W-KIT-42-3-V**

Kits consist of:
(1) disc
(1) disc follower
(1) disc holder
(1) spring
(1) gasket

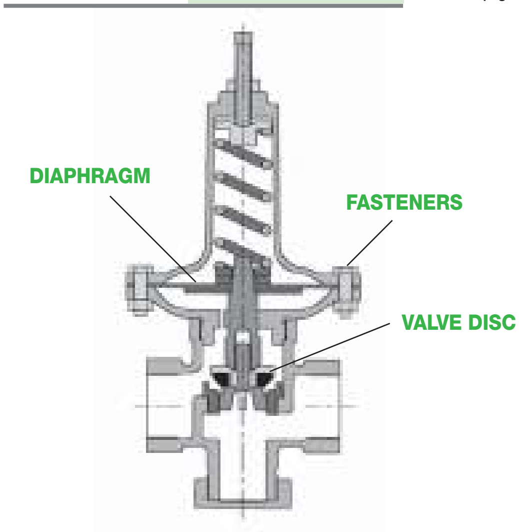


3040 Series — Back Pressure / Relief Valve Kits

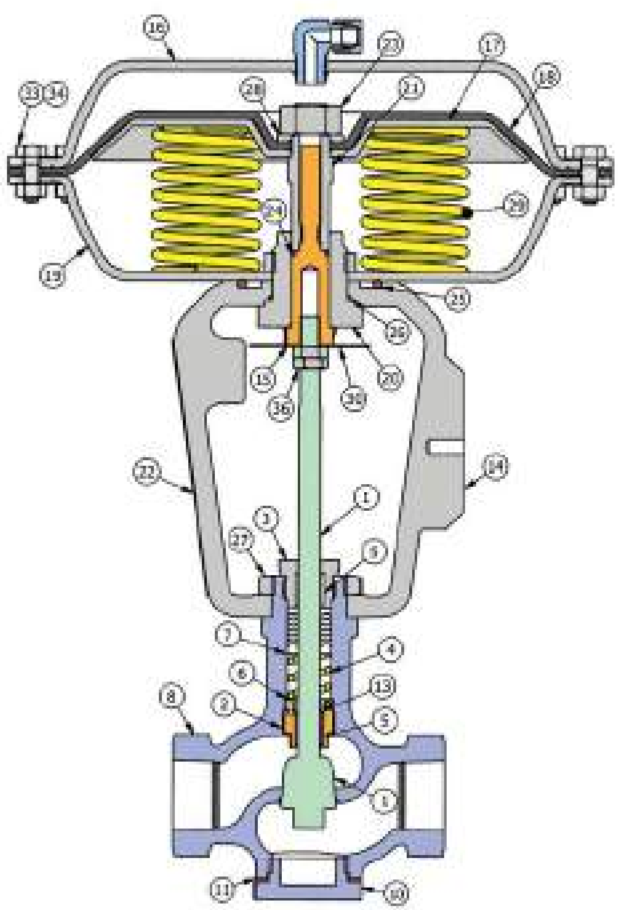
Size	Standard Trim Kit Order #
1/2", 3/4", 1"	W-KIT-3040-14
1 1/4"	W-KIT-3040-15
1 1/2"	W-KIT-3040-16
2"	W-KIT-3040-17

Kits consist of:
(1) valve disc (Viton)
(1) diaphragm (Viton)
(1) set of fasteners

2" size also includes:
(1) top gasket



HB Series — 2-Way Control Valve



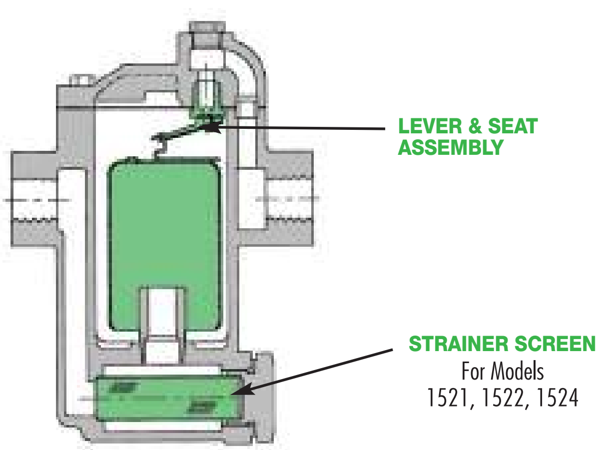
MATERIALS • Actuator		
18	Diaphragm	Nylon reinforced Neoprene
24	Stem O-ring	Viton
25	Yoke O-ring	Viton
26	Upper guide O-ring	Viton

MATERIALS • Valve Body		
1	Stem	316 Stainless Steel
1	Plug	302 Stainless Steel
4	Stem Seal Spring	302 Stainless Steel
5	Guide Bushing	Rulon 641
7	V-ring Stem Seals	PTFE
11	Body Gasket	303 Stainless Steel

Stem & Plug is a single piece unit.

WLD1500 Series — Liquid Drainer Kits

Size	For Model	Description	Kit Order #
3/4"	WLD1501 WLD1521 (with strainer)	Lever & Seat Assembly, Gasket	**W-KIT-5-09-150**
		Strainer Screen	**W-KIT-9-01**
		Gasket	**W-KIT-3-07**
3/4"	WLD1502 WLD1522 (with strainer)	Lever & Seat Assembly, Gasket	**W-KIT-5-10-200**
		Strainer Screen	**W-KIT-9-02**
		Gasket	**W-KIT-3-07**
1"	WLD1504 WLD1524 (with strainer)	Lever & Seat Assembly, Gasket	**W-KIT-5-11-200**
		Strainer Screen	**W-KIT-9-03**
		Gasket	**W-KIT-3-08**

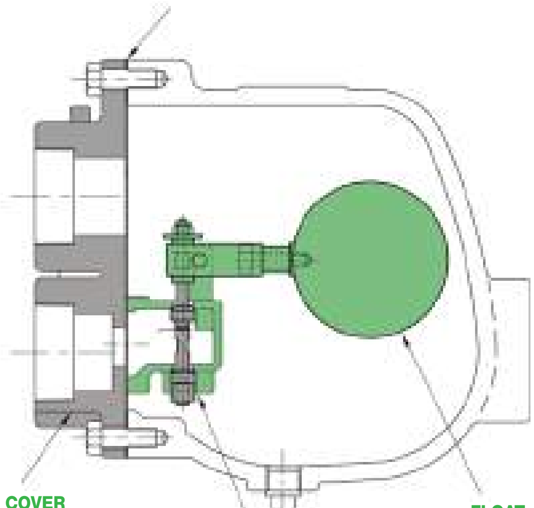


Lever Seat Assembly with Cover Gasket

WLD1600 Series — Liquid Drainer Kits

Size	For Model	Item Description	Kit Order #
3/4"	WLD1601	Cover Assembly	**W-KIT-7-12-LD**
		Lever, Seat Assembly, Gasket	**W-KIT-6-12**
		Float & Screw	**W-KIT-5-02**
		Gasket	**W-KIT-3-01**
1"	WLD1602	Cover Assembly	**W-KIT-7-13-LD**
		Lever, Seat Assembly, Gasket	**W-KIT-6-13**
		Float & Screw	**W-KIT-5-03**
		Gasket	**W-KIT-3-02**
1 1/2"	WLD1603	Cover Assembly	**W-KIT-7-17-LD**
		Lever, Seat Assembly, Gasket	**W-KIT-6-17**
		Float & Screw	**W-KIT-5-04**
		Gasket	**W-KIT-3-03**
2"	WLD1604	Cover Assembly	**W-KIT-7-20-LD**
		Lever, Seat Assembly, Gasket	**W-KIT-6-23**
		Float & Screw	**W-KIT-5-05**
		Gasket	**W-KIT-3-04**

WLDE/WLDES Series — Float Type Liquid Drainer Kits



Size	For Model	Kit Order #	Description
2″	WLDE-20	**W-KIT-3-18**	Cover Gasket
		W-KIT-5-18	Float
		W-KIT-6-28	Float, Lever & Seat Assembly
2″	WLDE-50	**W-KIT-3-19**	Cover Gasket
		W-KIT-5-19	Float
		W-KIT-6-29	Float, Lever & Seat Assembly
2$^1/_2$″	WLDE-50 WLDES-50	**W-KIT-3-19**	Cover Gasket
		W-KIT-5-20	Float
		W-KIT-6-30	Float, Lever & Seat Assembly
2$^1/_2$″	WLDE-125 WLDES-125	**W-KIT-3-19**	Cover Gasket
		W-KIT-5-21	Float
		W-KIT-6-24	Float, Lever & Seat Assembly
1$^1/_2$″	WLDE-200	**W-KIT-3-22**	Cover Gasket
		W-KIT-5-22	Float
		W-KIT-6-26	Float, Lever & Seat Assembly
2″	WLDE-200	**W-KIT-3-18**	Cover Gasket
		W-KIT-5-23	Float
		W-KIT-6-27	Float, Lever & Seat Assembly
2$^1/_2$″	WLDE-200 WLDES-300	**W-KIT-3-19**	Cover Gasket
		W-KIT-5-24	Float
		W-KIT-6-25	Float, Lever & Seat Assembly

WLD1400 Series — Float Type Liquid Drainer Kits

All internal components are identical to FTT-Series Steam Traps, less the thermostat. See Page 380.

WLD1900 Series — Float Type Liquid Drainer Kits

All internal components are identical to WFT-Series Steam Traps, less the thermostat. See Page 378 & 379.

WLD600/601 Series Liquid Drainer Kits

Size	Model	Order #	Item
3/4"	WLD600-65 WLD601-65	W-KIT-3-23	Cover Gasket
		W-KIT-5-25	Float & Screw
		W-KIT-6-31	Lever & seat Assembly
	WLD600-145 WLD601-145	W-KIT-3-23	Cover Gasket
		W-KIT-5-25	Float & Screw
		W-KIT-6-32	Lever & seat Assembly
	WLD600-200 WLD601-200	W-KIT-3-23	Cover Gasket
		W-KIT-5-25	Float & Screw
		W-KIT-6-33	Lever & seat Assembly
	WLD600-300 WLD601-300	W-KIT-3-23	Cover Gasket
		W-KIT-5-25	Float & Screw
		W-KIT-6-34	Lever & Seat Assembly
	WLD600-450 WLD601-300	W-KIT-3-23	Cover Gasket
		W-KIT-5-25	Float & Screw
		W-KIT-6-35	Lever & Seat Assembly

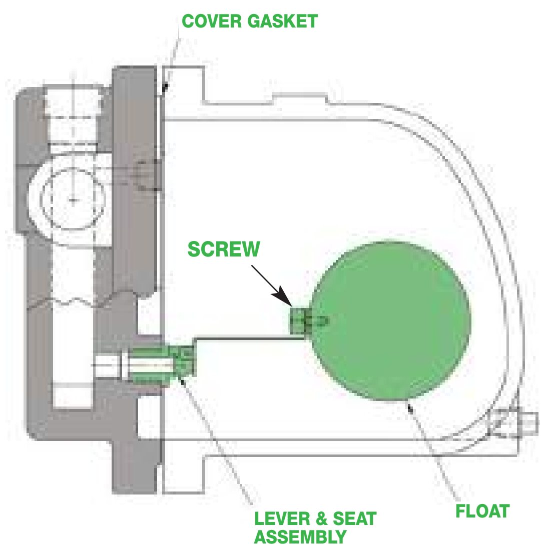
Size	Model	Order #	Item
1"	WLD600-65 WLD601-65	W-KIT-3-24	Cover Gasket
		W-KIT-5-26	Float & Screw
		W-KIT-6-36	Lever & Seat Assembly
	WLD600-145 WLD601-145	W-KIT-3-24	Cover Gasket
		W-KIT-5-26	Float & Screw
		W-KIT-6-37	Lever & Seat Assembl
	WLD600-200 WLD601-200	W-KIT-3-24	Cover Gasket
		W-KIT-5-26	Float & Screw
		W-KIT-6-38	Lever & Seat assembly
	WLD600-300 WLD601-300	W-KIT-3-24	Cover Gasket
		W-KIT-5-26	Float & Screw
		W-KIT-6-39	Lever & Seat assembly
	WLD600-450 WLD601-300	W-KIT-3-24	Cover Gasket
		W-KIT-5-26	Float & Screw
		W-KIT-6-40	Lever & Seat assembly

Size	Model	Order #	Item
11/2"	WLD600-65 WLD601-65	W-KIT-3-25	Cover Gasket
		W-KIT-5-27-1	Float & Screw
		W-KIT-6-41	Lever & Seat Assembly
	WLD600-145 WLD601-145	W-KIT-3-25	Cover Gasket
		W-KIT-5-27-1	Float & Screw
		W-KIT-6-42	Lever & Seat Assembly
	WLD600-200 WLD601-200	W-KIT-3-25	Cover Gasket
		W-KIT-5-27-2	Float & Screw
		W-KIT-6-43	Lever & Seat Assembly
	WLD600-300 WLD601-300	W-KIT-3-25	Cover Gasket
		W-KIT-5-27-2	Float & Screw
		W-KIT-6-44	Lever & Seat Assembly
	WLD600-450 WLD601-300	W-KIT-3-25	Cover Gasket
		W-KIT-5-27-2	Float & Screw
		W-KIT-6-45	Lever & Seat Assembly

Size	Model	Order #	Item
2"	WLD600-65 WLD601-65	W-KIT-3-26	Cover Gasket
		W-KIT-5-28-1	Float & Screw
		W-KIT-6-52	Lever & seat Assembly
	WLD600-145 WLD601-145	W-KIT-3-26	Cover Gasket
		W-KIT-5-28-1	Float & Screw
		W-KIT-6-53	Lever & Seat Assembly
	WLD600-200 WLD601-200	W-KIT-3-26	Cover Gasket
		W-KIT-5-28-2	Float & Screw
		W-KIT-6-54	Lever & Seat Assembly
	WLD600-300 WLD601-300	W-KIT-3-26	Cover Gasket
		W-KIT-5-28-2	Float & Screw
		W-KIT-6-49	Lever & Seat Assembly
	WLD600-450 WLD601-450	W-KIT-3-26	Cover Gasket
		W-KIT-5-28-2	Float & Screw
		W-KIT-6-50	Lever & Seat Assembly

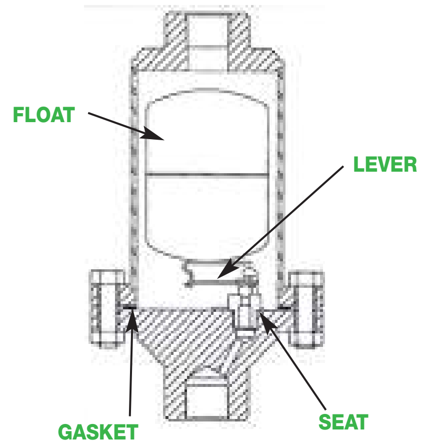
Size	Model	Order #	Item
3" & 4"	WLD600-450 WLD601-450	W-KIT-3-27	Cover Gasket
		W-KIT-5-29	Float & Screw
		W-KIT-6-51	Lever & Seat Assembly

Note:
Reference FT600 Parts Section for additional detailed drawings.
All internal parts of WLD600 are identical to FT600, except WLD600 Liquid Drainers do not include a thermostat.



WLD1800R Series — Liquid Drainer Kits

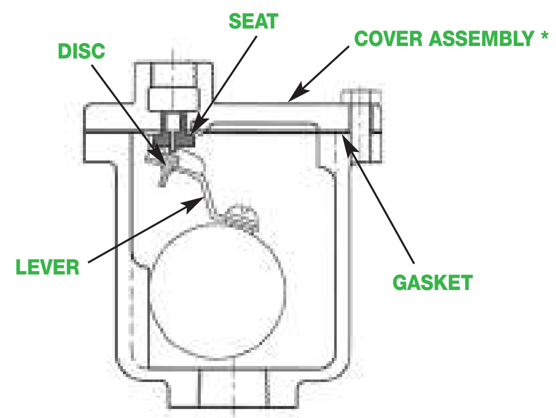
Model	Kit Order #	Description	PMO (PSI)
WLD1800R - All	**W-KIT-3-29**	Gasket	–
WLD1800R - All	**W-KIT-5-31**	Float	–
WLD1810R	**W-KIT-6-46**	Lever & Seat (.078 dia.)	400
WLD1820R	**W-KIT-6-47**	Lever & Seat (.101 dia.)	255
WLD1830R	**W-KIT-6-48**	Lever & Seat (.125 dia.)	175



AV813 Series — Air Eliminator Parts & Kits

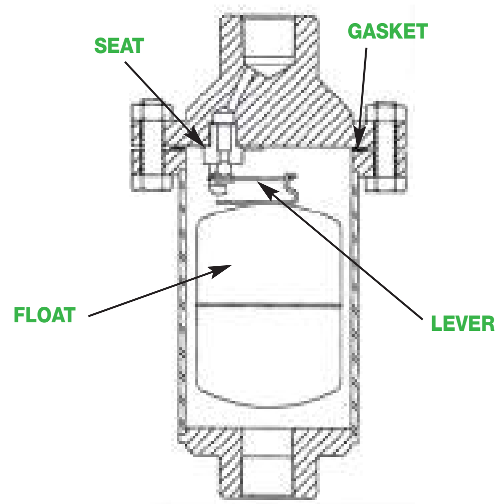
For Model	Kit Order #	Description	Cross Reference Spirax Sarco
AV813	**W-KIT-813-01**	Gasket	13WS
AV813	**W-KIT-813-02**	Lever & Disc, Seat	13WS
AV813	**W-KIT-813-03**	Cover Assembly *	13WS
AV813	**W-KIT-813-04**	Lever & Viton Seat	13WS

* Cover Assembly Consists of:
(1) lever & disc
(1) seat
(1) cover gasket
All fully assembled to cover.



AE1800R Series — Air Eliminator Parts & Kits

For Model	Kit Order #	Description	PMO (PSI)
AE1800R	**W-KIT-3-29**	Gasket	–
AE1800R	**W-KIT-5-31**	Float	–
AE1810R	**W-KIT-6-46**	Lever & Seat (.078 dia.)	400
AE1820R	**W-KIT-6-47**	Lever & Seat (.101 dia.)	255
AE1830R	**W-KIT-6-48**	Lever & Seat (.125 dia.)	175



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FORMULAS, CONVERSIONS & GUIDELINES

EQUIVALENTS & CONVERSION FACTORS

A MULTIPLY	B BY	C TO OBTAIN
Atmospheres	14.697	Pounds per sq. in.
Atmospheres	1.033	Kilograms per sq. cm
Atmospheres	29.92	Inches of mercury
Atmospheres	760	Millimeters of mercury
Atmospheres	407	Inches of water
Atmospheres	33.90	Feet of water
Barrels (petroleum)	42	Gallons
Barrels per day	0.0292	Gallons per minute
Bars-G	14.5	Pounds per sq. in.
Centimeters	0.3937	Inches
Centimeters	0.03281	Feet
Centimeters	0.01	Meters
Centimeters	0.01094	Yards
Cubic centimeters	0.06102	Cubic inches
Cubic feet	7.48055	Gallons
Cubic feet	0.17812	Barrels
Cubic feet per second	448.833	Gallons per minute
Cubic inches	16.39	Cubic centimeters
Cubic inches	0.004329	Gallons
Cubic meters	264.17	Gallons
Cubic meters per hour	4.40	Gallons per minute
Feet	0.3048	Meters
Feet	0.3333	Yards
Feet	30.48	Centimeters
Feet of water	0.882	Inches of mercury
Feet of water	0.433	Pounds per sq. in.
Gallons (U.S.)	3785	Cubic centimeters
Gallons (U.S.)	0.13368	Cubic feet
Gallons (U.S.)	231	Cubic inches
Gallons (Imperial)	277.4	Cubic inches
Gallons (U.S.)	0.833	Gallons (Imperial)
Gallons (U.S.)	3.785	Liters
Gallons of water	8.328	Pounds (at 70°F)
Gallons of liquid per minute	500 x Sp. Gr.	Pounds per hr liquid (at 70°F)
Gallons per minute	0.002228	Cubic feet per second
Horsepower (boiler)	34.5	Pounds water per hr. evaporation
Horsepower (boiler)	33479	Btu per hour
Inches	2.54	Centimeters
Inches	0.0833	Feet
Inches	0.0254	Meters
Inches	0.02778	Yards

A MULTIPLY	B BY	C TO OBTAIN
Inches of mercury	1.133	Feet of water
Inches of mercury	0.4912	Pounds per sq. in.
Inches of mercury	0.0345	Kilograms per sq. cm
Inches of water	0.03613	Pounds per sq. in.
Inches of water	0.07355	Inches of mercury
Kilograms	2.205	Pounds
Kilograms	0.001102	Short tons (2000 lbs.)
Kilograms per minute	132.3	Pounds per hour
Kilograms per sq. cm	14.22	Pounds per sq. in.
Kilograms per sq. cm	0.9678	Atmospheres
Kilograms per sq. cm	28.96	Inches of mercury
Kilopascals	0.145	Pounds per sq. in.
Liters	1000	Cubic centimeters
Liters	0.2642	Gallons
Liters per hour	0.0044	Gallons per minute
Meters	3.281	Feet
Meters	1.0936	Yards
Meters	100	Centimeters
Meters	39.37	Inches
Megapascals	145.0	Pounds per sq. in.
Pounds	0.0005	Short tons (2000 lbs.)
Pounds	0.4536	Kilograms
Pounds	0.000454	Metric Tons
Pounds	16	Ounces
Pounds per hour	6.32/M.W.	Cubic feet per minute
Pounds per hour liquid	0.002/Sp. Gr.	Gallons per minute liquid (at 70°F)
Pounds per sq. in.	27.684	Inches of water
Pounds per sq. in.	2.307	Feet of water
Pounds per sq. in.	2.036	Inches of mercury
Pounds per sq. in.	0.0703	Kilograms per sq. cm
Pounds per sq. in.	51.71	Millimeters of mercury
Pounds per sq. in.	0.7037	Meters of water
Specific Gravity (of gas or vapors)	28.97	Molecular Wt. (of gas or vapors)
Square centimeters	0.1550	Square inches
Square inches	6.452	Square centimeters
Tons (short ton 2000 lbs.)	907.2	Kilograms
Tons (short ton 2000 lbs.)	0.9072	Metric Tons
Tons (metric) per day	91.8	Pounds per hour
Water (cubic feet)	62.3	Pounds (at 70°F)
Yards	0.9144	Meters
Yards	91.44	Centimeters

This table may be used in two ways:

(1) Multiply the unit under column A by the figure under column B; the result is the unit under column C.

(2) Divide the unit under column C by the figure under column B; the result is the unit under column A.

CAPACITY FORMULAS FOR STEAM LOADS

Definition of Terms and Units:

Q_S = Steam Load or Steam Capacity (lbs/hr)
E = Heat Load (Btu/hr)
m = Amount of water to cool per time (lbs/hr)
C_P = Specific Heat of fluid being heated (Btu/(lb-°F))
C_{P1} = Specific heat of solid being heated (Btu/(lb-°F))
ΔT = Temperature rise (°F)
ΔT_1 = Condensate Temp. - Temp. Set Point (°F)
ΔT_2 = Temperature difference (°F)
(Temp. set point - temp. of cooling water)

LH = Latent Heat of Saturated Steam (Btu/lb)
s.g. = Specific gravity of fluid
Q_W = Flow rate of water (GPM)
Q_L = Flow rate of liquid (GPM)
Q_{air} = Flow rate of air (CFM or ft³/min)
G = Volume of liquid to be heated (gallons)
t = Time to heat product (hours)
W = Weight of material (lbs)
ρ_{air} = Density of air (lb/ft³)
500 = 60 min/hr x 8.33 lbs/gal (convert GPM of water to lbs/hr)

APPROXIMATE FORMULAS	EXACT FORMULAS
When Heating Water with Steam $Q_S = \frac{Q_W}{2} \times \Delta T$	$Q_S = \frac{Q_W \times \Delta T \times 500}{LH}$
When Heating Fuel Oil with Steam $Q_S = \frac{Q_L}{4} \times \Delta T$	$Q_S = \frac{Q_L \times \Delta T \times C_p \times 500 \times s.g.}{LH}$
When Heating Air Coils with Steam $Q_S = \frac{Q_{air}}{900} \times \Delta T$	$Q_S = \frac{Q_{air} \times 0.24 \times \rho_{air} \times 60(min/hr) \times \Delta T}{LH}$
When Heat Load (Btu/hr) is Known $Q_S = \frac{E}{1000}$	$Q_S = \frac{E}{LH}$

When Boiler Output (H.P.) is Known

Q_S = Boiler H.P. x 34.5

Heating Water in Open-Top Tank with Direct Steam Injection

$$Q_S = \frac{G \times \Delta T \times 8.33\ (lbs/gal)}{LH \times t}$$

When Square Feet Equivalent Direct Radiation (EDR) is Known

$$Q_S = \frac{EDR}{4}$$

Heating Liquid in Jacketed Kettles

$$Q_S = \frac{G \times s.g. \times C_P \times \Delta T \times 8.33\ (lbs/gal)}{LH \times t}$$

Condensate Cooling using Water

Step 1: $E = m\Delta T_1$
Step 2: $Q_S = E/\Delta T_2$
Step 3: Water required: $Q_w(GPM) = Q_s/500$

Heating Solids by Direct Steam Injection into Chamber (Platens, Autoclaves, etc.)

$$Q_S = \frac{W \times C_{p1} \times \Delta T}{LH \times t}$$

FORMULAS FOR CONTROL VALVE SIZING FOR LIQUIDS

The following formulas for Control Valve Sizing assume turbulent flow based on liquids similar in viscosity to water, and pipe sizes equal to the size of the valve ports, with no attached fittings.

C_V = Valve Flow Coefficient
Q = Volumetric Flow Rate of Liquid (US GPM)
P_1 = Absolute Inlet Pressure (psia)
P_2 = Absolute Outlet Pressure (psia)
ΔP = Pressure Drop (psi) = $P_1 - P_2$
G = Specific Gravity of the Liquid
P_V = Vapor Pressure of the Liquid

For Normal Flow:

When: $\Delta P < K_C (P_1 - P_V)$:

$$Q = C_V\sqrt{\frac{\Delta P}{G}}$$ Flow Rate based on C_V and ΔP.

$$C_V = Q\sqrt{\frac{G}{\Delta P}}$$ C_V required based on Flow Rate and ΔP.

$$\Delta P = \left[\frac{Q}{C_V}\right]^2 G$$ Pressure drop across valve based on Flow Rate and C_V.

Potential for Cavitation

Cavitation can occur when the pressure inside the control valve drops below the vapor pressure (P_V) of the liquid. Cavitation should be avoided because it restricts flow rate, generates noise and may reduce life expectancy of internal components. When $\Delta P < K_C (P_1 - P_V)$, the Standard Flow Equation will predict performance. When $\Delta P \geq K_C (P_1 - P_V)$, cavitation may occur and the accuracy of the normal flow equation may be reduced.

F_L = The Valve Pressure Recovery Factor. For Globe Style Control Valve. $F_L = 0.9$

K_C = $0.65\ F_L^2$ Based on when a 2% reduction of normal flow rate occurs. (0.65 proportionality conconstant is used for conservative determination of cavitation)

P_V = Vapor Pressure of the Liquid (psia). (see chart for water at various temperatures.)

Valve Sizing Example:

A control valve is needed that will handle a maximum flow rate of 100 GPM of water @ 180°F. Since the temperature of the water is elevated, cavitation becomes a concern. Determine the maximum pressure drop across the control valve before cavitation will occur. Based on this maximum pressure drop, determine the required minimum C_V value of the control valve.

Conditions of Service:

Q = 100 GPM
T = 180°F Water
P_1 = 50 psig = 64.7 psia

1 To Determine the ΔP across the valve when cavitation could potentially occur, use the formula $\Delta P_C = K_C (P_1 - P_V)$.

$$\Delta P_C = K_C (P_1 - P_V) = 0.53\,(64.7 - 7.51) = \mathbf{30}\text{ psi}$$

$K_C = 0.65\ F_L^2 = 0.65\,(0.9)^2 = 0.53$ (for globe value)

$P_V = 7.51$ @ 180°F for water (see chart)

2 Determine the minimum C_V of the control valve at the maximum ΔP of 30 psi.

$$C_V = Q\sqrt{\frac{G}{\Delta P}} = 100\sqrt{\frac{0.972}{30}} = \mathbf{18}$$

G = 0.972 @ 180°F for water (see chart)

Water Physical Properties		
Temp. (°F)	G (Ref. to 60°F)	P_V (psia)
32	1.001	0.09
40	1.001	0.12
50	1.001	0.18
60	1.000	0.26
70	0.999	0.36
80	0.998	0.51
90	0.996	0.70
100	0.994	0.95
120	0.990	1.69
140	0.985	2.89
160	0.979	4.74
180	0.972	7.51
200	0.964	11.5
212	0.959	14.7

NOTE: Since a minimum C_V of 18 was calculated, we could choose a 1-1/2" HB globe style control valve which has a C_V = 22.

FORMULAS FOR VALVE SIZING

Control Valve Sizing for Saturated Steam

The following formulas for Valve Sizing are based on ISA Standard 75.01.01-2007 (60534-2-1 Mod).
The formulas assume pipe sizes equal to the size of the valve ports, with no attached fittings.

Cv = Valve Flow Coefficient
ΔP = Pressure Drop = $P_1 - P_2$
P_1 = Absolute Inlet Pressure (psia)
P_2 = Absolute Outlet Pressure (psia)
W = Saturated Steam Flow (lbs/hr)
T_1 = Steam Inlet Temperature (°R) (see table)
Z_1 = Steam Compressibility Factor (see table)

γ = Heat Capacity Ratio for Steam = 1.3 (0-300 psig)
F_γ = Heat Capacity Ratio Factor for Steam = $\gamma/1.4 = 1.3/1.4 = 0.93$
x = Pressure Drop Ratio = $\Delta P/P_1$
ΔP_{cr} = Critical Pressure Drop
x_T = Critical Pressure Drop Ratio for Air
x_{cr} = Critical Pressure Drop Ratio for Steam
= $\Delta P_{cr} / P_1 = F_\gamma\, x_T = 0.93 x_T$

For Sub-critical Flow

$$Cv = \frac{W}{82\, P_1 \,(1 - x/3x_{cr})\sqrt{x/(T_1 Z_1)}}$$

When $\Delta P/P_1 < x_{cr}$: $x = \Delta P/P_1$

For Critical Flow

$$Cv = \frac{W}{54.6\, P_1 \sqrt{x_{cr}/(T_1 Z_1)}}$$

When $\Delta P/P_1 \geq x_{cr}$

For single-ported globe valve with flow-to-open seating arrangement:
$x_T = \mathbf{0.72}$ $x_{cr} = 0.93 x_T = \mathbf{0.67}$

$$Cv = \frac{W}{82\, P_1 \,(1 - x/2)\sqrt{x/(T_1 Z_1)}}$$

When $\Delta P/P_1 < \mathbf{0.67}$

$$Cv = \frac{W}{54.6\, P_1 \sqrt{0.67/(T_1 Z_1)}}$$

When $\Delta P/P_1 \geq \mathbf{0.67}$

Example: Determine the Cv Value for a Control Valve with 60 psig Inlet Steam Pressure, and 30 psig Outlet Pressure with a Flow Rate of 4,000 lbs/hr.

W = 4,000 lbs/hr
P_1 = 60 psig = 74.7 psia
P_2 = 30 psig = 44.7 psia
ΔP = 30 psi
x = $\Delta P/P_1$ = 30/74.4 = 0.40
x_{cr} = $0.93 x_T$ = 0.93 x 0.72 = 0.67
Since $x < x_{cr}$ flow is sub-critical
T_1 = 767 (from table)
Z_1 = 0.955 (from table)

$$Cv = \frac{W}{82\, P_1 \,(1 - x/2)\sqrt{x/(T_1 Z_1)}}$$

When $\Delta P/P_1 < 0.67$

$$Cv = \frac{4{,}000}{82\,(74.7)(1 - 0.4/2)\sqrt{0.4/(767 \times 0.955)}}$$

$$= \frac{4{,}000}{114.6} = \mathbf{35}$$

Saturated Steam Table

P_1 psig	P_1 psia	T_1 (°R)	Z_1
0	14.7	672	0.985
10	24.7	699	0.978
20	34.7	718	0.973
30	44.7	734	0.968
40	54.7	746	0.963
50	64.7	757	0.959
60	74.7	767	0.955
70	84.7	776	0.951
80	94.7	784	0.947
90	104.7	791	0.943
100	114.7	798	0.940
110	124.7	804	0.936
120	134.7	810	0.933
130	144.7	815	0.930
140	154.7	821	0.927
150	164.7	826	0.923
160	174.7	830	0.920
170	184.7	835	0.917
180	194.7	839	0.915
190	204.7	843	0.912
200	214.7	848	0.909
210	224.7	851	0.906
220	234.7	855	0.903
230	244.7	859	0.901
240	254.7	862	0.898
250	264.7	866	0.895
260	274.7	869	0.893
270	284.7	872	0.890
280	294.7	875	0.888
290	304.7	879	0.885
300	314.7	882	0.883

Properties of Saturated Steam

Pressure	Temp. (°F)	Heat (BTU/lb) Sensible	Heat (BTU/lb) Latent	Heat (BTU/lb) Total	Volume (ft^3/lb) Condensate	Volume (ft^3/lb) Steam
in Hg vac						
25	133	101	1018	1119	0.01626	143.3
20	161	129	1002	1131	0.01640	75.41
15	179	147	991	1138	0.01650	51.41
10	192	160	983	1143	0.01659	39.22
5	203	171	976	1147	0.01666	31.82
(PSIG)						
0	212	180	970	1151	0.01672	26.80
1	215	184	968	1152	0.01674	25.21
2	219	187	966	1153	0.01676	23.79
3	222	190	964	1154	0.01679	22.53
4	224	193	962	1155	0.01681	21.40
5	227	195	961	1156	0.01683	20.38
6	230	198	959	1157	0.01685	19.46
7	232	201	957	1158	0.01687	18.62
8	235	203	956	1159	0.01689	17.85
9	237	206	954	1160	0.01690	17.14
10	239	208	953	1160	0.01692	16.49
12	244	212	950	1162	0.01696	15.33
14	248	216	947	1163	0.01699	14.33
16	252	220	944	1165	0.01702	13.45
18	255	224	942	1166	0.01705	12.68
20	259	228	940	1167	0.01708	11.99
22	262	231	937	1168	0.01711	11.38
24	265	234	935	1169	0.01713	10.83
25	267	236	934	1170	0.01715	10.57
26	268	237	933	1170	0.01716	10.33
28	271	240	931	1171	0.01719	9.874
30	274	243	929	1172	0.01721	9.459
32	277	246	927	1173	0.01723	9.078
34	279	249	925	1174	0.01726	8.728
35	281	250	924	1174	0.01727	8.563
36	282	251	923	1174	0.01728	8.404
38	284	254	922	1175	0.01730	8.104
40	287	256	920	1176	0.01733	7.826
42	289	258	918	1177	0.01735	7.566
44	291	261	916	1177	0.01737	7.323
45	292	262	916	1178	0.01738	7.208
46	294	263	915	1178	0.01739	7.096
48	296	265	913	1178	0.01741	6.883
50	298	267	912	1179	0.01743	6.683
55	303	272	908	1180	0.01748	6.230
60	307	277	905	1182	0.01753	5.837
65	312	282	901	1183	0.01757	5.491
70	316	286	898	1184	0.01761	5.184
75	320	291	895	1185	0.01766	4.911
80	324	295	892	1186	0.01770	4.665
85	328	298	889	1187	0.01774	4.444
90	331	302	886	1188	0.01778	4.242
95	335	306	883	1189	0.01782	4.059
100	338	309	881	1190	0.01785	3.891
105	341	312	878	1190	0.01789	3.736
110	344	316	876	1191	0.01792	3.594
115	347	319	873	1192	0.01796	3.462
120	350	322	871	1192	0.01799	3.340
125	353	325	868	1193	0.01803	3.226
130	356	328	866	1194	0.01806	3.119
135	358	331	864	1194	0.01809	3.020
140	361	333	861	1195	0.01812	2.927
145	363	336	859	1195	0.01815	2.839

(continued)

Pressure (PSIG)	Temp. (°F)	Heat (BTU/lb) Sensible	Heat (BTU/lb) Latent	Heat (BTU/lb) Total	Volume (ft^3/lb) Condensate	Volume (ft^3/lb) Steam
150	366	339	857	1196	0.01818	2.756
155	368	341	855	1196	0.01821	2.678
160	371	344	853	1196	0.01824	2.605
165	373	346	851	1197	0.01827	2.535
170	375	349	849	1197	0.01830	2.469
175	377	351	847	1198	0.01833	2.407
180	380	353	845	1198	0.01835	2.347
185	382	355	843	1198	0.01839	2.291
190	384	358	841	1199	0.01841	2.237
195	386	360	839	1199	0.01844	2.185
200	388	362	837	1199	0.01847	2.136
205	390	364	836	1200	0.01850	2.089
210	392	366	834	1200	0.01852	2.044
215	394	368	832	1200	0.01855	2.001
220	395	370	830	1200	0.01857	1.960
225	397	372	829	1201	0.01860	1.920
230	399	374	827	1201	0.01863	1.882
235	401	376	825	1201	0.01865	1.845
240	403	378	823	1201	0.01868	1.810
245	404	380	822	1202	0.01870	1.776
250	406	382	820	1202	0.01873	1.744
255	408	384	818	1202	0.01875	1.712
260	409	385	817	1202	0.01878	1.682
265	411	387	815	1202	0.01880	1.652
270	413	389	814	1203	0.01882	1.624
275	414	391	812	1203	0.01885	1.596
280	416	392	811	1203	0.01887	1.570
285	417	394	809	1203	0.01889	1.544
290	419	396	808	1203	0.01891	1.520
295	420	397	806	1203	0.01894	1.497
300	422	399	805	1203	0.01896	1.473
310	425	402	802	1204	0.01901	1.428
320	428	405	799	1204	0.01906	1.386
330	430	408	796	1204	0.01910	1.346
340	433	411	793	1204	0.01915	1.309
350	436	414	790	1204	0.01919	1.273
360	438	417	787	1204	0.01923	1.240
370	441	420	785	1204	0.01927	1.207
380	443	423	782	1205	0.01932	1.177
390	446	426	779	1205	0.01936	1.148
400	448	428	777	1205	0.01940	1.120
450	460	441	764	1205	0.01961	0.9992
500	470	453	752	1205	0.01980	0.9010
550	480	464	740	1204	0.02000	0.8195
600	489	475	729	1203	0.02019	0.7509
650	497	485	718	1203	0.02038	0.6922
700	505	494	707	1202	0.02056	0.6415
750	513	504	697	1200	0.02074	0.5971
800	520	512	687	1199	0.02092	0.5580
900	534	529	667	1196	0.02128	0.4922
1000	546	545	648	1192	0.02164	0.4390
1250	574	581	601	1182	0.02256	0.3410
1500	598	614	556	1169	0.02352	0.2740
1750	618	644	510	1155	0.02456	0.2248
2000	637	674	463	1137	0.02572	0.1864
2250	654	703	413	1116	0.02707	0.1554
2500	669	734	358	1092	0.02871	0.1293
2750	683	766	295	1061	0.03097	0.1062
3000	696	805	211	1016	0.03465	0.0835

DRAINING CONDENSATE FROM STEAM MAINS OR STEAM SUPPLY LINES

Charts Assume All Pipes are Insulated (with 80% efficiency)

Warm Up Loads in Pounds of Condensate per hour per 100 ft. of Steam Main

Warm Up Loads are based on a 1 hour warm up time

Outside Temperature at 70˚F. Based on Sch. 40 Pipe up to 250 PSI; Sch. 80 above 250 PSI; Sch. 120, 5″ & Larger, above 800 PSI.

Steam Pressure (PSIG)	Pipe Size 2″	2 1/2″	3″	4″	5″	6″	8″	10″	12″	14″	16″	18″	20″	24″	0˚F Correction Factor †
0	6.2	9.7	12.8	18.2	24.6	31.9	48	68	90	107	140	176	207	308	1.50
5	6.9	11.0	14.4	20.4	27.7	35.9	48	77	101	120	157	198	233	324	1.44
10	7.5	11.8	15.5	22.0	29.9	38.8	58	83	109	130	169	213	251	350	1.41
20	8.4	13.4	17.5	24.9	33.8	44	66	93	124	146	191	241	284	396	1.37
40	9.9	15.8	20.6	90.3	39.7	52	78	110	145	172	225	284	334	465	1.32
60	11.0	17.5	22.9	32.6	44	57	86	122	162	192	250	316	372	518	1.29
80	12.0	19.0	24.9	35.3	48	62	93	132	175	208	271	342	403	561	1.27
100	12.8	20.3	26.6	37.8	51	67	100	142	188	222	290	366	431	600	1.26
125	13.7	21.7	28.4	40	55	71	107	152	200	238	310	391	461	642	1.25
150	14.5	23.0	30.0	43	58	75	113	160	212	251	328	414	487	679	1.24
175	15.3	24.2	31.7	45	61	79	119	169	224	265	347	437	514	716	1.23
200	16.0	25.3	33.1	47	64	83	125	177	234	277	362	456	537	748	1.22
250	17.2	27.3	35.8	51	69	89	134	191	252	299	390	492	579	807	1.21
300	25.0	38.3	51	75	104	143	217	322	443	531	682	854	1045	1182	1.20
400	27.8	43	57	83	116	159	241	358	493	590	759	971	1163	1650	1.18
500	30.2	46	62	91	126	173	262	389	535	642	825	1033	1263	1793	1.17
600	32.7	50	67	98	136	187	284	421	579	694	893	1118	1367	1939	1.16
800	38	58	77	113	203	274	455	670	943	1132	1445	1835	2227	3227	1.16
1000	45	64	86	126	227	305	508	748	1052	1263	1612	2047	2485	3601	1.15
1200	52	72	96	140	253	340	566	833	1172	1407	1796	2280	2767	4010	1.14
1400	62	79	106	155	280	376	626	922	1297	1558	1988	2524	3064	4440	1.13
1600	71	87	117	171	309	415	692	1018	1432	1720	2194	2786	3382	4901	1.13
1750	78	94	126	184	333	448	746	1098	1544	1855	2367	3006	3648	5285	1.13
1800	80	97	129	189	341	459	764	1125	1584	1902	2427	3082	3741	5420	1.13

Running Loads in Pounds of Condensate per hour per 100 ft. of Steam Main

Outside Temperature at 70˚F.

Steam Pressure (PSIG)	Pipe Size 2″	2 1/2″	3″	4″	5″	6″	8″	10″	12″	14″	16″	18″	20″	24″	0˚F Correction Factor †
10	6	7	9	11	13	16	20	24	29	32	36	39	44	53	1.58
30	8	9	11	14	17	20	26	32	38	42	48	51	57	68	1.50
60	10	12	14	18	24	27	33	41	49	54	62	67	74	89	1.45
100	12	15	18	22	28	33	41	51	61	67	77	83	93	111	1.41
125	13	16	20	24	30	36	45	56	66	73	84	90	101	121	1.39
175	16	19	23	26	33	43	53	66	78	86	98	107	119	141	1.38
250	18	22	27	34	42	50	62	77	92	101	116	126	140	168	1.36
300	20	25	30	37	46	54	68	85	101	111	126	138	154	184	1.35
400	23	28	34	43	53	63	80	99	118	130	148	162	180	216	1.33
500	27	33	39	49	61	73	91	114	135	148	170	185	206	246	1.32
600	30	37	44	55	68	82	103	128	152	167	191	208	232	277	1.31
800	36	44	53	69	85	101	131	164	194	214	244	274	305	365	1.30
1000	43	52	63	82	101	120	156	195	231	254	290	326	363	435	1.27
1200	51	62	75	97	119	142	185	230	274	301	343	386	430	515	1.26
1400	60	73	89	114	141	168	219	273	324	356	407	457	509	610	1.25
1600	69	85	103	132	163	195	253	31	375	412	470	528	588	704	1.22
1750	76	93	113	145	179	213	278	347	411	452	516	580	645	773	1.22
1800	79	96	117	150	185	221	288	358	425	467	534	600	667	800	1.21

† For outdoor temperatures of 0˚F, multiply load value selected from table by correction factor shown.

STEAM PROPERTIES & FLOW CHARACTERISTICS

STEAM CAPACITY TABLES

This chart provides a simple method for sizing steam pipes with velocities in the range of 7,000 to 10,000 ft/min.
(Example: a 1″ pipe with 100 PSIG steam pressure has a flow rate of 672 lbs/hr at a velocity of 7250 ft/min.)

STEAM CAPACITY – Flow in lbs/hr

Pressure (PSIG)	Temp. (°F) (sat.)	FULL-PORT VALVE or PIPE SIZE																
		1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
		VELOCITY (FPM)																
		7062	7094	7125	7187	7250	7312	7375	7500	7625	7750	7875	8000	8250	8500	9000	9500	10000
250	406	176	324	518	916	1498	2615	3591	6018	8731	13700	18620	24360	39470	58730	107700	179200	267700
200	388	143	264	423	748	1223	2135	2932	4913	7128	11190	15200	19880	32230	47950	87910	146300	218500
175	378	127	235	375	664	1086	1895	2603	4361	6328	9931	13490	17650	28610	42560	78040	129800	194000
150	366	111	205	328	580	948	1655	2273	3810	5528	8675	11790	15420	24990	37180	68170	113400	169500
125	353	95	175	280	496	811	1415	1943	3256	4724	7414	10070	13180	21360	31780	58260	96940	144800
100	338	79	145	232	411	672	1173	1612	2701	3919	6150	8356	10930	17720	26360	48330	80410	120100
90	331	72	133	213	377	617	1076	1478	2477	3594	5641	7665	10030	16250	24180	44330	73760	110200
80	324	66	121	194	343	561	979	1345	2254	3270	5132	6973	9122	14780	22000	40330	67100	100300
70	316	59	109	175	309	505	881	1211	2029	2943	4619	6277	8211	13310	19800	36300	60400	90240
60	308	53	97	155	274	449	783	1076	1803	2616	4105	5577	7296	11820	17590	32260	53670	80190
50	298	46	85	136	240	392	684	940	1575	2286	3587	4874	6376	10330	15380	28190	46900	70080
40	287	39	72	116	205	335	585	803	1346	1953	3066	4166	5449	8831	13140	24090	40080	59890
30	274	33	60	96	170	278	485	666	1115	1618	2539	3451	4514	7315	10880	19960	33200	49610
25	267	29	54	86	152	249	434	596	999	1449	2274	3090	4042	6551	9747	17870	29730	44430
20	259	26	47	76	134	219	383	526	881	1279	2006	2726	3566	5780	8600	15770	26230	39200
15	250	22	41	66	116	190	331	455	763	1107	1737	2360	3087	5003	7444	13650	22710	33930
10	240	19	35	55	98	160	279	384	643	933	1464	1990	2603	4218	6276	11510	19150	28610
5	228	15	28	45	79	130	227	311	522	757	1188	1615	2112	3423	5093	9339	15540	23220
0	212	11	21	34	60	97	170	233	391	568	891	1210	1583	2566	3818	7000	11650	17400

This table represents steam loss thru an orifice on a failed open steam trap, assuming that 25% of the flow consists of condensate.

STEAM FLOW – thru various orifice diameters discharging to atmosphere (0 PSIG) in lbs/hr

Orifice Diameter (Inches)	Inlet Pressure (PSIG)											
	2	5	10	15	25	50	75	100	125	150	200	250	300
1/32	0.31	0.47	0.58	0.70	0.94	1.53	2.12	2.70	3.30	3.90	5.10	6.30	7.40
1/16	1.25	1.86	2.30	2.80	3.80	6.10	8.50	10.80	13.20	15.60	20.30	25.10	29.80
3/32	2.81	4.20	5.30	6.30	8.45	13.80	19.10	24.40	29.70	35.10	45.70	56.40	67.00
1/8	4.50	7.50	7.40	11.20	15.00	24.50	34.00	43.40	52.90	62.40	81.30	100.00	119.00
5/32	7.80	11.70	14.60	17.60	23.50	38.30	53.10	67.90	82.70	97.40	127.00	156.00	186.00
3/16	11.20	16.70	21.00	25.30	33.80	55.10	76.40	97.70	119.00	140.00	183.00	226.00	268.00
7/32	15.30	22.90	28.70	34.40	46.00	75.00	104.00	133.00	162.00	191.00	249.00	307.00	365.00
1/4	20.00	29.80	37.40	45.00	60.10	98.00	136.00	173.00	212.00	250.00	325.00	401.00	477.00
9/32	25.20	37.80	47.40	56.90	76.10	124.00	172.00	220.00	268.00	316.00	412.00	507.00	603.00
5/16	31.20	46.60	58.50	70.30	94.00	153.00	212.00	272.00	331.00	390.00	508.00	627.00	745.00
11/32	37.70	56.40	70.70	85.10	114.00	185.00	257.00	329.00	400.00	472.00	615.00	758.00	901.00
3/8	44.90	67.10	84.20	101.00	135.00	221.00	306.00	391.00	478.00	561.00	732.00	902.00	1073.00
13/32	52.70	78.80	98.80	119.00	159.00	259.00	359.00	459.00	559.00	659.00	859.00	1059.00	1259.00
7/16	61.10	91.40	115.00	138.00	184.00	300.00	416.00	532.00	648.00	764.00	996.00	1228.00	1460.00
15/32	70.20	105.00	131.00	158.00	211.00	344.00	478.00	611.00	744.00	877.00	1144.00	1410.00	1676.00
1/2	79.80	119.00	150.00	180.00	241.00	392.00	544.00	695.00	847.00	998.00	1301.00	1604.00	1907.00

SIZING STEAM PIPES • Steam Velocity Chart (Schedule 40 pipe)

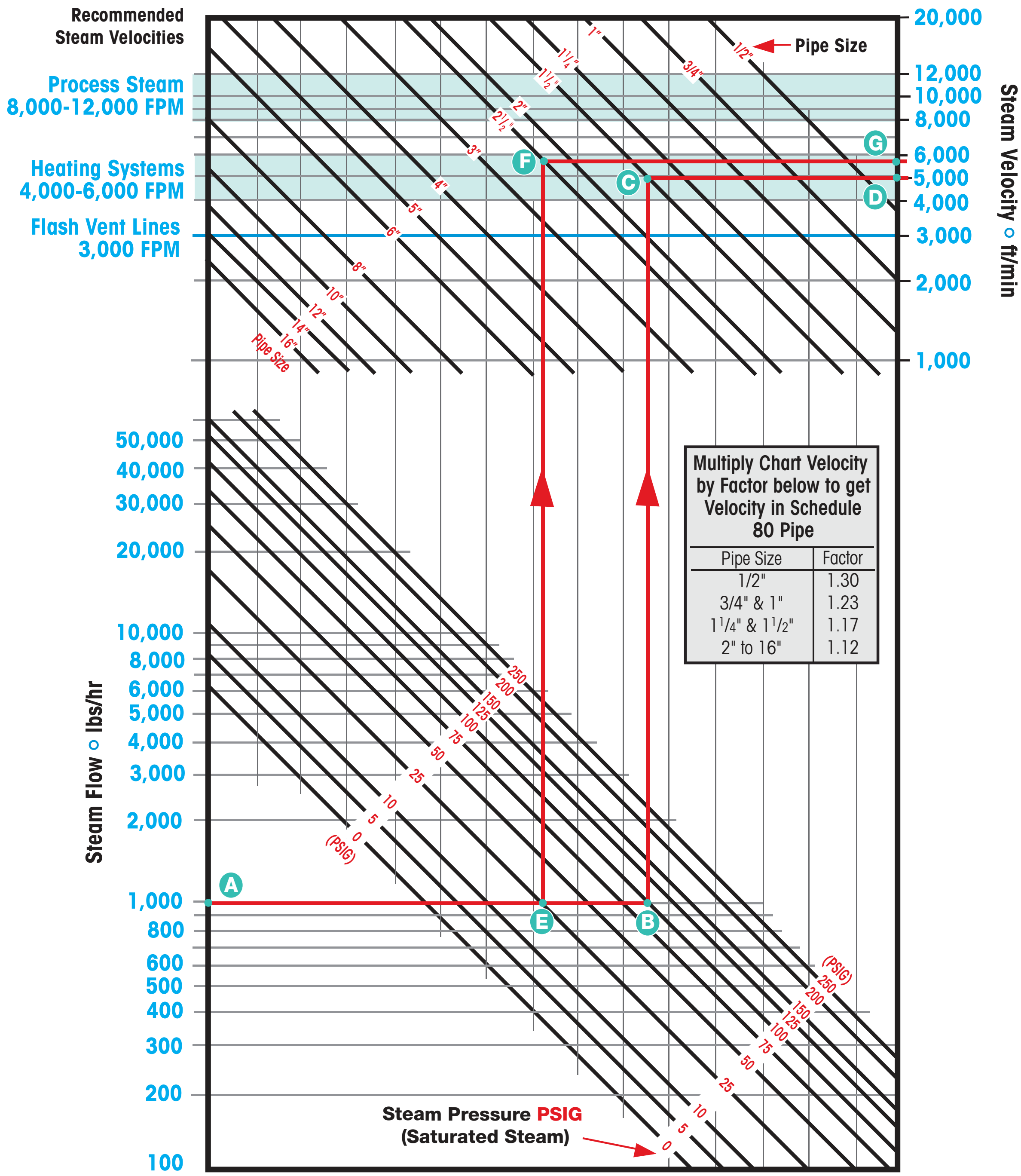
Saturated steam lines should be sized for a steam velocity of 4800 to 7200 ft/min.

Piping on pressure reducing stations should be sized for the same steam velocity on both sides of the regulator. This usually results in having a regulator smaller than the piping and having larger piping on the downstream side of the regulator.

Example using Steam Velocity Chart:
100 PSIG Inlet Pressure to control valve; 25 PSIG Outlet Pressure; 1,000 lbs/hr flow rate; Determine pipe size required.

Upstream Piping:
Enter Velocity Chart at A 1000 lbs/hr. Follow line to B 100 PSIG Inlet Pressure. Follow line vertically upwards to C $1^1/2$″ Pipe Diameter. Steam Velocity at D shows 4800 ft/min.

Downstream Piping:
Enter Velocity Chart at A 1000 lbs/hr. Follow line to E 25 PSIG Outlet Pressure. Follow line vertically upwards to F $2^1/2$″ Pipe Diameter. Steam Velocity at G shows 5500 ft/min.



Multiply Chart Velocity by Factor below to get Velocity in Schedule 80 Pipe	
Pipe Size	Factor
1/2"	1.30
3/4" & 1"	1.23
$1^1/4$" & $1^1/2$"	1.17
2" to 16"	1.12

Note: Condensate Line & Vent Line Size based on using Schedule 40 Pipe

ENGINEERING

SIZING OF CONDENSATE RETURN LINE, FLASH TANK DIAMETER & VENT LINE

- Velocity of Flash Steam in Condensate Return Lines should be between 4000 and 6000 ft/min.
- Velocity in Flash Tank should be less than 600 ft/min.
- Velocity in a Vent Pipe should be less than 4000 ft/min.

Example: **A steam trap with a 150 PSIG steam inlet pressure is being discharged into a flash tank operating at 20 PSIG. The condensate load on the trap is 3200 lbs/hr.**

Problem:

(1) Determine the size of the condensate return line from the trap to the flash tank based on velocities of 4,000 - 6,000 ft/min.

(2) Determine the diameter of the flash tank based on velocities less than 600 ft/min.

(3) Determine the size of the vent line on the flash tank based on velocities less than 4000 ft/min.

Solution:

The accepted practice of determining condensate return pipe sizing is to base the size of the return pipe on the amount of flash steam in the return line. This is due to the fact that the volume of flash steam is over 1,000 times greater than the equivalent volume of liquid condensate. Therefore, the flash steam is the dominant factor affecting flow in the return line. We must first calculate the amount of flash steam produced.

From the **Percent Flash Steam Table** we find that 11.8% of the condensate will flash into steam.
Therefore .118 X 3200 = 377 lbs/hr of flash steam will be produced in the condensate return line and flash tank.

Enter **Condensate Line, Flash Tank & Vent Line Sizing** chart at A **377 lbs/hr**.

Move horizontally to point B 20 PSIG Flash Tank Pressure.

Move vertically upwards to point D to determine a **5" Flash Tank Diameter** is needed to keep velocities less than 600 ft/min.

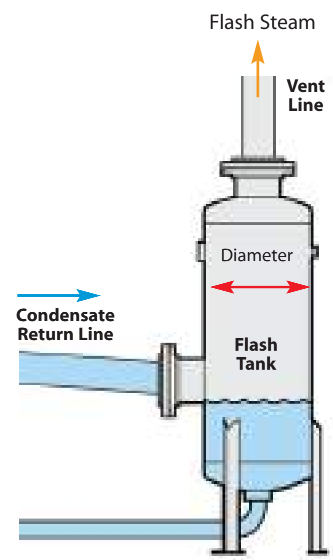
Continue to move vertically to point E to determine that the Vent Line on the Flash Tank should be **2" Diameter** in order to keep velocities less than 4,000 ft/min.

Continue to move vertically to point C to determine that the **Condensate Line should be 1 1/2" Diameter** in order to maintain condensate return line velocities between 4000 and 6000 ft/min.

PERCENT (%) FLASH STEAM TABLE

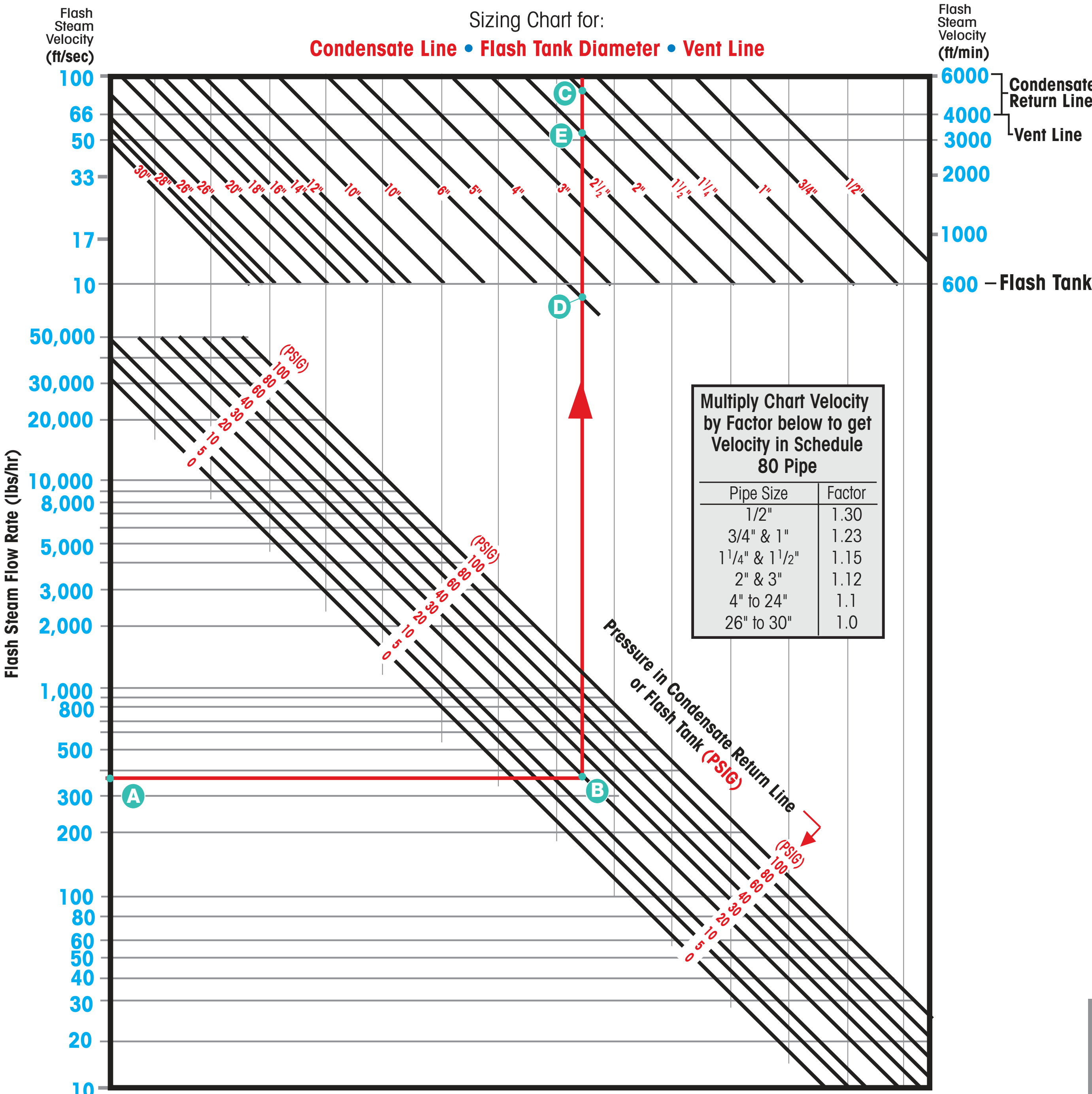
Percent Flash Steam produced when condensate is discharged to atmosphere (0 PSIG) or into a flash tank controlled at various pressures

Condensate Pressure (PSIG)	Flash Tank Pressure (PSIG)								
	0	5	10	20	30	40	60	80	100
5	1.6	0.0							
10	2.9	1.3	0.0						
15	3.9	2.4	1.1						
20	4.9	3.3	2.1	0.0					
30	6.5	5.0	3.7	1.7	0.0				
40	7.8	6.3	5.1	3.0	1.4	0.0			
60	10.0	8.5	7.3	5.3	3.7	2.3	0.0		
80	11.8	10.3	9.1	7.1	5.5	4.2	1.9	0.0	
100	13.3	11.8	10.6	8.7	7.1	5.8	3.5	1.6	0.0
125	14.9	13.5	12.3	10.4	8.8	7.5	5.3	3.4	1.8
150	16.3	14.9	13.7	11.8	10.3	9.0	6.8	4.9	3.3
200	18.7	17.3	16.2	14.3	12.8	11.5	9.4	7.6	6.0
250	20.8	19.4	18.2	16.4	14.9	13.7	11.5	9.8	8.2
300	22.5	21.2	20.0	18.2	16.8	15.5	13.4	11.7	10.2
350	24.1	22.8	21.7	19.9	18.4	17.2	15.1	13.4	11.9
400	25.6	24.2	23.1	21.4	19.9	18.7	16.7	15.0	13.5



SIZING OF CONDENSATE RETURN LINE, FLASH TANK DIAMETER & VENT LINE

- Velocity of Flash Steam in Condensate Return Lines should be between 4000 and 6000 ft/min.
- Velocity in Flash Tank should be less than 600 ft/min.
- Velocity in a Vent Pipe should be less than 4000 ft/min.



Multiply Chart Velocity by Factor below to get Velocity in Schedule 80 Pipe

Pipe Size	Factor
1/2"	1.30
3/4" & 1"	1.23
1 1/4" & 1 1/2"	1.15
2" & 3"	1.12
4" to 24"	1.1
26" to 30"	1.0

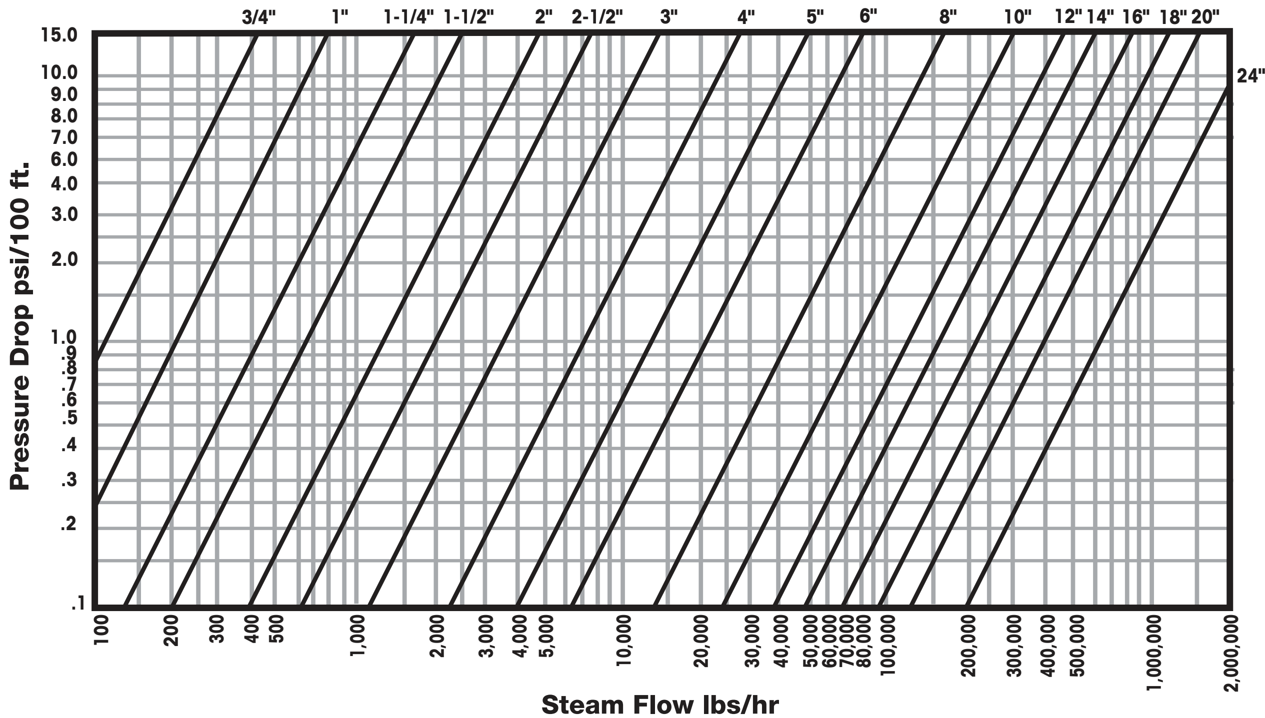
ENGINEERING

PRESSURE DROP IN SCHEDULE 40 PIPE

100 PSIG Saturated Steam

For other pressures use correction factors

psi	0	0	5	10	15	20	30	40	60	75	90	100	110	125	150	175	200	225	250	300	350	400	500	600
factor	6.9	6.0	5.2	4.3	3.6	3.1	2.4	2.0	1.5	1.3	1.1	1.0	0.92	0.83	0.70	0.62	0.55	0.49	0.45	0.38	0.33	0.29	0.23	0.19



Flow of Water thru Schedule 40 Steel Pipe

Pressure Drop per 1,000 Feet of Schedule 40 Steel Pipe

Flow Rate (GPM)	Velocity (ft/s)	Pressure Drop (PSI)	Velocity (ft/s)	Pressure Drop (PSI)	Velocity (ft/s)	Pressure Drop (PSI)	Velocity (ft/s)	Pressure Drop (PSI)	Velocity (ft/s)	Pressure Drop (PSI)	Velocity (ft/s)	Pressure Drop (PSI)	Velocity (ft/s)	Pressure Drop (PSI)	Velocity (ft/s)	Pressure Drop (PSI)	Velocity (ft/s)	Pressure Drop (PSI)
	1”																	
1	0.37	0.49	1 1/4”															
2	0.74	1.70	0.43	0.45	1 1/2”													
3	1.12	3.53	0.64	0.94	0.47	0.44												
4	1.49	5.94	0.86	1.55	0.63	0.74												
5	1.86	9.02	1.07	2.36	0.79	1.12	2”											
6	2.24	12.25	1.28	3.30	0.95	1.53	0.57	0.46										
8	2.98	21.1	1.72	5.52	1.26	2.63	0.76	0.75	2 1/2”									
10	3.72	30.8	2.14	8.34	1.57	3.86	0.96	1.14	0.67	0.48								
15	5.60	64.6	3.21	17.6	2.36	8.13	1.43	2.33	1.00	0.99	3”							
20	7.44	110.5	4.29	29.1	3.15	13.5	1.91	3.86	1.34	1.64	0.87	0.59	3 1/2”					
25			5.36	43.7	3.94	20.2	2.39	5.81	1.68	2.48	1.08	0.67	0.81	0.42				
30			6.43	62.9	4.72	29.1	2.87	8.04	2.01	3.43	1.30	1.21	0.97	0.60	4”			
35			7.51	82.5	5.51	38.2	3.35	10.95	2.35	4.49	1.52	1.58	1.14	0.79	0.88	0.42		
40					6.30	47.8	3.82	13.7	2.68	5.88	1.74	2.06	1.30	1.00	1.01	0.53		
45					7.08	60.6	4.30	17.4	3.00	7.14	1.95	2.51	1.46	1.21	1.13	0.67		
50					7.87	74.7	4.78	20.6	3.35	8.82	2.17	3.10	1.62	1.44	1.26	0.80		
60							5.74	29.6	4.02	12.2	2.60	4.29	1.95	2.07	1.51	1.10	5”	
70							6.69	38.6	4.69	15.3	3.04	5.84	2.27	2.71	1.76	1.50	1.12	0.48
80							7.65	50.3	5.37	21.7	3.48	7.62	2.59	3.53	2.01	1.87	1.28	0.63
90	6”						8.60	63.6	6.04	26.1	3.91	9.22	2.92	4.46	2.26	2.37	1.44	0.80
100	1.11	0.39					9.56	75.1	6.71	32.3	4.34	11.4	3.24	5.27	2.52	2.81	1.60	0.95
125	1.39	0.56							8.38	48.2	5.42	17.1	4.05	7.86	3.15	4.38	2.00	1.48
150	1.67	0.78							10.06	60.4	6.51	23.5	4.86	11.3	3.78	6.02	2.41	2.04
175	1.94	1.06							11.73	90.0	7.59	32.0	5.67	14.7	4.41	8.20	2.81	2.78
200	2.22	1.32	8”								8.68	39.7	6.48	19.2	5.04	10.2	3.21	3.46
225	2.50	1.66	1.44	0.44							9.77	50.2	7.29	23.1	5.67	12.9	3.61	4.37
250	2.78	2.05	1.60	0.55							10.85	61.9	8.10	28.5	6.30	15.9	4.01	5.14
275	3.06	2.36	1.76	0.63							11.94	75.0	8.91	34.4	6.93	18.3	4.41	6.22
300	3.33	2.80	1.92	0.75							13.02	84.7	9.72	40.9	7.56	21.8	4.81	7.41
325	3.61	3.29	2.08	0.88									10.53	45.5	8.18	25.5	5.21	8.25
350	3.89	3.62	2.24	0.97									11.35	52.7	8.82	29.7	5.61	9.57
375	4.16	4.16	2.40	1.11									12.17	60.7	9.45	32.3	6.01	11.0
400	4.44	4.72	2.56	1.27									12.97	68.9	10.08	36.7	6.41	12.5
425	4.72	5.34	2.72	1.43									13.78	77.8	10.70	41.5	6.82	14.1
450	5.00	5.96	2.88	1.60	10”								14.59	87.3	11.33	46.5	7.22	15.0
475	5.27	6.66	3.04	1.69	1.93	0.30									11.96	51.7	7.62	16.7
500	5.55	7.39	3.20	1.87	2.04	0.63									12.59	57.3	8.02	18.5
550	6.11	8.94	3.53	2.26	2.24	0.70									13.84	69.3	8.82	22.4
600	6.66	10.6	3.85	2.70	2.44	0.86									15.10	82.5	9.62	26.7
650	7.21	11.8	4.17	3.16	2.65	1.01	12”										10.42	31.3
700	7.77	13.7	4.49	3.69	2.85	1.18	2.01	0.48									11.22	36.3
750	8.32	15.7	4.81	4.21	3.05	1.35	2.15	0.55									12.02	41.6
800	8.88	17.8	5.13	4.79	3.26	1.54	2.29	0.62	14”								12.82	44.7
850	9.44	20.2	5.45	5.11	3.46	1.74	2.44	0.70	2.02	0.43							13.62	50.5
900	10.00	22.6	5.77	5.73	3.66	1.94	2.58	0.79	2.14	0.48							14.42	56.6
950	10.55	23.7	6.09	6.38	3.87	2.23	2.72	0.88	2.25	0.53							15.22	63.1
1,000	11.10	26.3	6.41	7.08	4.07	2.40	2.87	0.98	2.38	0.59							16.02	70.0
1,100	12.22	31.8	7.05	8.56	4.48	2.74	3.16	1.18	2.61	0.68	16”						17.63	84.6
1,200	13.32	37.8	7.69	10.2	4.88	3.27	3.45	1.40	2.85	0.81	2.18	0.40						
1,300	14.43	44.4	8.33	11.3	5.29	3.86	3.73	1.56	3.09	0.95	2.36	0.47						
1,400	15.54	51.5	8.97	13.0	5.70	4.44	4.02	1.80	3.32	1.10	2.54	0.54						
1,500	16.65	55.5	9.62	15.0	6.10	5.11	4.30	2.07	3.55	1.19	2.73	0.62						
1,600	17.76	63.1	10.26	17.0	6.51	5.46	4.59	2.36	3.80	1.35	2.91	0.71	18”					
1,800	19.98	79.8	11.54	21.6	7.32	6.91	5.16	2.98	4.27	1.71	3.27	0.85	2.58	0.48				
2,000	22.20	98.5	12.83	25.0	8.13	8.54	5.73	3.47	4.74	2.11	3.63	1.05	2.88	0.56				
2,500			16.03	39.0	10.18	12.5	7.17	5.41	5.92	3.09	4.54	1.63	3.59	0.88	20”			
3,000			19.24	52.4	12.21	18.0	8.60	7.31	7.12	4.45	5.45	2.21	4.31	1.27	3.45	0.73		
3,500			22.43	71.4	14.25	22.9	10.03	9.95	8.32	6.18	6.35	3.00	5.03	1.52	4.03	0.94	24”	
4,000			25.65	93.3	16.28	29.9	11.48	13.0	9.49	7.92	7.25	3.92	5.74	2.12	4.61	1.22	3.19	0.51
4,500					18.31	37.8	12.90	15.4	10.67	9.36	8.17	4.97	6.47	2.50	5.19	1.55	3.59	0.60
5,000					20.35	46.7	14.34	18.9	11.84	11.6	9.08	5.72	7.17	3.08	5.76	1.78	3.99	0.74
6,000					24.42	67.2	17.21	27.3	14.32	15.4	10.88	8.24	8.62	4.45	6.92	2.57	4.80	1.00
7,000					28.50	85.1	20.08	37.2	16.60	21.0	12.69	12.2	10.04	6.06	8.06	3.50	5.68	1.36
8,000							22.95	45.1	18.98	27.4	14.52	13.6	11.48	7.34	9.23	4.57	6.38	1.78
9,000							25.80	57.0	21.35	34.7	16.32	17.2	12.92	9.20	10.37	5.36	7.19	2.25
10,000							28.63	70.4	23.75	42.9	18.16	21.2	14.37	11.5	11.53	6.63	7.96	2.78
12,000							34.38	93.6	28.50	61.8	21.80	30.9	17.23	16.5	13.83	9.54	9.57	3.71
14,000									33.20	84.0	25.42	41.6	20.10	20.7	16.14	12.0	11.18	5.05
16,000											29.05	54.4	22.96	27.1	18.43	15.7	12.77	6.60

PIPE, FITTING & FLANGE SPECIFICATIONS

PIPE DATA TABLE

Pipe Size (in.)	Outside Diameter (in.)	Weight Class	Carbon Steel Schedule	Stainless Steel Schedule	Wall Thickness (in.)	Inside Diameter (in.)	Circum. (Ext.) (in.)	Circum. (Int.) (in.)	Flow Area (sq. in.)	Weight of Pipe (lbs/Ft.)	Weight of Water (lbs/Ft.)	Gallons of Water per Ft.	Section Modulus	Pipe Size (in.)
		–	–	10S	.049	.307		.96	.074	.19	.032	.004	.00437	
1/8	0.405	STD	40	40S	.068	.269	1.27	.85	.057	.24	.025	.003	.00523	1/8
		XS	80	80S	.095	.215		.68	.036	.31	.016	.002	.00602	
		–	–	10S	.065	.410		1.29	.132	.33	.057	.007	.01032	
1/4	0.540	STD	40	40S	.088	.364	1.70	1.14	.104	.42	.045	.005	.01227	1/4
		XS	80	80S	.119	.302		.95	.072	.54	.031	.004	.01395	
		–	–	10S	.065	.545		1.71	.233	.42	.101	.012	.01736	
3/8	0.675	STD	40	40S	.091	.493	2.12	1.55	.191	.57	.083	.010	.0216	3/8
		XS	80	80S	.126	.423		1.33	.141	.74	.061	.007	.0255	
		–	–	5S	.065	.710		2.23	.396	.54	.172	.021	.0285	
		–	–	10S	.083	.674		2.12	.357	.67	.155	.019	.0341	
1/2	0.840	STD	40	40S	.109	.622	2.64	1.95	.304	.85	.132	.016	.0407	1/2
		XS	80	80S	.147	.546		1.72	.234	1.09	.102	.012	.0478	
		–	160	–	.187	.466		1.46	.171	1.31	.074	.009	.0527	
		XXS	–	–	.294	.252		.79	.050	1.71	.022	.003	.0577	
		–	–	5S	.065	.920		2.89	.665	.69	.288	.035	.0467	
		–	–	10S	.083	.884		2.78	.614	.86	.266	.032	.0566	
3/4	1.050	STD	40	40S	.113	.824	3.30	2.59	.533	1.13	.231	.028	.0706	3/4
		XS	80	80S	.154	.742		2.33	.433	1.47	.188	.022	.0853	
		–	160	–	.219	.612		1.92	.296	1.94	.128	.015	.1004	
		XXS	–	–	.308	.434		1.36	.148	2.44	.064	.008	.1103	
		–	–	5S	.065	1.185		3.72	1.103	.87	.478	.057	.0760	
		–	–	10S	.109	1.097		3.45	.945	1.40	.409	.049	.1151	
1	1.315	STD	40	40S	.133	1.049	4.13	3.30	.864	1.68	.375	.045	.1328	1
		XS	80	80S	.179	.957		3.01	.719	2.17	.312	.037	.1606	
		–	160	–	.250	.815		2.56	.522	2.84	.230	.027	.1903	
		XXS	–	–	.358	.599		1.88	.282	3.66	.122	.015	.2136	
		–	–	5S	.065	1.530		4.81	1.839	1.11	.797	.096	.1250	
		–	–	10S	.109	1.442		4.53	1.633	1.81	.708	.085	.1934	
1 1/4	1.660	STD	40	40S	.140	1.380	5.22	4.34	1.495	2.27	.649	.078	.2346	1 1/4
		XS	80	80S	.191	1.278		4.02	1.283	3.00	.555	.067	.2913	
		–	160	–	.250	1.160		3.64	1.057	3.76	.458	.055	.3421	
		XXS	–	–	.382	.896		2.81	.630	5.21	.273	.033	.4110	
		–	–	5S	.065	1.770		5.56	2.461	1.28	1.066	.128	.1662	
		–	–	10S	.109	1.682		5.28	2.222	2.09	.963	.115	.2598	
1 1/2	1.900	STD	40	40S	.145	1.610	5.97	5.06	2.036	2.72	.882	.106	.3262	1 1/2
		XS	80	80S	.200	1.500		4.71	1.767	3.63	.765	.092	.4118	
		–	160	–	.281	1.338		4.20	1.406	4.86	.608	.073	.5078	
		XXS	–	–	.400	1.100		3.46	.950	6.41	.420	.049	.5977	
		–	–	5S	.065	2.245		7.05	3.958	1.61	1.72	.206	.2652	
		–	–	10S	.109	2.157		6.78	3.654	2.64	1.58	.190	.4204	
2	2.375	STD	40	40S	.154	2.067	7.46	6.49	3.355	3.65	1.45	.174	.5606	2
		XS	80	80S	.218	1.939		6.09	2.953	5.02	1.28	.153	.7309	
		–	160	–	.344	1.687		5.30	2.241	7.46	.97	.116	.9790	
		XXS	–	–	.436	1.503		4.72	1.774	9.03	.77	.092	1.1040	
		–	–	5S	.083	2.709		8.51	5.764	2.48	2.50	.299	.4939	
		–	–	10S	.120	2.635		8.28	5.453	3.53	2.36	.283	.6868	
2 1/2	2.875	STD	40	40S	.203	2.469	9.03	7.76	4.788	5.79	2.07	.249	1.064	2 1/2
		XS	80	80S	.276	2.323		7.30	4.238	7.66	1.87	.220	1.339	
		–	160	–	.375	2.125		6.68	3.546	10.01	1.54	.184	1.638	
		XXS	–	–	.552	1.771		5.56	2.464	13.69	1.07	.128	1.997	
		–	–	5S	.083	3.334		10.47	8.730	3.03	3.78	.454	.744	
		–	–	10S	.120	3.260		10.24	8.347	4.33	3.62	.434	1.041	
3	3.500	STD	40	40S	.216	3.068	11.00	9.64	7.393	7.58	3.20	.384	1.724	3
		XS	80	80S	.300	2.900		9.11	6.605	10.25	2.86	.343	2.225	
		–	160	–	.438	2.624		8.24	5.408	14.32	2.35	.281	2.876	
		XXS	–	–	.600	2.300		7.23	4.155	18.58	1.80	.216	3.424	
		–	–	5S	.083	4.334		13.62	14.75	3.92	6.39	.766	1.249	
		–	–	10S	.120	4.260		13.38	14.25	5.61	6.18	.740	1.761	
		STD	40	40S	.237	4.026		12.65	12.73	10.79	5.50	.661	3.214	
4	4.500	XS	80	80S	.337	3.826	14.14	12.02	11.50	14.98	4.98	.597	4.271	4
		–	120	–	.438	3.624		11.39	10.31	19.00	4.47	.536	5.178	
		–	160	–	.531	3.438		10.80	9.28	22.51	4.02	.482	5.898	
		XXS	–	–	.674	3.152		9.90	7.80	27.54	3.38	.405	6.791	
		–	–	5S	.109	5.345		16.79	22.44	6.36	9.72	1.17	2.498	
		–	–	10S	.134	5.295		16.63	22.02	7.77	9.54	1.14	3.029	
		STD	40	40S	.258	5.047		15.86	20.01	14.62	8.67	1.04	5.451	
5	5.563	XS	80	80S	.375	4.813	17.48	15.12	18.19	20.78	7.88	.945	7.431	5
		–	120	–	.500	4.563		14.34	16.35	27.04	7.09	.849	9.250	
		–	160	–	.625	4.313		13.55	14.61	32.96	6.33	.759	10.796	
		XXS	–	–	.750	4.063		12.76	12.97	38.55	5.61	.674	12.090	

PIPE DATA TABLE *(continued)*

Pipe Size (in.)	Outside Diameter (in.)	Weight Class	Carbon Steel Schedule	Stainless Steel Schedule	Wall Thickness (in.)	Inside Diameter (in.)	Circum. (Ext.) (in.)	Circum. (Ext.) (in.)	Flow Area (sq. in.)	Weight of Pipe (lbs/Ft.)	Weight of Water (lbs/Ft.)	Gallons of Water per Ft.	Section Modulus	Pipe Size (in.)
6	6.625	–	–	5S	.109	6.407	20.81	20.13	32.24	7.60	13.97	1.68	3.576	6
		–	–	10S	.134	6.357		19.97	31.74	9.29	13.75	1.65	4.346	
		STD	40	40S	.280	6.065		19.05	28.89	18.97	12.51	1.50	8.496	
		XS	80	80S	.432	5.761		18.10	26.07	28.57	11.29	1.35	12.22	
		–	120	–	.562	5.501		17.28	23.77	36.39	10.30	1.24	14.98	
		–	160	–	.719	5.187		16.30	21.15	45.35	9.16	1.10	17.81	
		XXS	–	–	.864	4.897		15.38	18.84	53.16	8.16	.978	20.02	
8	8.625	–	–	5S	.109	8.407	27.10	26.41	55.51	9.93	24.06	2.88	6.131	8
		–	–	10S	.148	8.329		26.17	54.48	13.40	23.61	2.83	8.212	
		–	20	–	.250	8.125		25.53	51.85	22.36	22.47	2.69	13.39	
		–	30	–	.277	8.071		25.36	51.16	24.70	22.17	2.66	14.69	
		STD	40	40S	.322	7.981		25.07	50.03	28.55	21.70	2.60	16.81	
		–	60	–	.406	7.813		24.55	47.94	35.64	20.77	2.49	20.58	
		XS	80	80S	.500	7.625		23.95	45.66	43.39	19.78	2.37	24.51	
		–	100	–	.594	7.437		23.36	43.46	50.95	18.83	2.26	28.14	
		–	120	–	.719	7.187		22.58	40.59	60.71	17.59	2.11	32.58	
		–	140	–	.812	7.001		21.99	38.50	67.76	16.68	2.00	35.65	
		XXS	–	–	.875	6.875		21.60	37.12	72.42	16.10	1.93	37.56	
		–	160	–	.906	6.813		21.40	36.46	74.69	15.80	1.89	38.48	
10	10.750	–	–	5S	.134	10.482	33.77	32.93	86.29	15.19	37.39	4.48	11.71	10
		–	–	10S	.165	10.420		32.74	85.28	18.65	36.95	4.43	14.30	
		–	20	–	.250	10.250		32.20	82.52	28.04	35.76	4.29	21.15	
		–	30	–	.307	10.136		31.84	80.69	34.24	34.96	4.19	25.57	
		STD	40	40S	.365	10.020		31.48	78.86	40.48	34.20	4.10	29.90	
		XS	60	80S	.500	9.750		30.63	74.66	54.74	32.35	3.88	39.43	
		–	80	–	.594	9.562		30.04	71.84	64.43	31.13	3.73	45.54	
		–	100	–	.719	9.312		29.25	68.13	77.03	29.53	3.54	53.22	
		–	120	–	.844	9.062		28.47	64.53	89.29	27.96	3.35	60.32	
		XXS	140	–	1.000	8.750		27.49	60.13	104.13	26.06	3.12	68.43	
		–	160	–	1.125	8.500		26.70	56.75	115.64	24.59	2.95	74.29	
12	12.750	–	–	5S	.156	12.438	40.06	39.08	121.50	20.98	52.65	6.31	19.2	12
		–	–	10S	.180	12.390		38.92	120.57	24.17	52.25	6.26	22.0	
		–	20	–	.250	12.250		38.48	117.86	33.38	51.07	6.12	30.2	
		–	30	–	.330	12.090		37.98	114.80	43.77	49.74	5.96	39.0	
		STD	–	40S	.375	12.000		37.70	113.10	49.56	49.00	5.88	43.8	
		–	40	–	.406	11.938		37.50	111.93	53.52	48.50	5.81	47.1	
		XS	–	80S	.500	11.750		36.91	108.43	65.42	46.92	5.63	56.7	
		–	60	–	.562	11.626		36.52	106.16	73.15	46.00	5.51	62.8	
		–	80	–	.688	11.374		35.73	101.64	88.63	44.04	5.28	74.6	
		–	100	–	.844	11.062		34.75	96.14	107.32	41.66	4.99	88.1	
		XXS	120	–	1.000	10.750		33.77	90.76	125.49	39.33	4.71	100.7	
		–	140	–	1.125	10.500		32.99	86.59	139.67	37.52	4.50	109.9	
		–	160	–	1.312	10.126		31.81	80.53	160.27	34.89	4.18	122.6	
14	14.000	–	–	5S	.156	13.688	43.98	43.00	147.15	23.07	63.77	7.64	23.2	14
		–	–	10S	.188	13.624		42.80	145.78	27.73	63.17	7.57	27.8	
		–	10	–	.250	13.500		42.41	143.14	36.71	62.03	7.44	36.6	
		–	20	–	.312	13.376		42.02	140.52	45.61	60.89	7.30	45.0	
		STD	30	–	.375	13.250		41.63	137.88	54.57	59.75	7.16	53.2	
		–	40	–	.438	13.124		41.23	135.28	63.44	58.64	7.03	61.3	
		XS	–	–	.500	13.000		40.84	132.73	72.09	57.46	6.90	69.1	
		–	60	–	.594	12.812		40.25	128.96	85.05	55.86	6.70	80.3	
		–	80	–	.750	12.500		39.27	122.72	106.13	53.18	6.37	98.2	
		–	100	–	.938	12.124		38.09	115.49	130.85	50.04	6.00	117.8	
		–	120	–	1.094	11.812		37.11	109.62	150.79	47.45	5.69	132.8	
		–	140	–	1.250	11.500		36.13	103.87	170.28	45.01	5.40	146.8	
		–	160	–	1.406	11.188		35.15	98.31	189.11	42.60	5.11	159.6	
16	16.00	–	–	5S	.165	15.670	50.27	49.23	192.85	27.90	83.57	10.02	32.2	16
		–	–	10S	.188	15.624		49.08	191.72	31.75	83.08	9.96	36.5	
		–	10	–	.250	15.500		48.69	188.69	42.05	81.74	9.80	48.0	
		–	20	–	.312	15.376		48.31	185.69	52.27	80.50	9.65	59.2	
		STD	30	–	.375	15.250		47.91	182.65	82.58	79.12	9.49	70.3	
		XS	40	–	.500	15.000		47.12	176.72	82.77	76.58	9.18	91.5	
		–	60	–	.656	14.688		46.14	169.44	107.50	73.42	8.80	116.6	
		–	80	–	.844	14.312		44.96	160.92	136.61	69.73	8.36	144.5	
		–	100	–	1.031	13.938		43.79	152.58	164.82	66.12	7.93	170.5	
		–	120	–	1.219	13.562		42.61	144.50	192.43	62.62	7.50	194.5	
		–	140	–	1.438	13.124		41.23	135.28	233.64	58.64	7.03	220.0	
		–	160	–	1.594	12.812		40.26	128.96	245.25	55.83	6.70	236.7	

PIPE DATA TABLE *(continued)*

Pipe Size (in.)	Outside Diameter (in.)	Weight Class	Carbon Steel Schedule	Stainless Steel Schedule	Wall Thickness (in.)	Inside Diameter (in.)	Circum. (Ext.) (in.)	Circum. (Ext.) (in.)	Flow Area (sq. in.)	Weight of Pipe (lbs/Ft.)	Weight of Water (lbs/Ft.)	Gallons of Water per Ft.	Section Modulus	Pipe Size (in.)
18	18.00	–	–	5S	.165	17.67	56.55	55.51	245.22	31.43	106.26	12.74	40.8	18
		–	–	10S	.188	17.62		55.37	243.95	35.76	105.71	12.67	46.4	
		–	10	–	.250	17.50		54.98	240.53	47.39	104.21	12.49	61.1	
		–	20	–	.312	17.38		54.59	237.13	58.94	102.77	12.32	75.5	
		STD	–	–	.375	17.25		54.19	233.71	70.59	101.18	12.14	89.6	
		–	30	–	.438	17.12		53.80	230.30	82.15	99.84	11.96	103.4	
		XS	–	–	.500	17.00		53.41	226.98	93.45	98.27	11.79	117.0	
		–	40	–	.562	16.88		53.02	223.68	104.87	96.93	11.62	130.1	
		–	60	–	.750	16.50		51.84	213.83	138.17	92.57	11.11	168.3	
		–	80	–	.938	16.12		50.66	204.24	170.92	88.50	10.61	203.8	
		–	100	–	1.156	15.69		49.29	193.30	207.96	83.76	10.04	242.3	
		–	120	–	1.375	15.25		47.91	182.66	244.14	79.07	9.49	277.6	
		–	140	–	1.562	14.88		46.73	173.80	274.22	75.32	9.03	305.5	
		–	160	–	1.781	14.44		45.36	163.72	308.50	70.88	8.50	335.6	
20	20.00	–	–	5S	.188	19.62	62.83	61.65	302.46	39.78	131.06	15.71	57.4	20
		–	–	10S	.218	19.56		61.46	300.61	46.06	130.27	15.62	66.3	
		–	10	–	.250	19.50		61.26	298.65	52.73	129.42	15.51	75.6	
		–	20	–	.375	19.25		60.48	290.04	78.60	125.67	15.12	111.3	
		STD	30	–	.500	19.00		59.69	283.53	104.13	122.87	14.73	145.7	
		XS	40	–	.594	18.81		59.10	278.00	123.11	120.46	14.44	170.4	
		–	60	–	.812	18.38		57.73	265.21	166.40	114.92	13.78	225.7	
		–	80	–	1.031	17.94		56.35	252.72	208.87	109.51	13.13	277.1	
		–	100	–	1.281	17.44		54.78	238.83	256.10	103.39	12.41	331.5	
		–	120	–	1.500	17.00		53.41	226.98	296.37	98.35	11.79	375.5	
		–	140	–	1.750	16.50		51.84	213.82	341.09	92.66	11.11	421.7	
		–	160	–	1.969	16.06		50.46	202.67	379.17	87.74	10.53	458.5	
22	22.00	–	–	5S	.188	21.62	69.12	67.93	367.25	43.80	159.14	19.08	69.7	22
		–	–	10S	.218	21.56		67.75	365.21	50.71	158.26	18.97	80.4	
		–	10	–	.250	21.50		67.54	363.05	58.07	157.32	18.86	91.8	
		STD	20	–	.375	21.25		66.76	354.66	86.61	153.68	18.42	135.4	
		XS	30	–	.500	21.00		65.97	346.36	114.81	150.09	17.99	177.5	
		–	60	–	.875	20.25		63.62	322.06	197.41	139.56	16.73	295.0	
		–	80	–	1.125	19.75		62.05	306.35	250.81	132.76	15.91	366.4	
		–	100	–	1.375	19.25		60.48	291.04	302.88	126.12	15.12	432.6	
		–	120	–	1.625	18.75		58.90	276.12	353.61	119.65	14.34	493.8	
		–	140	–	1.875	18.25		57.33	261.59	403.00	113.36	13.59	550.3	
		–	160	–	2.125	17.75		55.76	247.45	451.06	107.23	12.85	602.4	
24	24.00	–	–	5S	.218	23.56	75.40	74.03	436.10	55	188.98	22.65	96.0	24
		–	10	10S	.250	23.50		73.83	433.74	63	187.95	22.53	109.6	
		STD	20	–	.375	23.25		73.04	424.56	95	183.95	22.05	161.9	
		XS	–	–	.500	23.00		72.26	415.48	125	179.87	21.58	212.5	
		–	30	–	.562	22.88		71.86	411.00	141	178.09	21.35	237.0	
		–	40	–	.688	22.62		71.08	402.07	171	174.23	20.88	285.1	
		–	60	–	.969	22.06		69.31	382.35	238	165.52	19.86	387.7	
		–	80	–	1.219	21.56		67.74	365.22	297	158.26	18.97	472.8	
		–	100	–	1.531	20.94		65.78	344.32	367	149.06	17.89	570.8	
		–	120	–	1.812	20.38		64.01	326.08	430	141.17	16.94	652.1	
		–	140	–	2.062	19.88		62.44	310.28	483	134.45	16.12	718.9	
		–	160	–	2.344	19.31		60.67	292.98	542	126.84	15.22	787.9	
30	30.00	–	–	5S	.250	29.50	94.25	92.68	683.49	79	296.18	35.51	172.3	30
		–	10	10S	.312	29.38		92.29	677.71	99	293.70	35.21	213.8	
		STD	–	–	.375	29.25		91.89	671.96	119	291.18	34.91	255.3	
		XS	20	–	.500	29.00		91.11	660.52	158	286.22	34.31	336.1	
		–	30	–	.625	28.75		90.32	649.18	196	281.31	33.72	414.9	

ENGINEERING

MAXIMUM ALLOWABLE WORKING PRESSURES (PSIG) FOR SEAMLESS CARBON STEEL PIPE

Nominal	Maximum allowable working pressure at -20 to 650 °F ▲												
Pipe Size (in.)	SCH 10	SCH 20	SCH 30	STD WALL	SCH 40	SCH 60	XH	SCH 80	SCH 100	SCH 120	SCH 140	SCH 160	XXH
1/2	-	-	-	1694	1694	-	3036	3036	-	-	-	4551	9223
3/4	659	-	-	1450	1450	-	2589	2589	-	-	-	4505	7531
1	1065	-	-	1578	1578	-	2601	2601	-	-	-	4290	7150
1 1/4	556	-	-	1069	1069	-	1941	1941	-	-	-	3001	5593
1 1/2	486	-	-	1004	1004	-	1821	1821	-	-	-	3091	5114
2	388	-	-	903	903	-	1659	1659	-	-	-	3225	4475
2 1/2	431	-	-	1214	1214	-	1936	1936	-	-	-	2963	4936
3	346	-	-	1094	1094	-	1773	1773	-	-	-	2933	4405
3 1/2	303	-	-	1023	1023	-	1671	1671	-	-	-	-	-
4	269	-	-	974	974	-	1598	1598	-	2243	-	2868	3858
5	284	-	-	888	888	-	1475	1475	-	2123	-	2791	3485
6	239	-	-	833	833	-	1473	1473	-	2038	-	2738	3414
8	225	543	628	770	1038	1343	1343	1649	2068	2388	2715	2605	-
10	224	434	578	723	723	1070	1070	1311	1641	1975	2406	2754	-
12	219	366	534	630	696	1033	898	1305	1653	2009	2295	2735	-
14	333	451	573	573	693	999	816	1311	1690	2013	2341	2675	-
16	291	395	500	500	711	980	711	1305	1638	1975	2378	2669	-
18	258	350	538	444	725	1013	631	1303	1648	1998	2303	2665	-
20	233	399	568	399	693	995	568	1299	1653	1970	2338	2663	-
22	211	-	-	363	-	-	515	-	-	-	-	-	-
24	194	331	541	331	683	1004	471	1295	1664	2003	2309	2656	-
26	-	-	-	306	-	-	435	-	-	-	-	-	-
30	209	376	488	265	-	-	376	-	-	-	-	-	-
36	-	-	-	220	-	-	314	-	-	-	-	-	-
42	-	-	-	189	-	-	269	-	-	-	-	-	-

▲ For allowable working pressures at higher temperatures, multiply values listed above by the following factors:

Grade A

Temperature	700 °F	750 °F	800 °F	850 °F	900 °F
Multiply by	0.971	0.892	0.750	0.708	0.417

Grade B

Temperature	700 °F	750 °F	800 °F	850 °F	900 °F
Multiply by	0.956	0.853	0.720	0.620	0.333

ENGINEERING

PIPE, FITTING & FLANGE SPECIFICATIONS

FLANGE STANDARDS – Dimensional Data in inches

125 lb. CAST IRON — ANSI STANDARD B16.1

PIPE SIZE	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
Diameter of Flange	–	–	4 1/4	4 5/8	5	6	7	7 1/2	8 1/2	9	10	11	13 1/2	16	19
Thickness of Flange (min)[a]	–	–	7/16	1/2	9/16	5/8	11/16	3/4	13/16	15/16	15/16	1	1 1/8	1 3/16	1 1/4
Diameter of Bolt Circle	–	–	3 1/8	3 1/2	3 7/8	4 3/4	5 1/2	6	7	7 1/2	8 1/2	9 1/2	11 3/4	14 1/4	17
Number of Bolts	–	–	4	4	4	4	4	4	8	8	8	8	8	12	12
Diameter of Bolts	–	–	1/2	1/2	1/2	5/8	5/8	5/8	5/8	5/8	3/4	3/4	3/4	7/8	7/8

[a] 125 lb. Cast Iron Flanges have plain faces (i.e. not raised faces).

250 lb. CAST IRON — ANSI STANDARD B16.1

PIPE SIZE	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
Diameter of Flange	–	–	4 7/8	5 1/4	6 1/8	6 1/2	7 1/2	8 1/4	9	10	11	12 1/2	15	17 1/2	20 1/2
Thickness of Flange (min)[b]	–	–	11/16	3/4	13/16	7/8	1	1 1/8	1 3/16	1 1/4	1 3/8	1 7/16	1 5/8	1 7/8	2
Diameter of Raised Face	–	–	2 11/16	3 1/16	3 9/16	4 3/16	4 15/16	5 11/16	6 5/16	6 15/16	8 5/16	9 11/16	11 15/16	14 1/16	16 7/16
Diameter of Bolt Circle	–	–	3 1/2	3 7/8	4 1/2	5	5 7/8	6 5/8	7 1/4	7 7/8	9 1/4	10 5/8	13	15 1/4	17 3/4
Number of Bolts	–	–	4	4	4	8	8	8	8	8	8	12	12	16	16
Diameter of Bolts	–	–	5/8	5/8	3/4	5/8	3/4	3/4	3/4	3/4	3/4	3/4	7/8	1	1 1/8

[b] 250 lb. Cast Iron Flanges have a 1/16" raised face which is included in the flange thickness dimensions.

150 lb. BRONZE — ANSI STANDARD B16.24

PIPE SIZE	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
Diameter of Flange	3 1/2	3 7/8	4 1/4	4 5/8	5	6	7	7 1/2	8 1/2	9	10	11	13 1/2	16	19
Thickness of Flange (min)[c]	5/16	11/32	3/8	13/32	7/16	1/2	9/16	5/8	11/16	11/16	3/4	13/16	15/16	1	1 1/16
Diameter of Bolt Circle	2 3/8	2 3/4	3 1/8	3 1/2	3 7/8	4 3/4	5 1/2	6	7	7 1/2	8 1/2	9 1/2	11 3/4	14 1/4	17
Number of Bolts	4	4	4	4	4	4	4	4	8	8	8	8	8	12	12
Diameter of Bolts	1/2	1/2	1/2	1/2	1/2	5/8	5/8	5/8	5/8	5/8	3/4	3/4	3/4	7/8	7/8

[c] 150 lb. Bronze Flanges have plain faces (i.e. not raised faces) with two concentric gasket-retaining grooves between the port and the bolt holes.

300 lb. BRONZE — ANSI STANDARD B16.24

PIPE SIZE	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
Diameter of Flange	3 3/4	4 5/8	4 7/8	5 1/4	6 1/2	6 1/2	7 1/2	8 1/4	9	10	11	12 1/2	15	–	–
Thickness of Flange (min)[d]	1/2	17/32	19/32	5/8	11/16	3/4	13/16	29/32	31/32	1 1/16	1 1/8	1 3/16	1 3/8	–	–
Diameter of Bolt Circle	2 5/8	3 1/4	3 1/2	3 7/8	4 1/2	5	5 7/8	6 5/8	7 1/4	7 7/8	9 1/4	10 5/8	13	–	–
Number of Bolts	4	4	4	4	4	8	8	8	8	8	8	12	12	–	–
Diameter of Bolts	1/2	5/8	5/8	5/8	3/4	5/8	3/4	3/4	3/4	3/4	3/4	3/4	7/8	–	–

[d] 300 lb. Bronze Flanges have plain faces (i.e. not raised faces) with two concentric gasket-retaining grooves between the port and the bolt holes.

FLANGE STANDARDS – Dimensional Data in inches (continued)

150 lb. STEEL — ANSI STANDARD B16.5

PIPE SIZE	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
Diameter of Flange	–	–	4	4 5/8	5	6	7	7 1/2	8 1/2	9	10	11	13 1/2	16	19
Thickness of Flange (min)[e]	–	–	7/16	1/2	9/16	5/8	11/16	3/4	13/16	15/16	15/16	1	1 1/8	1 3/16	1 1/4
Diameter of Raised Face	–	–	2	2 1/2	2 7/8	3 5/8	4 1/8	5	5 1/2	6 3/16	7 5/16	8 1/2	10 5/8	12 3/4	15
Diameter of Bolt Circle	–	–	3 1/8	3 1/2	3 7/8	4 3/4	5 1/2	6	7	7 1/2	8 1/2	9 1/2	11 3/4	14 1/4	17
Number of Bolts	–	–	4	4	4	4	4	4	8	8	8	8	8	12	12
Diameter of Bolts	–	–	1/2	1/2	1/2	5/8	5/8	5/8	5/8	5/8	3/4	3/4	3/4	7/8	7/8

[e] 150 lb. Steel Flanges have a 1/16" raised face which is included in the flange thickness dimensions.

300 lb. STEEL — ANSI STANDARD B16.5

PIPE SIZE	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
Diameter of Flange	–	–	4 7/8	5 1/4	6 1/8	6 1/2	7 1/2	8 1/4	9	10	11	12 1/2	15	17 1/2	20 1/2
Thickness of Flange (min)[f]	–	–	11/16	3/4	13/16	7/8	1	1 1/8	1 3/16	1 1/4	1 3/8	1 7/16	1 5/8	1 7/8	2
Diameter of Raised Face	–	–	2	2 1/2	2 7/8	3 5/8	4 1/8	5	5 1/2	6 3/16	7 5/16	8 1/2	10 5/8	12 3/4	15
Diameter of Bolt Circle	–	–	3 1/2	3 7/8	4 1/2	5	5 7/8	6 5/8	7 1/4	7 7/8	9 1/4	10 5/8	13	15 1/4	17 3/4
Number of Bolts	–	–	4	4	4	8	8	8	8	8	8	12	12	16	16
Diameter of Bolts	–	–	5/8	3/4	5/8	3/4	3/4	3/4	3/4	3/4	3/4	3/4	7/8	1	1 1/8

[f] 300 lb. Steel Flanges have a 1/16" raised face which is included in the flange thickness dimensions.

400 lb. STEEL — ANSI STANDARD B16.5

PIPE SIZE	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
Diameter of Flange	3 3/4	4 5/8	4 7/8	5 1/4	6 1/8	6 1/2	7 1/2	8 1/4	9	10	11	12 1/2	15	17 1/2	20 1/2
Thickness of Flange (min)[g]	9/16	5/8	11/16	13/16	7/8	1	1 1/8	1 1/4	1 3/8	1 3/8	1 1/2	1 5/8	1 7/8	2 1/8	2 1/4
Diameter of Raised Face	1 3/8	1 11/16	2	2 1/2	2 7/8	3 5/8	4 1/8	5	5 1/2	6 3/16	7 5/16	8 1/2	10 5/8	12 3/4	15
Diameter of Bolt Circle	2 5/8	3 1/4	3 1/2	3 7/8	4 1/2	5	5 7/8	6 5/8	7 1/4	7 7/8	9 1/4	10 5/8	13	15 1/4	17 3/4
Number of Bolts	4	4	4	4	4	8	8	8	8	8	8	12	12	16	16
Diameter of Bolts	1/2	5/8	5/8	5/8	3/4	5/8	3/4	3/4	7/8	7/8	7/8	7/8	1	1 1/8	1 1/4

[g] 400 lb. Steel Flanges have a 1/4" raised face which is included in the flange thickness dimensions.

600 lb. STEEL — ANSI STANDARD B16.5

PIPE SIZE	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
Diameter of Flange	3 3/4	4 5/8	4 7/8	5 1/4	6 1/8	6 1/2	7 1/2	8 1/4	9	10 3/4	13	14	16 1/2	20	22
Thickness of Flange (min)[h]	9/16	5/8	11/16	13/16	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 3/4	1 7/8	2 3/16	2 1/2	2 5/8
Diameter of Raised Face	1 3/8	1 11/16	2	2 1/2	2 7/8	3 5/8	4 1/8	5	5 1/2	6 3/16	7 5/16	8 1/2	10 5/8	12 3/4	15
Diameter of Bolt Circle	2 5/8	3 1/4	3 1/2	3 7/8	4 1/2	5	5 7/8	6 5/8	7 1/4 8 1/2	10 1/2	11 1/2	13 3/4	17	19 1/4	
Number of Bolts	4	4	4	4	4	8	8	8	8	8	8	12	12	16	20
Diameter of Bolts	1/2	5/8	5/8	5/8	3/4	5/8	3/4	3/4	7/8	7/8	1	1	1 1/8	1 1/4	1 1/4

[h] 600 lb. Steel Flanges have a 1/4" raised face which is included in the flange thickness dimensions.

ENGINEERING

PIPE FITTING & FLANGE SPECIFICATIONS

FITTING STANDARDS & SPECIFICATIONS

Class or Material	Dimensions	Material Spec.	Galvanizing	Thread	Pressure Rating	Federal/Other
Malleable Iron Fittings						
Class 150/PN 20	ASME B16.3•	ASTM A-197	ASTM A-153	ASME B120.1+	ASME B16.3•	ASME B16.3**
Class 300/PN 50	ASME B16.3•	ASTM A-197	ASTM A-153	ASME B120.1+	ASME B16.3•	
Malleable Iron Unions						
Class 150/PN 20	ASME B16.39•	ASTM A-197	ASTM A-153	ASME B120.1+	ASME B16.39•	ASME B16.39***
Class 250	ASME B16.39•	ASTM A-197	ASTM A-153	ASME B120.1+	ASME B16.39•	
Class 300/PN 50	ASME B16.39•	ASTM A-197	ASTM A-153	ASME B120.1+	ASME B16.39•	
Cast Iron Threaded Fittings						
Class 125	ASME B16.4•	ASTM A-126 (A)	ASTM A-153	ASME B120.1+	ASME B16.4•	ASME B16.4u
Class 250	ASME B16.4•	ASTM A-126 (A)	ASTM A-153	ASME B120.1+	ASME B16.4•	ASME B16.4u
Cast Iron Plugs & Bushings						
	ASME B16.14•	ASTM A-126 (A)	ASTM A-153	ASME B120.1+	ASME B16.14•	WW-P-471
Cast Iron Drainage Threaded Fittings						
	ASME B16.12•	ASTM A-126 (A)	ASTM A-153	ASME B120.1+	ASME B16.12•	
Cast Iron Flanges & Flanged Fittings						
Class 125 (1”-12”)	ASME B16.1•	ASTM A-126 (A) or (B)	ASTM A-153	ASME B120.1+	ASME B16.1•	ASME B16.1•
Class 125 (14” & up)	ASME B16.1•	ASTM A-126 (B)	ASTM A-153	ASME B120.1+	ASME B16.1•	ASME B16.1•
Class 250 (1”-12”)	ASME B16.1•	ASTM A-126 (A) or (B)	ASTM A-153	ASME B120.1+	ASME B16.1•	ASME B16.1•
Class 250 (14” & up)	ASME B16.1•	ASTM A-126 (B)	ASTM A-153	ASME B120.1+	ASME B16.1•	ASME B16.1•
Forged Steel Threaded Fittings						
Class 2000, 3000, 6000	ASME B16.11•	ASTM A105, ASTM A182, ASTM A350		ASME B120.1+	ASME B16.11•	
Pipe Nipples						
Steel Pipe - welded	ASTM A733	ASTM A53 Type F or Type E		ASME B120.1+		WWN 351
Steel Pipe - seamless (High Temperature)	ASTM A733	ASTM A106 Gr.B		ASME B120.1+		WWN 351
Brass		ASTM B43		ASME B120.1+		WWN 351

• an American National standard (ANSI)
+ ASME B120.1 was ANSI B2.1
u Formerly WW-P-501
** Formerly WW-P-521
*** Formerly WW-U-531

ENGINEERING

STANDARD CLASS PRESSURE-TEMPERATURE RATINGS ANSI/ASME B16.34

Working Pressure by Classes	Temperature (°F)	A 216 WCB (a)	A 352 LCB (d)	A 216 WCC (a) A 352 LC2 (d) A 352 LC3 (d) A 352 LCC (e)	A 217 WC1 (b) A 352 LC1 (d)	A 217 WC4 (h) A 217 WC5 (i)	A 217 WC6 (j)	A 217 WC9 (j)	A 217 C5	A 217 C12	A 351 CF3 (f) A 351 CF8	A 351 CF3M (g) A 351 CF8M	A 351 CF8C	A 351 CN7M (l)
		Working Pressure in PSI												
150 LB.	-20 to 100	285	265	290	265	290	290	290	290	290	275	275	275	230
	200	260	250	260	260	260	260	260	260	260	235	240	245	215
	300	230	230	230	230	230	230	230	230	230	205	215	225	200
	400	200	200	200	200	200	200	200	200	200	180	195	200	185
	500	170	170	170	170	170	170	170	170	170	170	170	170	170
	600	140	140	140	140	140	140	140	140	140	140	140	140	140
	650	125	125	125	125	125	125	125	125	125	125	125	125	125
	700	110	110	110	110	110	110	110	110	110	110	110	110	110
	750	95	95	95	95	95	95	95	95	95	95	95	95	95
	800	80	80	80	80	80	80	80	80	80	80	80	80	80
	850	65	65	65	65	65	65	65	65	65	65	65	65	–
	900	50	50	50	50	50	50	50	50	50	50	50	50	–
	950	35	35	35	35	35	35	35	35	35	35	35	35	–
	1000	20	20	20	20	20	20	20	20	20	20	20	20	–
	1050	–	–	–	–	20(1)	20(1)	20(1)	20(1)	20(1)	20(1)	20(1)	20(1)	–
	1100	–	–	–	–	–	20(1)	20(1)	20(1)	20(1)	20(1)	20(1)	20(1)	–
	1150	–	–	–	–	–	20(1)	20(1)	20(1)	20(1)	20(1)	20(1)	20(1)	–
	1200	–	–	–	–	–	15(1)	20(1)	20(1)	20(1)	20(1)	20(1)	20(1)	–
	1250	–	–	–	–	–	–	–	–	–	20(1)	20(1)	20(1)	–
	1300	–	–	–	–	–	–	–	–	–	20(1)	20(1)	20(1)	–
	1350	–	–	–	–	–	–	–	–	–	20(1)	20(1)	20(1)	–
	1400	–	–	–	–	–	–	–	–	–	20(1)	20(1)	20(1)	–
	1450	–	–	–	–	–	–	–	–	–	15(1)	20(1)	20(1)	–
	1500	–	–	–	–	–	–	–	–	–	10(1)	15(1)	15(1)	–
300 LB.	-20 to 100	740	695	750	695	750	750	750	750	750	720	720	720	600
	200	675	655	750	680	750	710	715	750	750	600	620	635	555
	300	655	640	730	655	730	675	675	730	730	530	560	590	525
	400	635	620	705	640	705	660	650	705	705	470	515	555	480
	500	600	585	665	620	665	640	640	665	665	435	480	520	470
	600	550	535	605	605	605	605	605	605	605	415	450	490	455
	650	535	525	590	590	590	590	590	590	590	410	445	480	450
	700	535	520	570	570	570	570	570	570	570	405	430	470	445
	750	505	475	505	530	530	530	530	530	530	400	425	460	440
	800	410	390	410	510	510	510	510	510	510	395	415	455	430
	850	270	270	270	485	485	485	485	440	485	390	405	445	–
	900	170	170	170	450	450	450	450	355	450	385	395	430	–
	950	105	105	105	280	345	380	380	260	370	375	385	385	–
	1000	50	50	50	165	215	225	270	190	290	325	365	365	–
	1050	–	–	–	–	190	140	200	140	190	310	360	360	–
	1100	–	–	–	–	–	95	115	105	115	260	325	325	–
	1150	–	–	–	–	–	50	105	70	75	195	275	275	–
	1200	–	–	–	–	–	35	55	45	50	155	205	170	–
	1250	–	–	–	–	–	–	–	–	–	110	180	125	–
	1300	–	–	–	–	–	–	–	–	–	85	140	95	–
	1350	–	–	–	–	–	–	–	–	–	60	105	70	–
	1400	–	–	–	–	–	–	–	–	–	50	75	50	–
	1450	–	–	–	–	–	–	–	–	–	35	60	40	–
	1500	–	–	–	–	–	–	–	–	–	25	40	35	–

STANDARD CLASS PRESSURE-TEMPERATURE RATINGS ANSI/ASME B16.34 (continued)

Working Pressure by Classes	Temperature (°F)	A 216 WCB (a)	A 352 LCB (d)	A 216 WCC (a) A 352 LC2 (d) A 352 LC3 (d) A 352 LCC (e)	A 217 WC1 (b) A 352 LC1 (d)	A 217 WC4 (h) A 217 WC5 (i)	A 217 WC6 (j)	A 217 WC9 (j)	A 217 C5	A 217 C12	A 351 CF3 (f) A 351 CF8	A 351 CF3M (g) A 351 CF8M	A 351 CF8C	A 351 CN7M (l)
		Working Pressure in PSI												
400 LB.	-20 to 100	990	925	1000	925	1000	1000	1000	1000	1000	960	960	960	800
	200	900	875	1000	905	1000	950	955	1000	1000	800	825	850	740
	300	875	850	970	870	970	895	905	970	970	705	745	785	700
	400	845	825	940	855	940	880	865	940	940	630	685	740	640
	500	800	775	885	830	885	855	855	885	885	585	635	690	625
	600	730	710	805	805	805	805	805	805	805	555	600	655	605
	650	715	695	785	785	785	785	785	785	785	545	590	640	600
	700	710	690	755	755	755	755	755	755	755	540	575	625	595
	750	670	630	670	710	710	710	710	710	710	530	565	615	585
	800	550	520	550	675	675	675	675	675	675	525	555	610	575
	850	355	355	355	650	650	650	650	585	650	520	540	590	–
	900	230	230	230	600	600	600	600	470	600	510	525	575	–
	950	140	140	140	375	460	505	505	350	495	500	515	515	–
	1000	70	70	70	220	285	300	355	255	390	430	485	485	–
	1050	–	–	–	–	250	185	265	190	250	410	480	480	–
	1100	–	–	–	–	–	130	150	140	150	345	430	430	–
	1150	–	–	–	–	–	70	140	90	100	260	365	365	–
	1200	–	–	–	–	–	45	75	60	70	205	275	230	–
	1250	–	–	–	–	–	–	–	–	–	145	245	165	–
	1300	–	–	–	–	–	–	–	–	–	110	185	125	–
	1350	–	–	–	–	–	–	–	–	–	85	140	90	–
	1400	–	–	–	–	–	–	–	–	–	65	100	70	–
	1450	–	–	–	–	–	–	–	–	–	45	80	55	–
	1500	–	–	–	–	–	–	–	–	–	30	55	45	–
600 LB.	-20 to 100	1480	1390	1500	1390	1500	1500	1500	1500	1500	1440	1440	1440	1200
	200	1350	1315	1500	1360	1500	1425	1430	1500	1500	1200	1240	1270	1115
	300	1315	1275	1455	1305	1455	1345	1355	1455	1455	1055	1120	1175	1045
	400	1270	1235	1410	1280	1410	1315	1295	1410	1410	940	1030	1110	960
	500	1200	1165	1330	1245	1330	1285	1280	1330	1330	875	955	1035	935
	600	1095	1065	1210	1210	1210	1210	1210	1210	1210	830	905	985	910
	650	1075	1045	1175	1175	1175	1175	1175	1175	1175	815	890	960	900
	700	1065	1035	1135	1135	1135	1135	1135	1135	1135	805	865	935	890
	750	1010	945	1010	1065	1065	1065	1065	1065	1065	795	845	920	880
	800	825	780	825	1015	1015	1015	1015	1015	1015	790	830	910	865
	850	535	535	535	975	975	975	975	880	975	780	810	890	–
	900	345	345	345	900	900	900	900	705	900	770	790	865	–
	950	205	205	205	560	685	755	755	520	740	750	775	775	–
	1000	105	105	105	330	425	445	535	385	585	645	725	725	–
	1050	–	–	–	–	380	275	400	280	380	620	720	720	–
	1100	–	–	–	–	–	190	225	205	225	515	645	645	–
	1150	–	–	–	–	–	105	205	140	150	390	550	550	–
	1200	–	–	–	–	–	70	110	90	105	310	410	345	–
	1250	–	–	–	–	–	–	–	–	–	220	365	245	–
	1300	–	–	–	–	–	–	–	–	–	165	275	185	–
	1350	–	–	–	–	–	–	–	–	–	125	205	135	–
	1400	–	–	–	–	–	–	–	–	–	95	150	105	–
	1450	–	–	–	–	–	–	–	–	–	70	115	80	–
	1500	–	–	–	–	–	–	–	–	–	50	85	70	–

STANDARD CLASS PRESSURE-TEMPERATURE RATINGS ANSI/ASME B16.34 (continued)

Working Pressure by Classes	Temperature (°F)	A 216 WCB (a)	A 352 LCB (d)	A 216 WCC (a) A 352 LC2 (d) A 352 LC3 (d) A 352 LCC (e)	A 217 WC1 (b) A 352 LC1 (d)	A 217 WC4 (h) A 217 WC5 (i)	A 217 WC6 (j)	A 217 WC9 (j)	A 217 C5	A 217 C12	A 351 CF3 (f) A 351 CF8	A 351 CF3M (g) A 351 CF8M	A 351 CF8C	A 351 CN7M (l)
		Working Pressure in PSI												
900 LB.	-20 to 100	2220	2085	2250	2085	2250	2250	2250	2250	2250	2160	2160	2160	1800
	200	2025	1970	2250	2035	2250	2135	2150	2250	2250	1800	1860	1910	1670
	300	1970	1915	2185	1955	2185	2020	2030	2185	2185	1585	1680	1765	1570
	400	1900	1850	2115	1920	2115	1975	1945	2115	2115	1410	1540	1665	1445
	500	1795	1745	1995	1865	1995	1925	1920	1995	1995	1310	1435	1555	1405
	600	1640	1600	1815	1815	1815	1815	1815	1815	1815	1245	1355	1475	1365
	650	1610	1570	1765	1765	1765	1765	1765	1765	1765	1225	1330	1440	1350
	700	1600	1555	1705	1705	1705	1705	1705	1705	1705	1210	1295	1405	1335
	750	1510	1420	1510	1595	1595	1595	1595	1595	1595	1195	1270	1385	1320
	800	1235	1175	1235	1525	1525	1525	1525	1490	1525	1180	1245	1370	1295
	850	805	805	805	1460	1460	1460	1460	1315	1460	1165	1215	1330	–
	900	515	515	515	1350	1350	1350	1350	1060	1350	1150	1180	1295	–
	950	310	310	310	845	1030	1130	1130	780	1110	1125	1160	1160	–
	1000	155	155	155	495	640	670	805	575	875	965	1090	1090	–
	1050	–	–	–	–	565	410	595	420	565	925	1080	1080	–
	1100	–	–	–	–	–	290	340	310	340	770	965	965	–
	1150	–	–	–	–	–	155	310	205	225	585	825	825	–
	1200	–	–	–	–	–	105	165	135	155	465	620	515	–
	1250	–	–	–	–	–	–	–	–	–	330	545	370	–
	1300	–	–	–	–	–	–	–	–	–	245	410	280	–
	1350	–	–	–	–	–	–	–	–	–	185	310	205	–
	1400	–	–	–	–	–	–	–	–	–	145	225	155	–
	1450	–	–	–	–	–	–	–	–	–	105	175	125	–
	1500	–	–	–	–	–	–	–	–	–	70	125	105	–
1500 LB.	-20 to 100	3705	3470	3750	3470	3750	3750	3750	3750	3750	3600	3600	3600	3000
	200	3375	3280	3750	3395	3750	3560	3580	3750	3750	3000	3095	3180	2785
	300	3280	3190	3640	3260	3640	3365	3385	3640	3640	2640	2795	2940	2615
	400	3170	3085	3530	3200	3530	3290	3240	3530	3530	2350	2570	2770	2405
	500	2995	2910	3325	3105	3325	3210	3200	3325	3325	2185	2390	2590	2340
	600	2735	2665	3025	3025	3025	3025	3025	3025	3025	2075	2255	2460	2275
	650	2685	2615	2940	2940	2940	2940	2940	2940	2940	2040	2220	2400	2250
	700	2665	2590	2840	2840	2840	2840	2840	2840	2840	2015	2160	2340	2225
	750	2520	2365	2520	2660	2660	2660	2660	2660	2660	1990	2110	2305	2200
	800	2060	1955	2060	2540	2540	2540	2540	2485	2540	1970	2075	2280	2160
	850	1340	1340	1340	2435	2435	2435	2435	2195	2435	1945	2030	2220	–
	900	860	860	860	2245	2245	2245	2245	1765	2245	1920	1970	2160	–
	950	515	515	515	1405	1715	1885	1885	1305	1850	1870	1930	1930	–
	1000	260	260	260	825	1065	1115	1340	960	1460	1610	1820	1820	–
	1050	–	–	–	–	945	684	995	705	945	1545	1800	1800	–
	1100	–	–	–	–	–	480	565	515	565	1285	1610	1610	–
	1150	–	–	–	–	–	260	515	345	380	980	1370	1370	–
	1200	–	–	–	–	–	170	275	225	260	770	1030	855	–
	1250	–	–	–	–	–	–	–	–	–	550	910	615	–
	1300	–	–	–	–	–	–	–	–	–	410	685	465	–
	1350	–	–	–	–	–	–	–	–	–	310	515	345	–
	1400	–	–	–	–	–	–	–	–	–	240	380	255	–
	1450	–	–	–	–	–	–	–	–	–	170	290	205	–
	1500	–	–	–	–	–	–	–	–	–	120	205	170	–

Note: For welding end valves only.
(1) Flanged end ratings terminate at 1000°F.

Footnotes:
a) Permissible, but not recommended for prolonged usage above about 800°F.
b) Permissible, but not recommended for prolonged usage above about 850°F.
d) Not to be used over 650°F.
e) Not to be used over 700°F.
f) Not to be used over 800°F.
g) Not to be used over 850°F.
h) Not to be used over 1000°F.
i) Not to be used over 1050°F.
j) Not to be used over 1100°F.

INTRODUCTION TO STEAM TRAPS

WHAT IS A STEAM TRAP AND WHAT DOES IT DO?

A steam trap is an automatic valve that allows condensate, air and other non-condensable gases to be discharged from the steam system while holding or trapping the steam in the system. Several different types of steam trap technologies exist to accomplish this extremely critical and necessary task.

WHY ARE STEAM TRAPS REQUIRED?

For any steam system to operate properly the condensate, air and other non-condensable gases such as carbon dioxide must be removed from the steam system. This is the purpose of the steam trap.

CONDENSATE:

When steam releases its heat energy, the steam reverts back to water. This occurs in a heat exchanger making hot water, in a radiator heating a room, or in a steam pipe transferring steam. This water, technically referred to as *condensate*, must be removed from the system or the system would back up with water. The removal of condensate from the steam system is considered the primary function of the steam trap.

AIR:

Air exists in all steam pipes prior to system start-up when the system is cold. This air must be bled out of the piping system so that the steam can enter and eventually reach the designated process applications. If the air is not removed, the steam will effectively be blocked from entering the steam pipes by the residual air. In addition to blocking the steam, air acts as an insulator to heat transfer. Even after the system is filled with steam, small amounts of air can re-enter the system thru various paths such as boiler water make-up systems, vacuum breakers and air vents.

NON-CONDENSABLE GASES:

Gases other than air such as carbon dioxide exist inside steam systems. These non-condensable gases must also be separated from the steam and removed from the system for all processes to operate properly. In addition to inhibiting steam flow and proper heat transfer, carbon dioxide can be very corrosive to components in the system.

STEAM TRAP GENERAL APPLICATION CATEGORIES:

DRIP APPLICATIONS:

Drip applications are by far the most common application for steam traps. This application refers to removing the condensate that forms in steam lines when steam loses its heat energy due to radiation losses. Traps used in these applications are referred to as *drip traps*. Generally speaking, traps used for these applications require relatively small condensate capacities and don't normally need to discharge large amounts of air. (Air removal is the primary function of air vents and process traps located throughout the system.) The most common trap choices for drip applications are *thermodynamic* for steam pressures over 30 PSIG, and *float & thermostatic* for pressures up to 30 PSIG. Inverted bucket traps are also commonly used for drip trap applications due to their ability to handle large amounts of dirt and scale often found in this type of application.

PROCESS APPLICATIONS:

Process trap applications refer to removing condensate and air directly from a specific heat transfer process such as a heat exchanger that could be making hot water or a radiator heating a room. Traps used in these applications are referred to as *process traps*. Generally speaking, traps used for process applications require larger condensate handling capability and also need to be able to discharge large amounts of air. The most common trap choices for process applications are *float & thermostatic* traps and *thermostatic* traps. Both are known for their excellent condensate and air handling capabilities. In contrast, thermodynamic traps and inverted bucket traps, which have poor air handling ability, would normally make a poor choice for process applications.

TRACING APPLICATIONS:

Steam tracing refers to using steam to indirectly elevate the temperature of a product using jacketed pipes or tubing filled with steam. A typical application would be wrapping a pipeline containing high viscosity oil with tracing tubing. The steam inside the tubing heats the oil to lower its viscosity, allowing it to flow easily thru the pipeline. Similar to any steam applications, a steam trap must be used on the end of the steam tubing to discharge unwanted condensate. Steam traps used in these applications are referred to as *tracing traps*. The most common trap choice for tracing applications is the *thermostatic* type.

The **Thermodynamic Disc Trap** is simple and compact and an excellent choice for a wide variety of drip applications. They excel in drip applications of pressures ranging from 30 psig to high pressure applications exceeding 3,000 psig, including superheated steam. The ½" TD600L is suitable for most drip applications, and offers reduced size discharge orifice holes which are preferable in terms of performance, longevity, and efficiency.

The design of modern **Thermostatic** Bellows Traps allows these traps to be used on a wide variety of applications, from general service drips to small-to-medium process heating applications with relatively constant loads. The welded stainless steel bellows is extremely rugged which prevents failure from waterhammer and corrosion, making these traps suitable for demanding industrial service. Also, because thermostatic traps subcool condensate, the condensate discharged generates less flash steam which may be advantageous in certain installations. For these reasons, Thermostatic Bellows Traps can be considered as a primary selection or as an alternative to other styles.

The **Float & Thermostatic Trap** is the primary choice of steam trap for process applications. They are excellent at discharging air from the system during start-up and offer a wide range of capacities to accommodate the vast majority of process heating applications. Their design allows them to immediately respond to changing condensate loads and pressures, which is a typical requirement of continuous heating process applications where control valves are used to modulate steam flow. Available F&T models range from designs for low pressure

heating to high-pressure and capacity industrial applications requiring cast steel or stainless steel.

DRIP LEG DESIGN

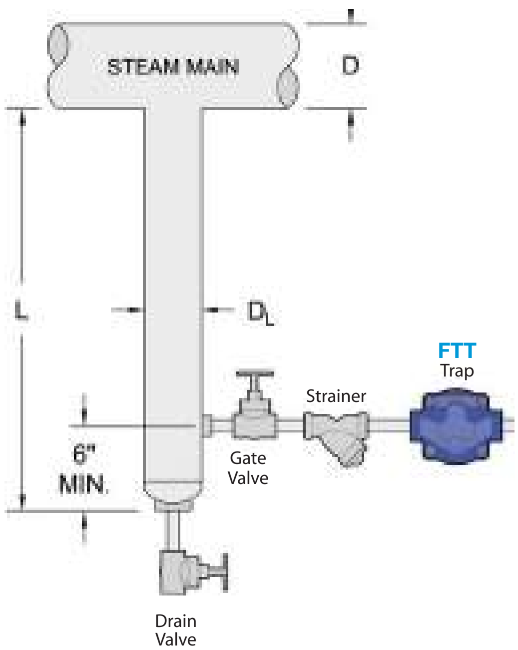
PURPOSE: Drip Legs are used for removing condensate from steam transmission and distribution lines. This helps ensure high quality steam for use in various plant applications and also will prevent damaging and dangerous waterhammer.

OPERATION: As steam travels at high velocity through piping, condensate forms as the result of piping heat losses and/or improper boiler control resulting in condensate carryover. Drip legs are therefore located at points where condensate may accumulate to allow for drainage by gravity down to a steam trap for proper discharge from the system. Since condensate drains by gravity, drip legs must be located on the bottom of piping and designed with diameters large enough to promote collection.

INSTALLATION GUIDELINES: (see Figure 1)

- For drainage of steam transmission and distribution lines, drip legs should be located at bends in piping (direction changes), low points, end of line, and in straight run of piping every 200 feet.
- For protection of equipment such as regulators and control valves, drip legs should be installed directly ahead of the regulating or control valve line.
- Proper steam trap selection for drip applications is dependent upon application requirements, such as pressure, number of and distance between installed steam traps, ambient conditions, start-up requirements, etc. A commonly accepted practice is to use float & thermostatic (F&T) steam traps for low pressure steam systems up to 30 PSIG, and thermodynamic steam traps for steam pressures over 30 PSIG.
- Because condensate drainage from steam systems is dependent upon gravity, drip leg diameter is critical for optimum removal – larger is better. Collection leg diameter (D_L) is recommended to be the same size as the steam main (D), up to 4”. For steam mains above 4”, the collection leg diameter may be half the diameter of the main, but not less than 4”. The length (L) of the drip leg for systems with automatic start-up should be a minimum of 28” to provide approximately 1 PSI head pressure. The length (L) of the drip leg for systems with supervised start-up should be 1.5 x D_L, but not less than 8”.
- Consider low-cracking pressure (1/4 PSI opening pressure) check valves after steam traps when discharging into condensate return lines. Check valves eliminate the possibility of condensate backing up through the steam trap into the system.
- A drain valve is included at the bottom of the collection leg for manual discharge of condensate during supervised start-up. The drain valve should be located at least 6” below the steam trap line.
- An isolation valve and strainer should be installed before the steam trap. The isolation valve simplifies maintenance of the trap and the strainer protects the trap from any dirt, debris or scale in the line.

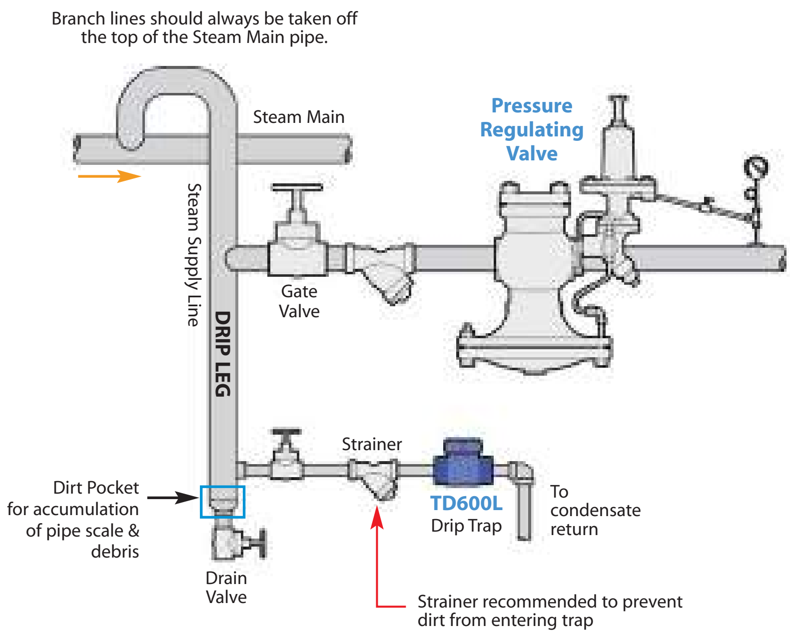
Figure 1: Proper DRIP LEG Designs



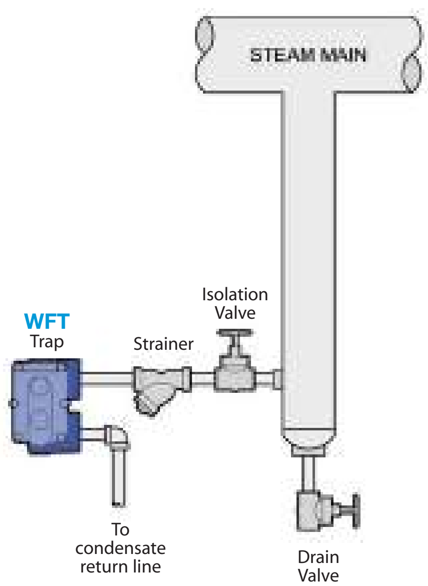
DRIP LEG DESIGN CRITERIA:

1) Locate prior to valves, bends in pipe (direction changes), low points, end of line and straight piping runs (max. 200 ft. apart).
2) Diameter:
   - Drip leg diameter (D_L) to be equal to steam main diameter (D) for steam main sizes up to 4”
   - Drip leg diameter (D_L) may be half the steam main diameter (D) for steam main sizes over 4”, but not less than 4”
3) Length (L):
   - For systems with automatic start-up, L to be 28” minimum (= 1 PSI minimum head pressure)
   - For systems with supervised start-up, L to be 1.5 x D_L, but not less than 8”

DRIP LEG
Before Regulator or Control Valve



DRIP LEG
Draining Steam Main



ENGINEERING

PROCESS TRAP GUIDELINES – Gravity Drainage

PURPOSE: For removing condensate from below steam heat transfer equipment to ensure optimum heating under various load conditions.

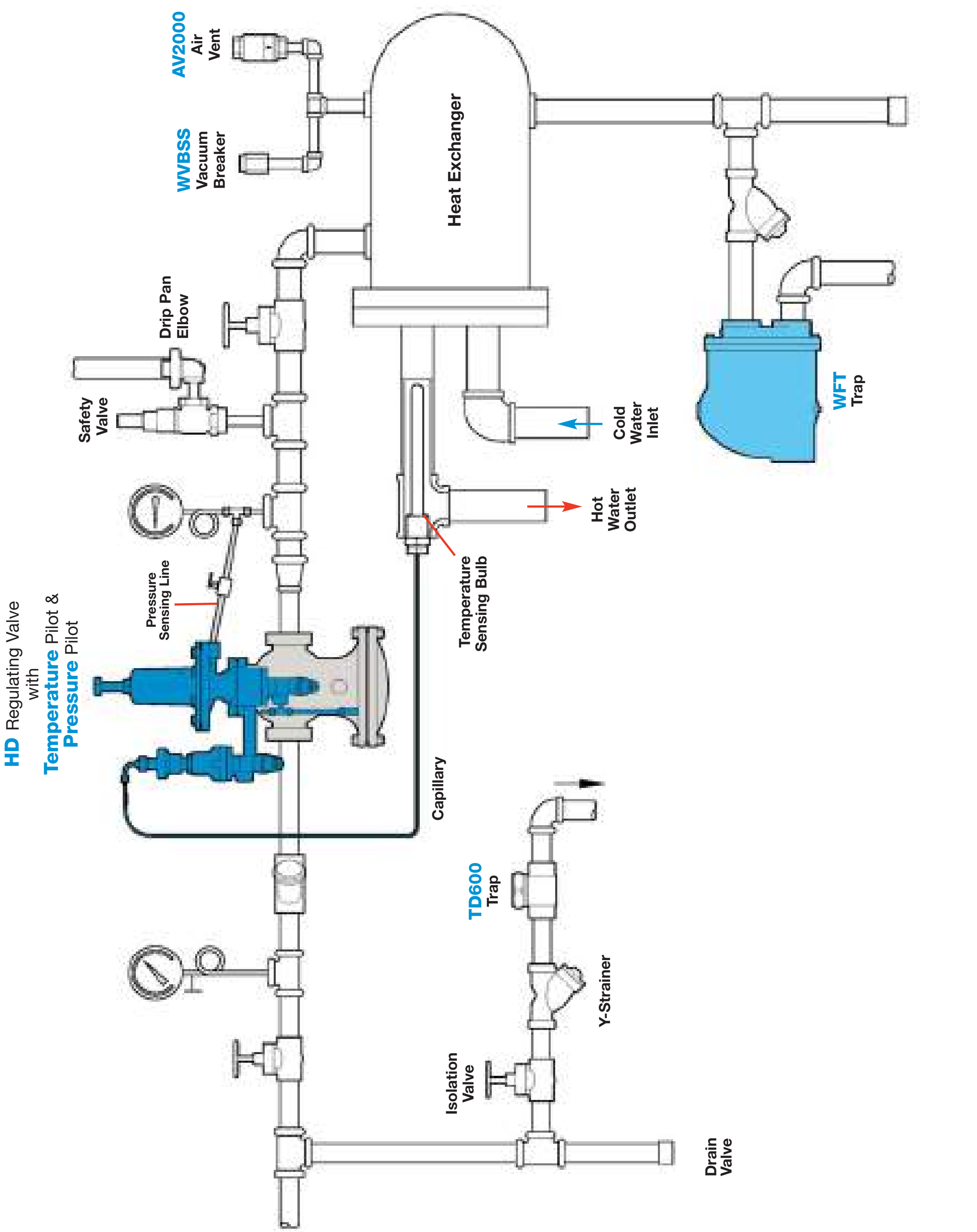
OPERATION: Steam used to heat product such as water in a heat exchanger condenses to liquid after passing though the heat exchanger and releasing its heating energy. To ensure optimum heating, this condensate is removed through an adequately sized drip leg and steam trap properly selected for the application and installed below the equipment. A Float and Thermostatic (F&T) steam trap is often an appropriate choice due to its modulating discharge and air venting capability.

INSTALLATION GUIDELINES: (see Figure 2)

- Selection and sizing of the process steam trap is critical to proper operation. A safety load factor (SLF) is applied to accommodate load variations, as well as high start-up requirements. Consult appropriate sections of this catalog or the factory for guidelines regarding proper process steam trap selection and sizing.
- The collecting leg to the process trap should be no smaller than the designed condensate outlet of the heat transfer equipment. Note that some steam trap technologies such as thermostatic require extended distance between the heat exchanger and steam trap to allow for back-up of subcooled condensate.
- The process trap should be located 2.3 feet (28") below the condensate outlet of the heat exchanger to provide a minimum of 1 PSI head pressure.
- The drip leg and steam trap prior to the regulating valve protect the valve from condensate, as well as ensure the best quality steam for heat transfer. Note the take-off from the top of the steam main to avoid condensate that would collect on the bottom of the main piping.
- The vacuum breaker and auxiliary air vent located at the top of the heat exchanger vessel promotes proper drainage and optimum heat transfer. The vacuum breaker allows system equalization with atmospheric air to allow gravity condensate drainage when vacuum is formed from condensing steam. The air vent improves heat-up times and overall heat transfer by expelling accumulated air on start-up.
- Consider low-cracking pressure (1/4 PSI opening pressure) check valves after steam traps when discharging into condensate return lines. Check valves eliminate the possibility of condensate backing up through the steam trap into the system.
- An isolation valve and strainer should be installed before any steam trap. The isolation valve simplifies maintenance of the trap and the strainer protects the trap from any dirt, debris or scale in the line.

PROCESS TRAP GUIDELINES – Gravity Drainage

Figure 2:



Shell & Tube Heat Exchanger with Gravity Drainage of Condensate

PROCESS TRAP GUIDELINES – Syphon Drainage

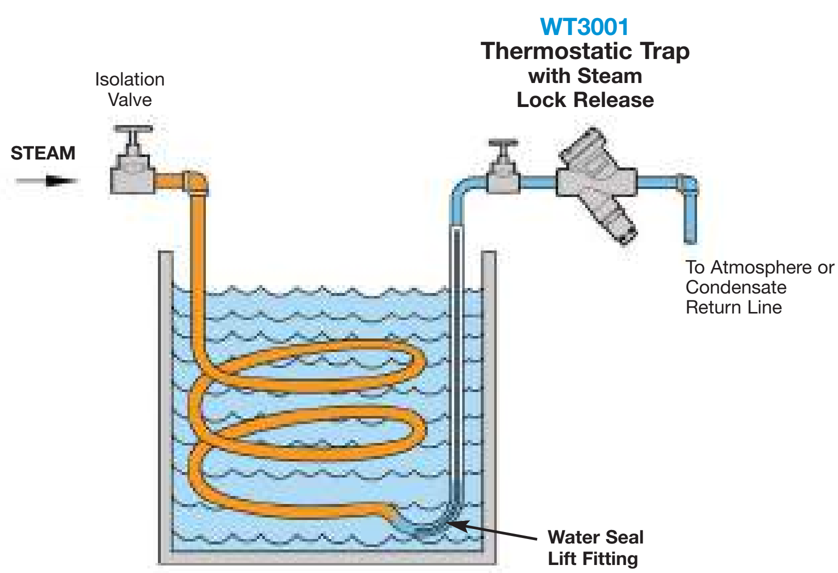
PURPOSE: For removing condensate from steam heat transfer equipment when the steam trap is to be installed *above* the point where condensate will collect.

OPERATION: When steam is used to heat liquid in a tank with a submerged coil or a rotary drum dryer, gravity drainage to the steam trap is not possible. For these applications, it is necessary to install the steam trap above the drain point of the equipment by creating a syphon lift to allow for proper condensate drainage.

INSTALLATION GUIDELINES: (see Figure 3)

- There are two critical requirements to ensure proper operation of syphon lift process drainage systems: A <u>water seal lift fitting</u> and a <u>steam trap with a function to prevent steam lock</u> (often referred to as Steam Lock Release or SLR).
- The lift fitting on a submerged coil provides a water seal to stop steam from pushing past the condensate and reaching the steam trap, preventing a vapor-lock condition of the trap.
- Steam Lock Release (SLR) is provided on the steam trap to ensure the syphon lift remains continuous by preventing steam from becoming trapped – or locked – between the cavity of the steam trap and incoming condensate. The SLR function allows any small portion of trapped steam to be automatically removed from the system, allowing continuous drainage.
- Consider low-cracking pressure (1/4 PSI opening pressure) check valves after steam traps when discharging into condensate return lines. Check valves eliminate the possibility of condensate backing up through the steam trap into the system.
- An isolation valve and strainer should be installed before any steam trap. The isolation valve simplifies maintenance of the trap and the strainer protects the trap from any dirt, debris or scale in the line.

Figure 3: **SUBMERGED COIL FOR HEATING LIQUID**
Steam Lock Release Mechanism
must be used when trap is positioned
above condensate level.

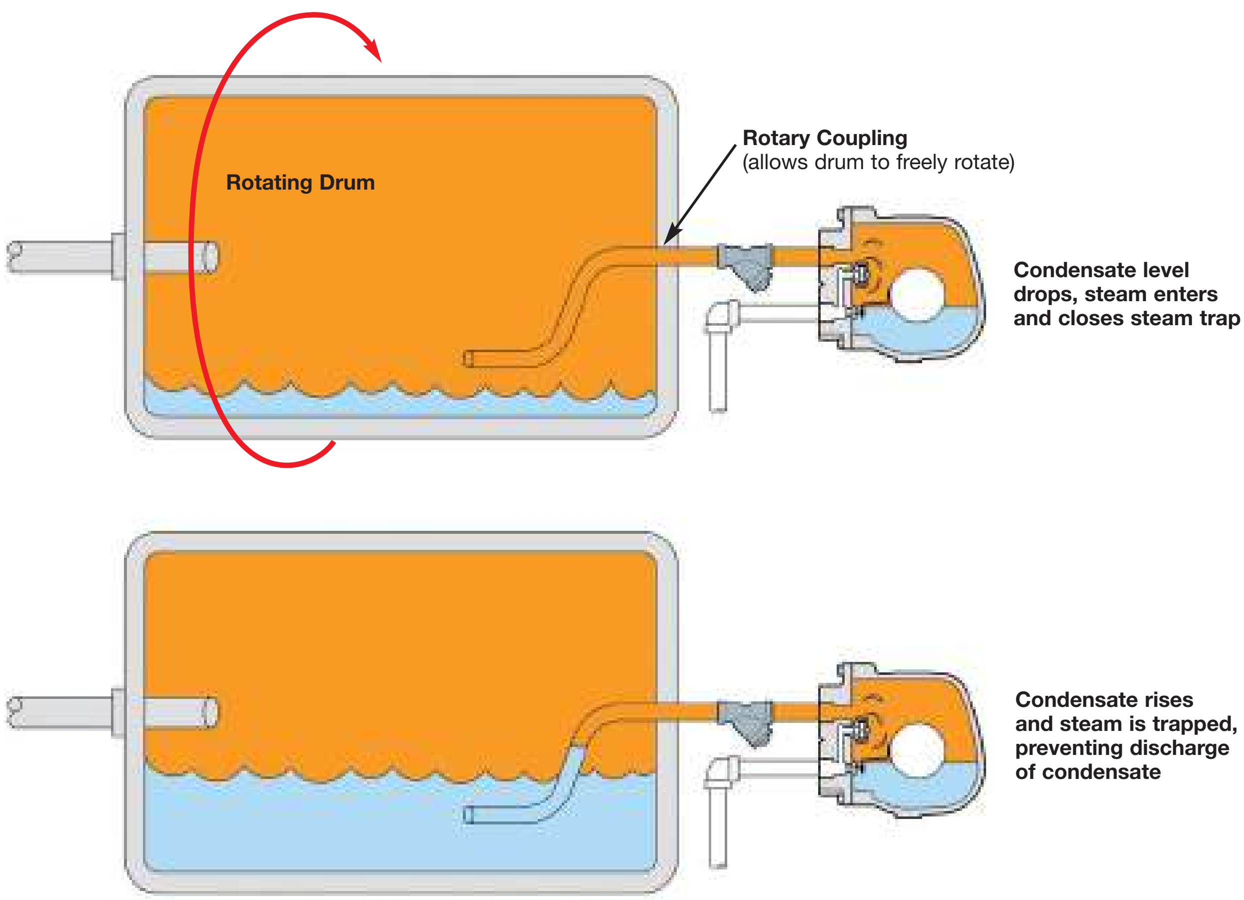


ROTATING STEAM DRYER

Commonly found in the Paper Making industry, a rotating piece of equipment offers a unique challenge of removing the condensate. Steam inside a rotating drum cylinder is used to heat product such as sheets of paper over the outside surface of the drum. The steam pressure pushes the condensate up through the pipe to the steam trap. Since the pipe that the condensate is traveling through is surrounded by steam, an issue can develop that will "**Steam Lock**" the trap causing the trap to stay closed, allowing the condensate to build up inside the rotating drum (Figure 4). By placing a **Steam Lock Release** feature on the Steam Trap, a small amount of steam will be constantly discharged through the trap. This allows condensate to reach the steam trap which causes it to open and function properly. This steam lock release feature is available on ALL F&T and Thermostatic traps and should be considered on this type of application.

Figure 4: Rotating Steam Dryer Illustrating **"Steam Lock"**

Steam Lock Release Option
must be used when trap is positioned above condensate level.



General Installation Guidelines

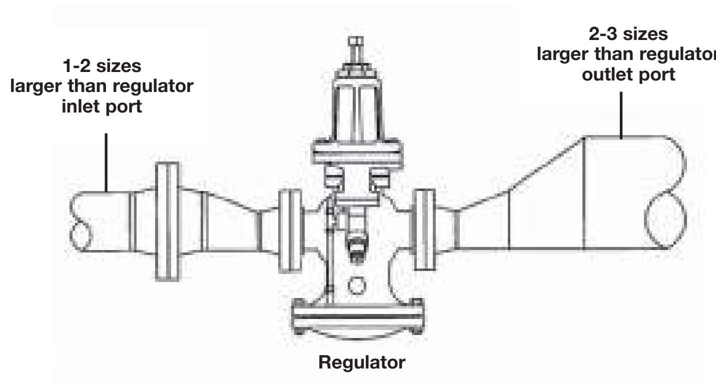
Regulator Application & Installation Notes

The following are considerations for all steam regulator installations, as system operation is dependent upon proper design, installation, start-up and maintenance procedures:

Inlet & Outlet Pipe Sizing

Improperly sized piping can contribute to excessive noise in a steam system. Make certain inlet and outlet piping to the regulator is adequately sized for the flow, velocity and pressure requirements.

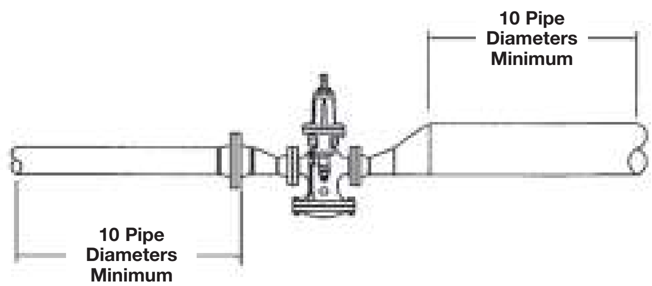
Inlet piping can be 1-2 sizes larger and outlet piping 2-3 sizes larger than the connection ports of a properly sized regulator.



Straight Run of Pipe Before and After the Valve

Pipe fittings, bends and other accessories contribute to fluid turbulence in a system which can result in erratic control. To limit this and ensure optimum system operation, follow recommended guidelines for minimum straight run lengths of pipe before and after a regulator.

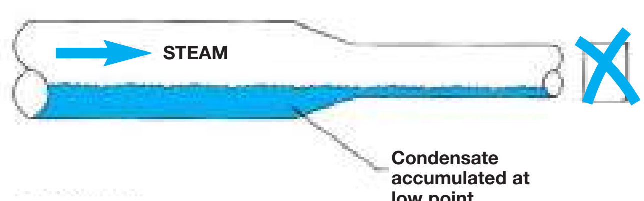
Note: *Any isolation valves or pipeline accessories should be full-ported.*



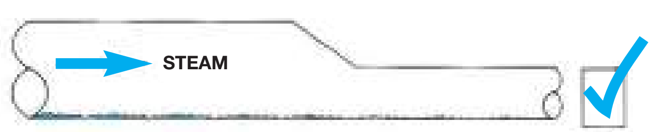
Reducer Selection

Concentric pipe reducers should be avoided on the inlet side of regulators as they can allow entrained condensate to collect, potentially leading to damaging and dangerous waterhammer. Therefore, when reducers are required in the steam piping to accommodate properly sized valves and pipes, <u>*use eccentric reducers on regulator inlets*</u> *and concentric or eccentric reducers on regulator outlets.*

Concentric Reducer



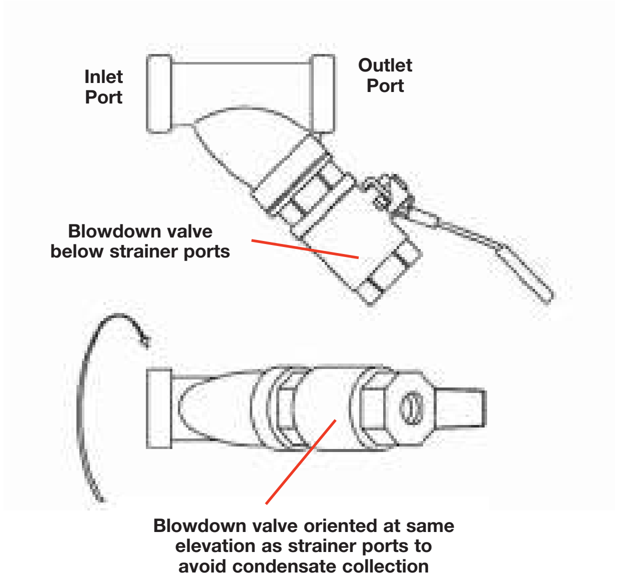
Eccentric Reducer



Strainers with Blowdown Valves

Regardless of any filters provided on a regulator, a strainer with blowdown valve is recommended before (upstream of) all regulator installations. Pipeline debris and scale can damage internal valve components, potentially leading to poor operation and/or failure.

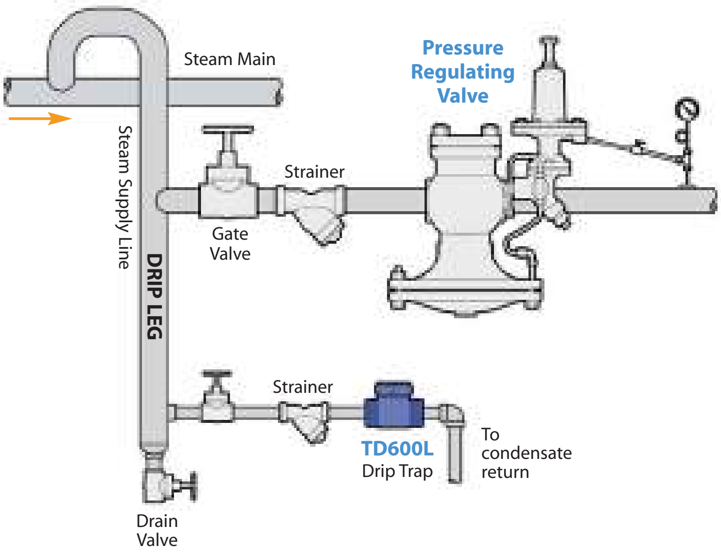
Note: Consider strainer orientation to avoid collection of condensate (see diagram).



Drip Legs & Steam Traps

To prevent condensate accumulated during shutdown from possibly damaging the regulator or piping at start-up, an adequately sized drip leg with steam trap should be installed prior to all regulators. This will also help protect the regulator during normal operation.

Note: Separators may be necessary when boiler carryover or "wet" steam is a concern.



Proper Start-up & Maintenance Procedures

It is important to follow good start-up practices to avoid operational complications and potential system damage. Starting a steam system too quickly or using an improper sequence may lead to a potentially hazardous working environment. Lack of system maintenance over time can also contribute to this situation.

It is imperative to develop proper start-up and maintenance procedures and train personnel on the importance of following them at all times.

Consult equipment manufacturers for specific guidelines, if necessary.

PRESSURE REDUCING STATION • Using Spring-Loaded Pilot

PURPOSE: For reducing system inlet pressure to a constant outlet pressure.

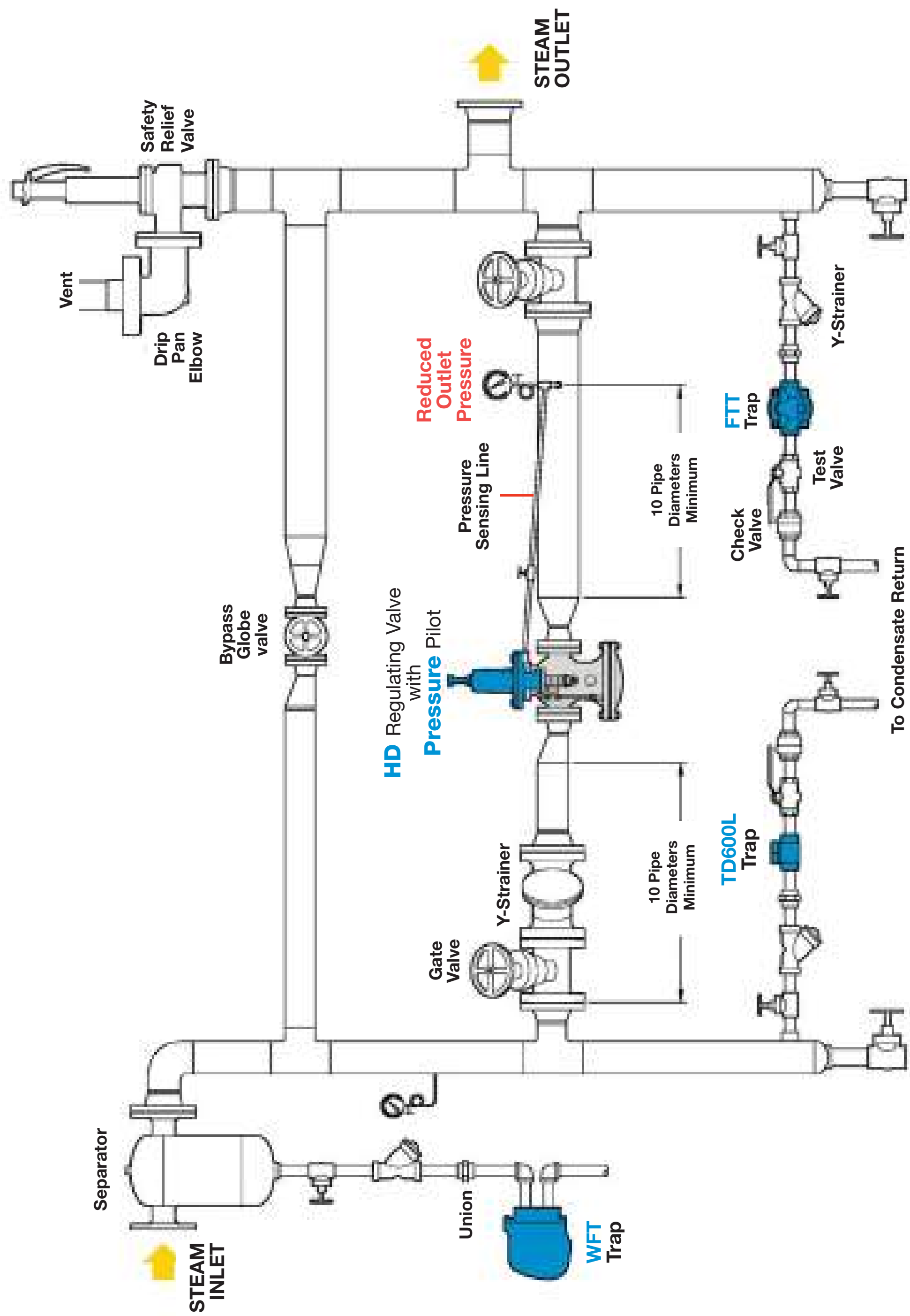
OPERATION: The pressure reducing valve (PRV) can be easily adjusted to set the desired outlet pressure and modulates to maintain that pressure setting. The PRV requires no external power source.

INSTALLATION GUIDELINES: (see Figure 5)

- This example depicts a pilot-operated steam PRV, whereby an external sensing line is required to sense downstream pressure. The end of the sensing line is placed away from the turbulent flow of the valve outlet. This helps to improve accuracy of the set pressure. Set pressure is adjusted by turning a screw on the pilot to increase or decrease compression on a balancing spring.
- For optimum operation and service life, maintain recommended minimum piping straight runs before and after the PRV. Inlet pipe diameters could be 1-2 sizes larger and outlet pipe diameters 2-3 sizes larger than the end connections of an appropriately sized PRV. The purpose of increasing the pipe size downstream of the regulator is to keep the steam velocity constant on both sides of the regulator.
- The pressure sensing line should slope downwards, away from the regulator, to prevent condensate from entering the pilot.
- Eccentric reducers, if required, are used on valve inlets to prevent accumulation of condensate which could become entrained with high-velocity steam, possibly resulting in dangerous waterhammer.
- While the separator shown upstream is appropriate for protection of the PRV, it is not always required as a properly sized drip leg with steam trap may sufficient. It is recommended for systems where steam is known to be "wet" and the entrained moisture could affect valve performance and/or result in component damage.
- Consider installing a properly sized bypass line with globe valve to provide continuous operation should regulator maintenance be required.
- Consider low-cracking pressure (1/4 PSI opening pressure) check valves after steam traps when discharging into condensate return lines. Check valves eliminate the possibility of condensate backing up through the steam trap into the system.
- A safety relief valve (SRV) is appropriate where applicable codes dictate their requirement, or anywhere protection of downstream piping and equipment from over-pressurization is desired. The SRV needs to handle the complete volume of steam from the regulator and bypass loop. Consult the factory for appropriate SRV sizing guidelines.

PRESSURE REDUCING STATION • Using Spring-Loaded Pilot

Figure 5:



SINGLE STAGE Pressure Reducing Station using Spring-loaded Pilot
(HD Regulator Applications)

PRESSURE REDUCING STATION • Using Air-Loaded Pilot

PURPOSE: For reducing system inlet pressure to a constant outlet pressure when valve is located in a remote location and/or using air pressure for control is desired.

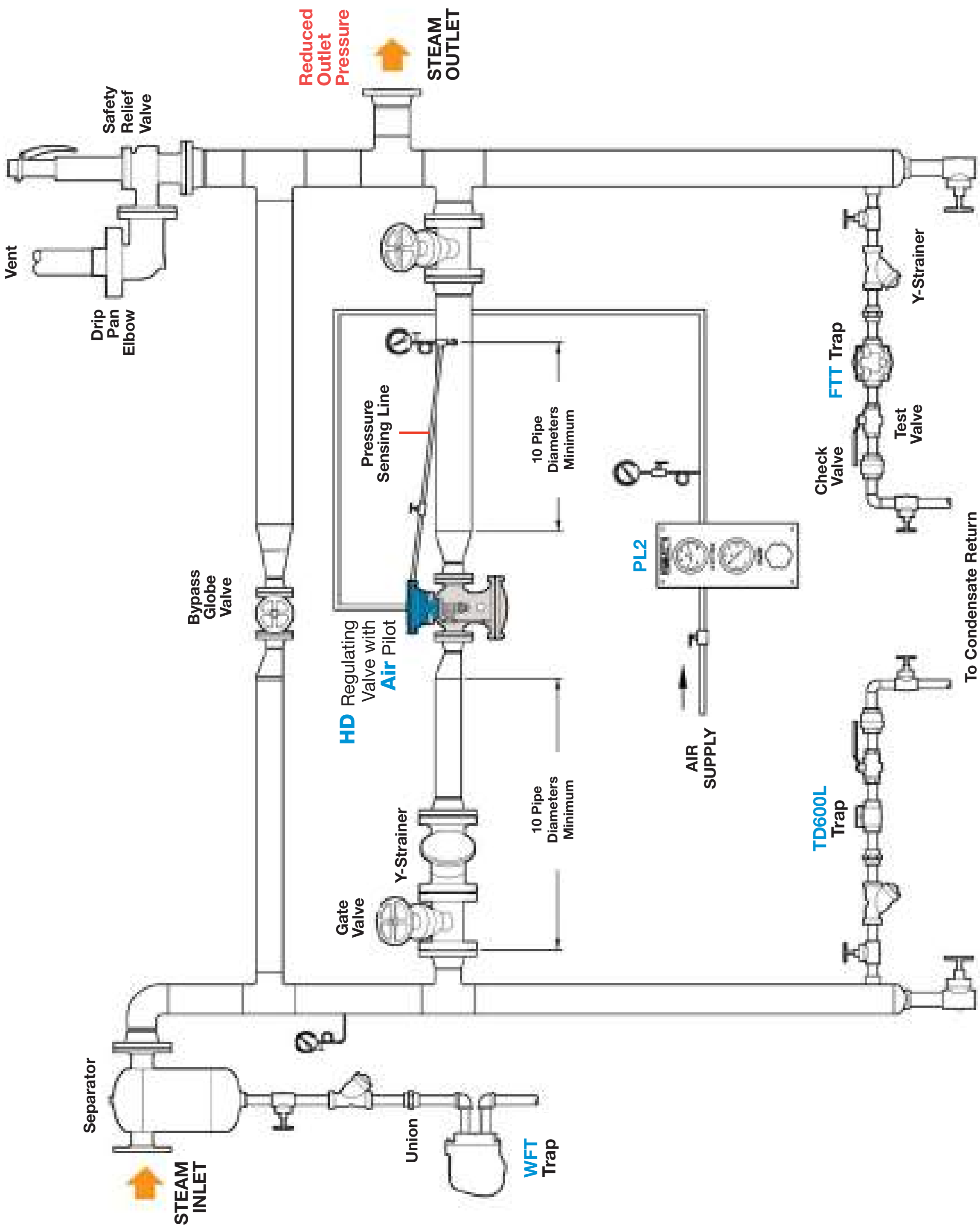
OPERATION: This combination of HD regulating valve and PA-pilot allows air to be used to control outlet pressure in lieu of the spring of a standard PP-pilot. Using air allows for simple adjustment of control pressure when valve is installed in a remote and/or difficult to access location.

INSTALLATION GUIDELINES: (see Figure 6)

- The desired set outlet pressure will determine the specific PA-Pilot required as well as the air supply pressure to attain the set pressure. Consult the appropriate section of this catalog or the factory for selection guidelines.
- For optimum operation and service life, maintain recommended minimum piping straight runs before and after the PRV. Inlet pipe diameters could be 1-2 sizes larger and outlet pipe diameters 2-3 sizes larger than the end connections of an appropriately sized PRV. The purpose of increasing the pipe size downstream of the regulator is to keep the steam velocity constant on both sides of the regulator.
- The pressure sensing line should slope downwards, away from the regulator, to prevent condensate from entering the pilot.
- Eccentric reducers, if required, are used on valve inlets to prevent accumulation of condensate which could become entrained with high-velocity steam, possibly resulting in dangerous waterhammer.
- While the separator shown upstream is appropriate for protection of the PRV, it is not always required, as a properly sized drip leg with steam trap may be sufficient. It is recommended for systems where steam is known to be “wet” and the entrained moisture could affect valve performance and/or result in component damage.
- Consider installing a properly sized bypass line with globe valve to provide continuous operation should regulator maintenance be required.
- Consider low-cracking pressure (1/4 PSI opening pressure) check valves after steam traps when discharging into condensate return lines. Check valves eliminate the possibility of condensate backing up through the steam trap into the system.
- A safety relief valve (SRV) is appropriate where applicable codes dictate their requirement, or anywhere protection of downstream piping and equipment from over-pressurization is desired. The SRV needs to handle the complete volume of steam from the regulator and bypass loop. Consult the factory for appropriate SRV sizing guidelines.

PRESSURE REDUCING STATION • Using Air-Loaded Pilot

Figure 6:



Pressure Reducing Station with Air-Loaded Pilot for Remote Installations
(HD Regulator Applications)

PRESSURE REDUCING STATION • 2-Stage (Series) for High Pressure Turndown

PURPOSE: For reducing steam system inlet pressure to a constant outlet pressure when the pressure drop exceeds the recommended operation of a single-stage pressure regulating valve (PRV). This will help reduce overall velocity, resulting in less noise and improved equipment service life.

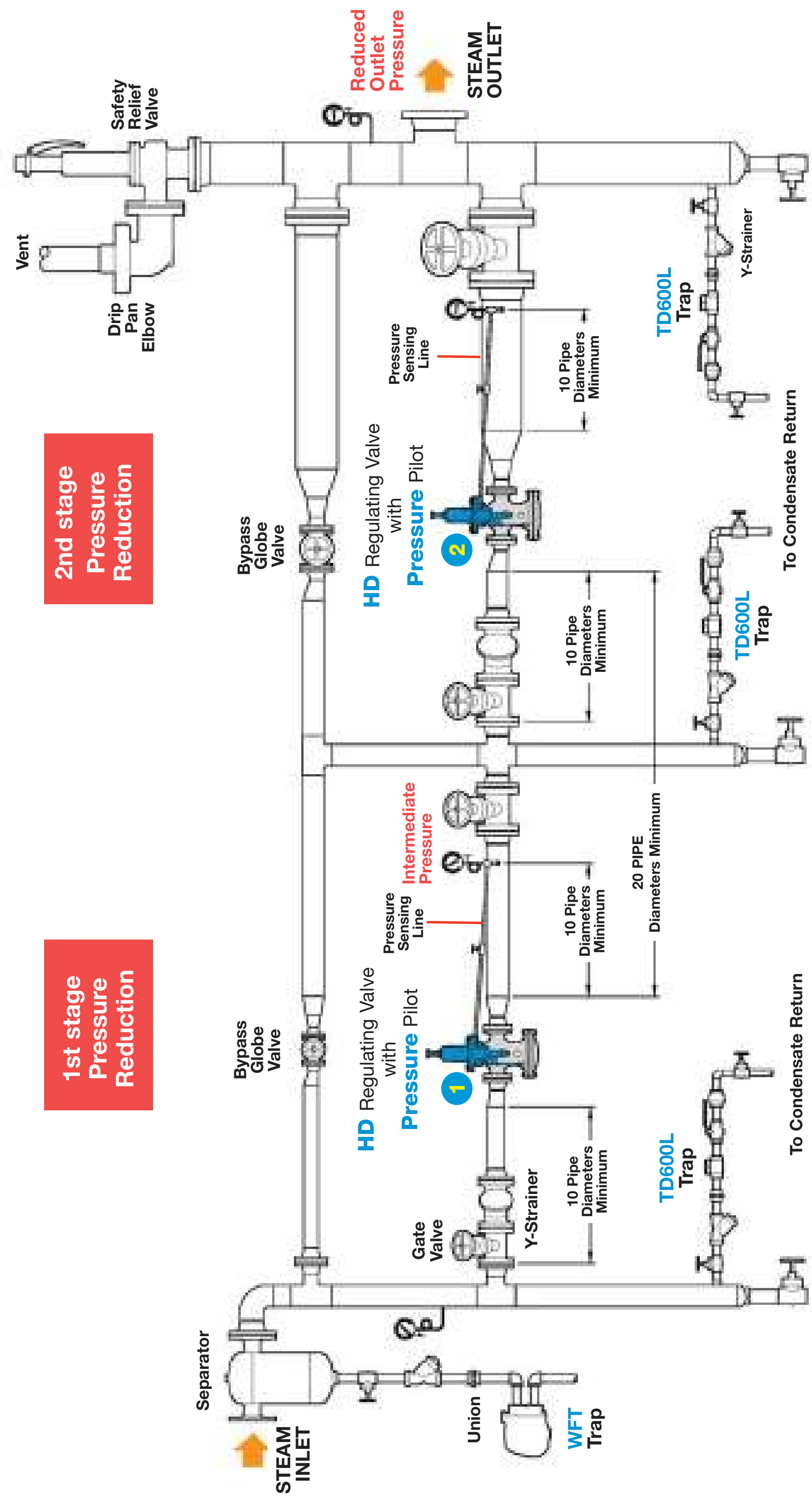
OPERATION: The 1st stage PRV is selected to reduce the initial steam pressure to a reasonable pressure between the initial inlet and desired outlet delivery pressure. This intermediate pressure is typically selected to ensure that each PRV is within recommended turndown guidelines. However, it is also possible there will be a use for steam at a specific intermediate pressure, which must be considered when evaluating turndown and sizing guidelines. The 2nd stage PRV, installed in series with the 1st stage, then reduces pressure to the final outlet delivery pressure. Individual valve setting and operation is the same as for single-stage applications.

INSTALLATION GUIDELINES: (see Figure 7)

- This example depicts a two-stage (series) pilot-operated steam PRV pressure reducing station using HD Regulators with Pressure Pilot. An external sensing line is required to sense downstream pressure from each regulator. The end of each sensing line is placed away from the turbulent flow at the valve outlet. This helps to improve accuracy of the set pressures. Set pressure for each PRV is adjusted by turning a screw on the pilot to increase or decrease compression on a balancing spring.
- For optimum operation and service life, maintain recommended minimum piping straight runs before and after the PRV. Inlet pipe diameters could be 1-2 sizes larger and outlet pipe diameters 2-3 sizes larger than the end connections of an appropriately sized PRV. The purpose of increasing the pipe size downstream of the regulator is to keep the steam velocity constant on both sides of the regulator.
- Each pressure sensing line should slope downwards, away from the regulator, to prevent condensate from entering the pilot.
- Eccentric reducers, if required, are used on valve inlets to prevent accumulation of condensate which could become entrained with high-velocity steam, possibly resulting in dangerous waterhammer.
- While the separator shown upstream is appropriate for protection of the PRVs, it is not always required, as a properly sized drip leg with steam trap may be sufficient. It is recommended for systems where steam is known to be “wet” and the entrained moisture could affect valve performance and/or result in component damage.
- Consider installing a properly sized bypass line with globe valve on each stage, to provide continuous operation should regulator maintenance be required.
- Consider low-cracking pressure (1/4 PSI opening pressure) check valves after steam traps when discharging into condensate return lines. Check valves eliminate the possibility of condensate backing up through the steam trap into the system.
- A safety relief valve (SRV) is appropriate where applicable codes dictate their requirement, or anywhere protection of downstream piping and equipment from over-pressurization is desired. The SRV needs to handle the complete volume of steam from the regulator and bypass loop. Consult the factory for appropriate SRV sizing guidelines.

PRESSURE REDUCING STATION • 2-Stage (Series) for High Pressure Turndown

Figure 7:



Two-Stage (Series) Pressure Reducing Station
(HD Regulator Applications)

ENGINEERING

PRESSURE REDUCING STATION • Parallel for High Flow Turndown

PURPOSE: For reducing steam system inlet pressure to a constant outlet pressure when steam flow rates vary widely. This will help improve system rangeability resulting in more accurate control.

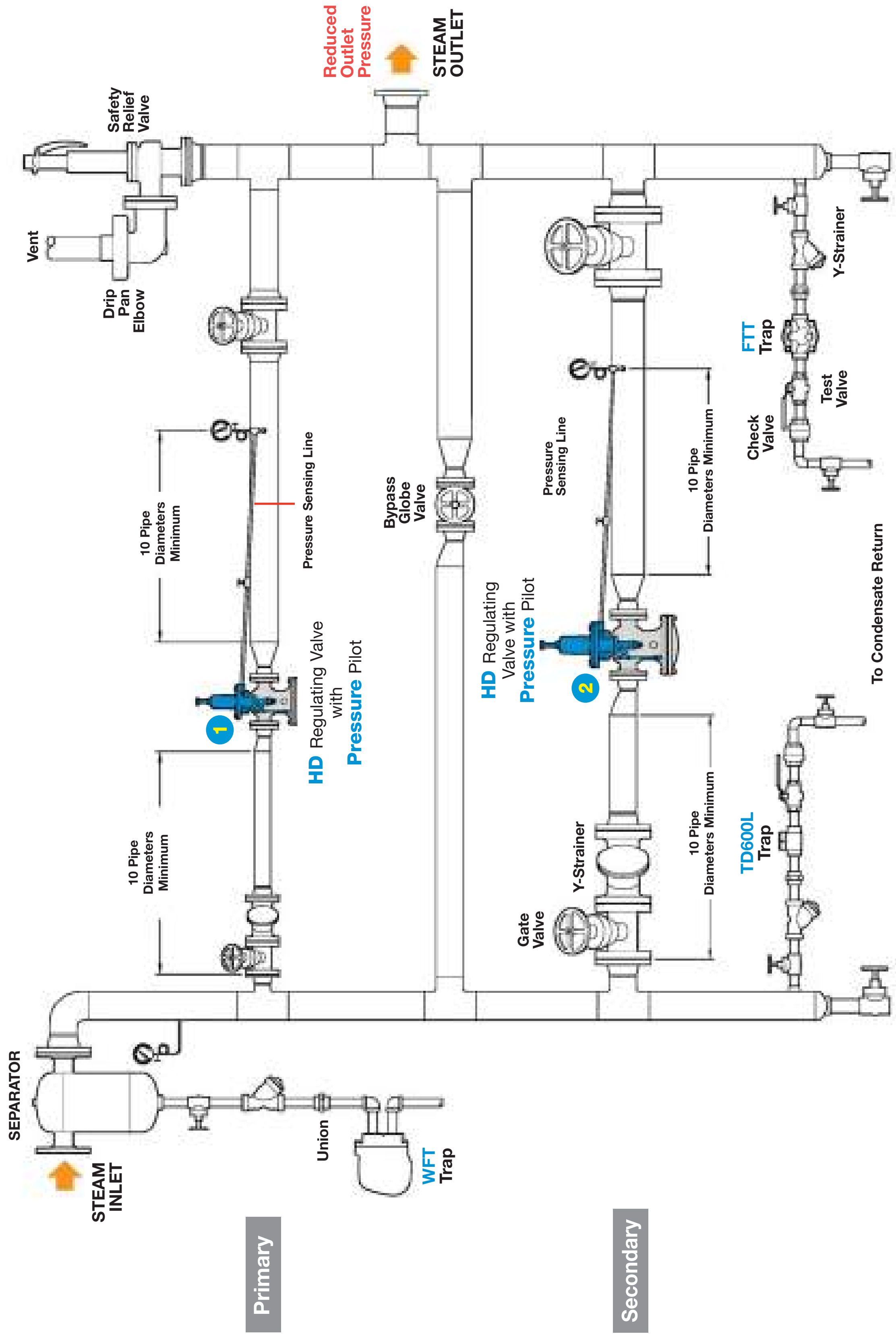
OPERATION: Because regulators are simple, self-powered devices which do not rely on an external control signal to determine valve steam position, they may not have the flow rangeability of control valves. Therefore, if a system has large flow variations (such as summer and winter loads), multiple regulators should be considered. Typically referred to as a 1/3 - 2/3 system, one valve may be sized for approximately 1/3 of the total maximum load demand and a larger valve for the remaining 2/3. When full load is required, both valves will be open and regulating. The small regulator is typically the primary valve and is set at a pressure 2 psi higher than the larger secondary valve. This allows the small regulator to be the only one flowing when demand is low. When flow increases and the small valve cannot keep up with the demand, the downstream pressure will begin to drop which will allow the larger secondary valve to open in order to help satisfy the demand. Although the smaller regulator is commonly selected as the primary valve, either the smaller or larger regulator may be set as the primary valve based on anticipated load demand requirements. The primary valve should always be set a minimum of 2 psi above the secondary valve.

INSTALLATION GUIDELINES: (see Figure 8)

- This example depicts a parallel pilot-operated steam PRV pressure reducing station using HD Regulators with Pressure Pilot. An external sensing line is required to sense downstream pressure from each regulator. The end of each sensing line is placed away from the turbulent flow at the valve outlet. This helps to improve accuracy of the set pressures. Set pressure for each PRV is adjusted by turning a screw on the pilot to increase or decrease compression on a balancing spring.
- Proper setting of the valves is key to proper operation. The chosen primary valve should be set at a pressure approximately 2 PSI higher than that of the secondary valve.
- For optimum operation and service life, maintain recommended minimum piping straight runs before and after the PRV. Inlet pipe diameters could be 1-2 sizes larger and outlet pipe diameters 2-3 sizes larger than the end connections of an appropriately sized PRV. The purpose of increasing the pipe size downstream of the regulator is to keep the steam velocity constant on both sides of the regulator.
- Each pressure sensing line should slope downwards, away from the regulator, to prevent condensate from entering the pilot.
- Eccentric reducers, if required, are used on valve inlets to prevent accumulation of condensate which could become entrained with high-velocity steam, possibly resulting in dangerous waterhammer.
- While the separator shown upstream is appropriate for protection of the PRV, it is not always required, as a properly sized drip leg with steam trap may be sufficient. It is recommended for systems where steam is known to be “wet” and the entrained moisture could affect valve performance and/or result in component damage.
- Consider installing a properly sized bypass line with globe valve to provide continuous operation should regulator maintenance be required.
- Consider low-cracking pressure (1/4 PSI opening pressure) check valves after steam traps when discharging into condensate return lines. Check valves eliminate the possibility of condensate backing up through the steam trap into the system.
- A safety relief valve (SRV) is appropriate where applicable codes dictate their requirement, or anywhere protection of downstream piping and equipment from over-pressurization is desired. The SRV needs to handle the complete volume of steam from the regulator and bypass loop. Consult the factory for appropriate SRV sizing guidelines.

PRESSURE REDUCING STATION • Parallel for High Flow Turndown

Figure 8:



PARALLEL Pressure Reducing Station
(HD Regulator Applications)

PRESSURE REDUCING STATION • for Combination High Pressure & High Flow Turndown

PURPOSE: For reducing steam system inlet pressure to a constant outlet pressure when flow conditions vary widely combined with a high pressure drop (i.e. higher than the recommended range of a single-stage regulator).

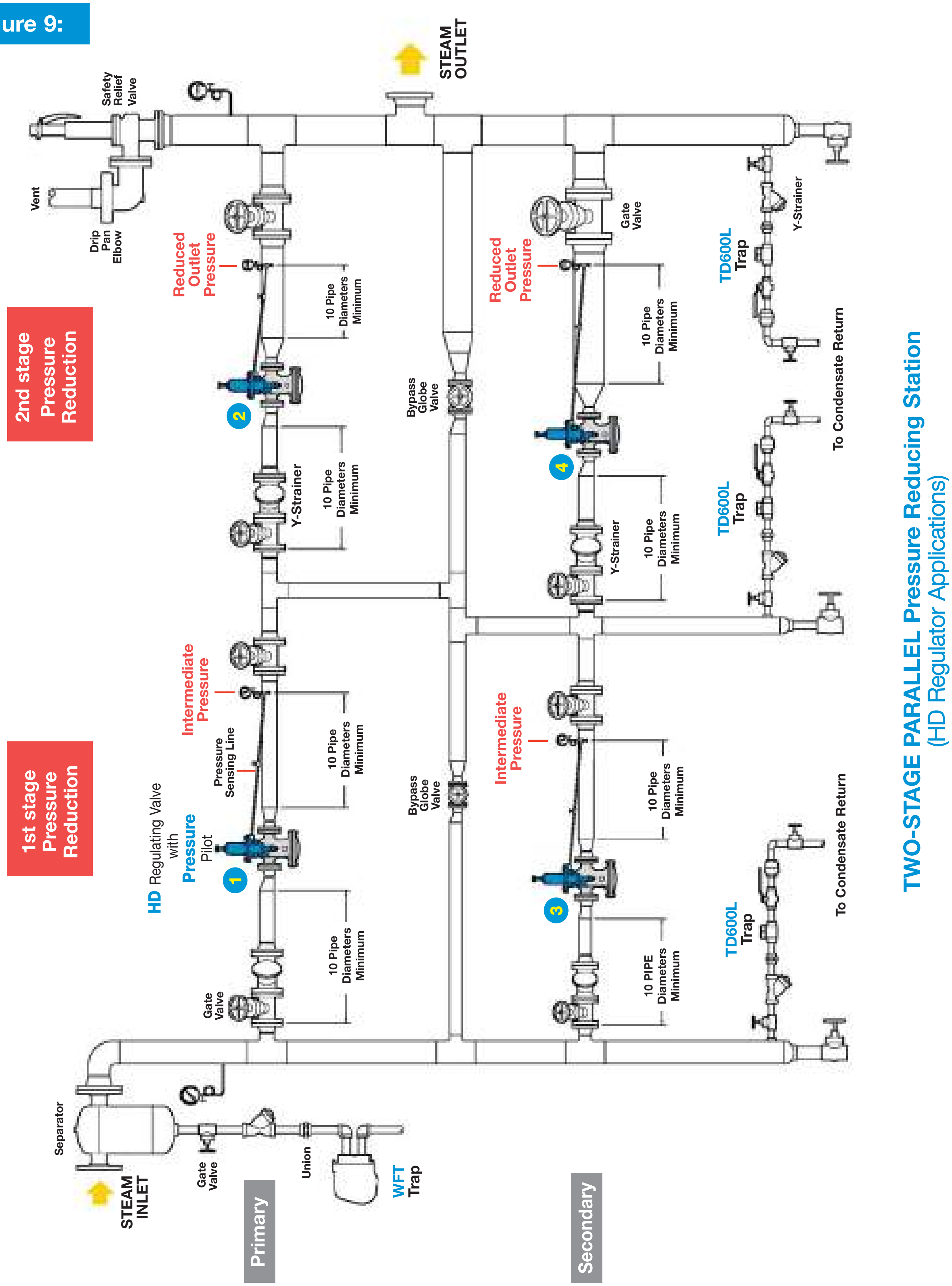
OPERATION: This system is a combination of Two-Stage (Series) and Parallel pressure reducing stations and operates based on the individual principles of each system. Each series of valves will be sized to handle a portion of the total maximum load demand, typically 1/3 and 2/3 of the total anticipated flow. If the smaller series of valves is determined to operate as the primary, then the 2nd stage valve will be set 2 psi higher than the 2nd stage valve in the secondary series. This allows the primary series to be the only one flowing when demand is low. When flow increases and the primary series cannot keep up with demand, the downstream pressure will being to drop which will allow the larger secondary series of valves to open in order to help satisfy the demand.

INSTALLATION GUIDELINES: (see Figure 9)

- This example depicts a two-stage parallel pilot-operated steam PRV pressure reducing station using HD Regulators with Pressure Pilot. An external sensing line is required to sense downstream pressure from each regulator. The end of each sensing line is placed away from the turbulent flow at the valve outlet. This helps to improve accuracy of the set pressures. Set pressure for each PRV is adjusted by turning a screw on the pilot to increase or decrease compression on a balancing spring.
- Proper setting of the valves is key to proper operation. The chosen 1st stage primary valve should be set at a pressure approximately 2 PSI higher than that of the 1st stage secondary valve.
- For optimum operation and service life, maintain recommended minimum piping straight runs before and after the PRV. Inlet pipe diameters could be 1-2 sizes larger and outlet pipe diameters 2-3 sizes larger than the end connections of an appropriately sized PRV. The purpose of increasing the pipe size downstream of the regulator is to keep the steam velocity constant on both sides of the regulator.
- Each pressure sensing line should slope downwards, away from the regulator, to prevent condensate from entering the pilot.
- Eccentric reducers, if required, are used on valve inlets to prevent accumulation of condensate which could become entrained with high-velocity steam, possibly resulting in dangerous waterhammer.
- While the separator shown upstream is appropriate for protection of the PRVs, it is not always required, as a properly sized drip leg with steam trap may be sufficient. It is recommended for systems where steam is known to be “wet” and the entrained moisture could affect valve performance and/or result in component damage.
- Consider installing a properly sized bypass line with globe valve on each stage, to provide continuous operation should regulator maintenance be required.
- Consider low-cracking pressure (1/4 PSI opening pressure) check valves after steam traps when discharging into condensate return lines. Check valves eliminate the possibility of condensate backing up through the steam trap into the system.
- A safety relief valve (SRV) is appropriate where applicable codes dictate their requirement, or anywhere protection of downstream piping and equipment from over-pressurization is desired. The SRV needs to handle the complete volume of steam from the regulator and bypass loops. Consult the factory for appropriate SRV sizing guidelines.

PRESSURE REDUCING STATION • for Combination High Pressure & High Flow Turndown

Figure 9:



TWO-STAGE PARALLEL Pressure Reducing Station
(HD Regulator Applications)

ENGINEERING

TEMPERATURE CONTROL • of Heat Exchanger with Pressure Limiting Pilot

PURPOSE: For accurately controlling both temperature of a product being heated in heat transfer equipment as well as limiting the pressure of the incoming steam, providing optimum heat transfer characteristics.

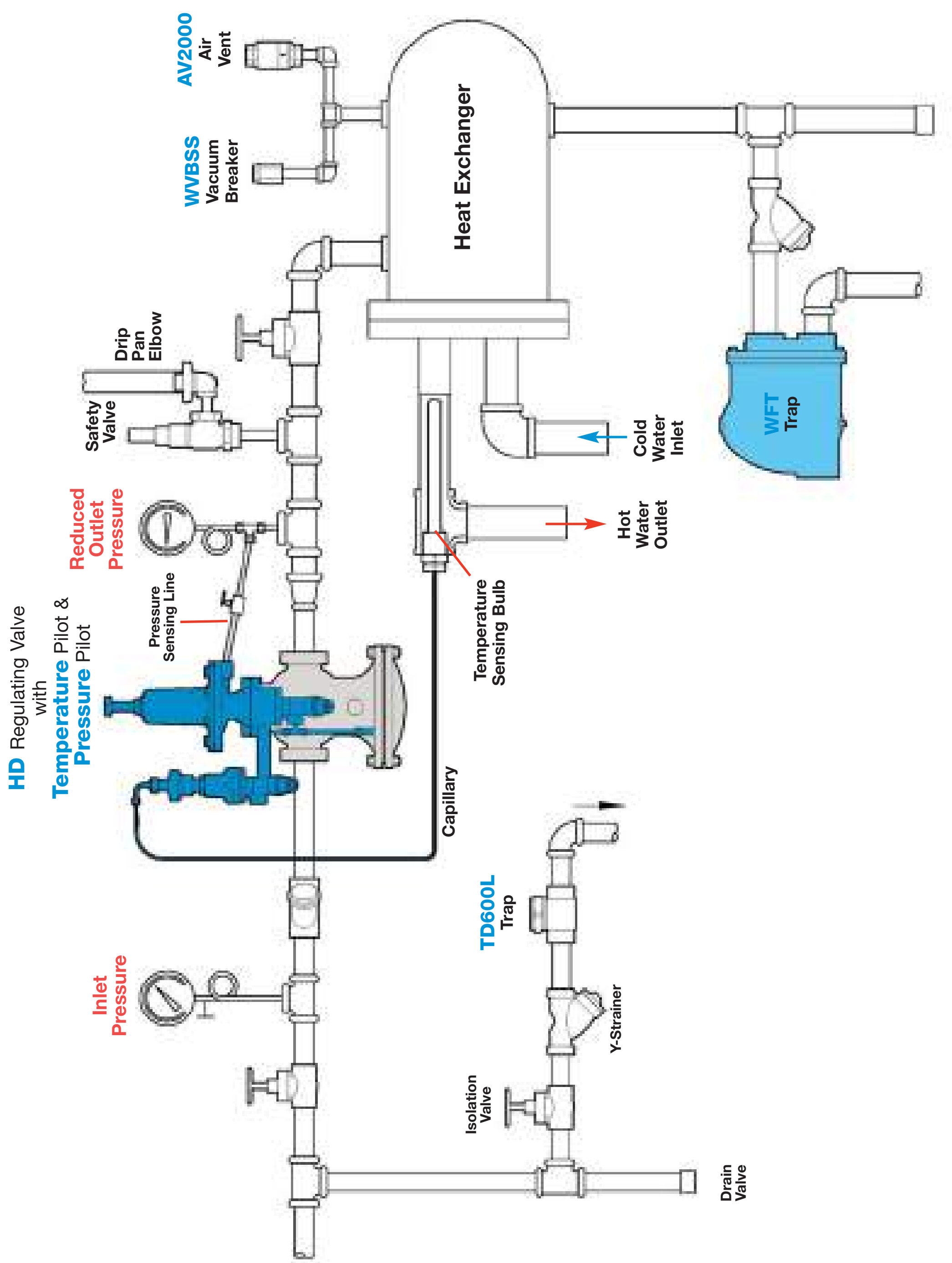
OPERATION: When a pilot-operated HD valve is selected, a single valve can be used for both pressure and temperature control when equipped with a PP-Pilot and PT-Pilot. As temperature at the sensing bulb falls below set point, the valve begins to modulate open to supply steam for heating. Supply pressure to the heat exchanger is them limited by adjusting the pressure pilot to the recommended value for optimum heat transfer and/or a limiting pressure of the heat transfer equipment. The HD Regulator with combination PT & PP Pilots requires no external power source.

INSTALLATION GUIDELINES: (see Figure 10)

- The temperature and pressure pilots should be set individually, starting slowly and gradually with the PT-pilot.
- Care should be given to the installation of the temperature sensing bulb to ensure full immersion in the liquid. The sensing bulb should be placed as close as possible to the heat exchanger vessel to ensure accurate temperature control of the process fluid.
- For optimum operation and service life, maintain recommended minimum piping straight runs before and after the Regulator. Inlet pipe diameters could be 1-2 sizes larger and outlet pipe diameters 2-3 sizes larger than the end connections of an appropriately sized Regulator. The purpose of increasing the pipe size downstream of the regulator is to keep the steam velocity constant on both sides of the regulator.
- The pressure sensing line should slope downwards, away from the regulator, to prevent condensate from entering the pilot.
- Eccentric reducers, if required, are used on valve inlets to prevent accumulation of condensate which could become entrained with high-velocity steam, possibly resulting in dangerous waterhammer.
- While a separator is appropriate for protection of the Regulator, it is not always required, as a properly sized drip leg with steam trap may be sufficient. It is recommended for systems where steam is known to be "wet" and the entrained moisture could affect valve performance and/or result in component damage.
- Consider low-cracking pressure (1/4 PSI opening pressure) check valves after steam traps when discharging into condensate return lines. Check valves eliminate the possibility of condensate backing up through the steam trap into the system.
- The vacuum breaker and auxiliary air vent located at the top of the heat exchanger vessel promotes proper drainage and optimum heat transfer. The vacuum breaker allows system equalization with atmospheric air to allow gravity condensate drainage when vacuum is formed from condensing steam. The air vent improves heat-up times and overall heat transfer by expelling accumulated air on start-up.
- A safety relief valve (SRV) is appropriate where applicable codes dictate their requirement, or anywhere protection of downstream piping and equipment from over-pressurization is desired. Consult the factory for appropriate SRV sizing guidelines.

TEMPERATURE CONTROL • of Heat Exchanger with Pressure Limiting Pilot

Figure 10:



Temperature Control of a Heat Exchanger with Pressure Limiting
(HD Regulator Applications)

REGULATING VALVE APPLICATIONS

TEMPERATURE CONTROL

of a BATCH PROCESS with Electrical Time Sequence Programmer (Solenoid Pilot)

PURPOSE: For accurately controlling temperature of a batch process where on-off operation is to be electronically controlled.

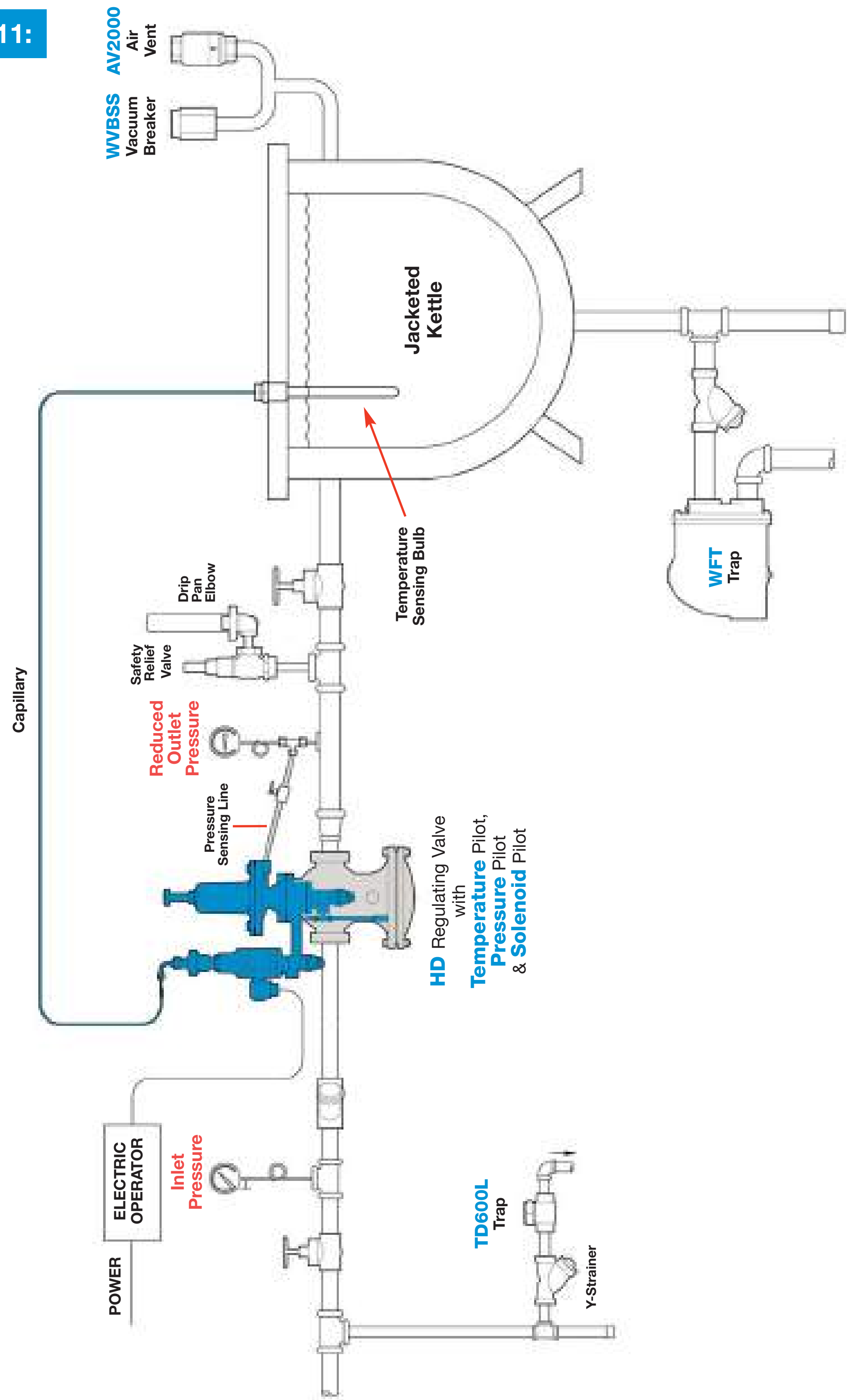
OPERATION: Operation is similar to that of the pressure and temperature combination pilot-operated regulator whereby the temperature (PT) pilot senses the temperature of the heated product (e.g. water) and appropriately modulates the flow of steam. Pressure is limited by the pressure (PP) pilot. The solenoid valve (PS-pilot) is electronically activated to control on-off operation of the batch process.

INSTALLATION GUIDELINES: (see Figure 11)

- The temperature and pressure pilots should be set individually, starting slowly and gradually with the PT-pilot.
- For optimum operation and service life, maintain recommended minimum piping straight runs before and after the PRV. Inlet pipe diameters could be 1-2 sizes larger and outlet pipe diameters 2-3 sizes larger than the end connections of an appropriately sized Regulator. The purpose of increasing the pipe size downstream of the regulator is to keep the steam velocity constant on both sides of the regulator.
- The pressure sensing line should slope downwards, away from the regulator, to prevent condensate from entering the pilot.
- Eccentric reducers, if required, are used on valve inlets to prevent accumulation of condensate which could become entrained with high-velocity steam, possibly resulting in dangerous waterhammer.
- While a separator is appropriate for protection of the Regulator, it is not always required, as a properly sized drip leg with steam trap may be sufficient. It is recommended for systems where steam is known to be “wet” and the entrained moisture could affect valve performance and/or result in component damage.
- Consider low-cracking pressure (1/4 PSI opening pressure) check valves after steam traps when discharging into condensate return lines. Check valves eliminate the possibility of condensate backing up through the steam trap into the system.
- The vacuum breaker and auxiliary air vent located at the top of the jacketed kettle vessel promotes proper drainage and optimum heat transfer. The vacuum breaker allows system equalization with atmospheric air to allow gravity condensate drainage when vacuum is formed from condensing steam. The air vent improves heat-up times and overall heat transfer by expelling accumulated air on start-up.
- A safety relief valve (SRV) is appropriate where applicable codes dictate their requirement, or anywhere protection of downstream piping and equipment from over-pressurization is desired. Consult the factory for appropriate SRV sizing guidelines.

TEMPERATURE CONTROL
of a BATCH PROCESS with Electrical Time Sequence Programmer (Solenoid Pilot)

Figure 11:



AUTOMATIC TEMPERATURE CONTROL of a BATCH PROCESS with Electrical Time Sequence Programmer (Solenoid Pilot)
(HD Regulator Applications)

REGULATING VALVE APPLICATIONS

TEMPERATURE CONTROL of a SEMI-INSTANTANEOUS HEATER using a Self-Contained Temperature Regulating Valve

PURPOSE: For accurate control of the temperature of a product being heated when the benefits of a self-contained regulator are required.

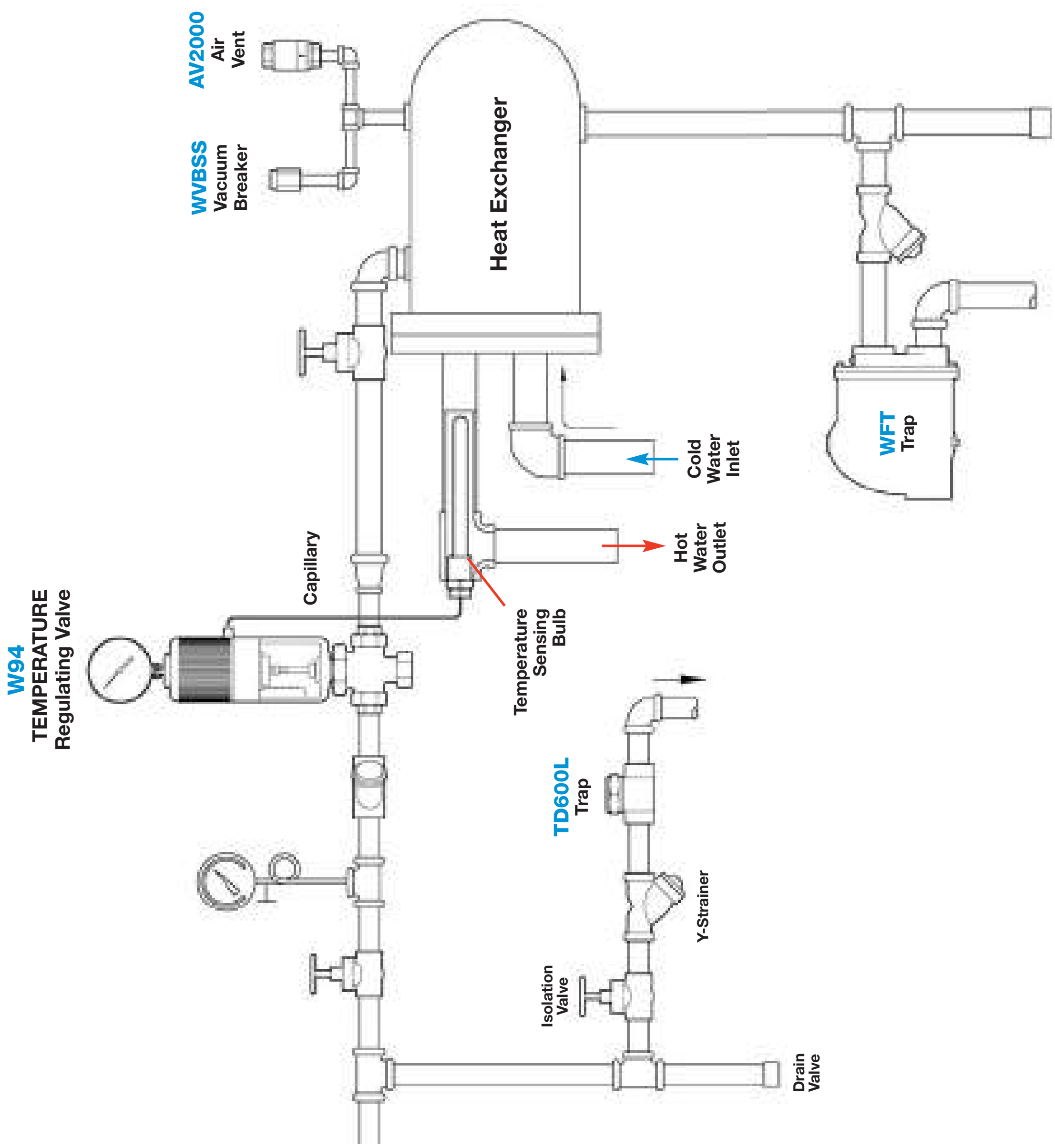
OPERATION: A self-contained temperature regulating valve (TRV) such as the W94, offers response times and characteristics suitable for semi-instantaneous heating applications. The temperature sensing bulb senses the temperature of the liquid being heated and allows modulation of the valve for appropriate supply of steam.

INSTALLATION GUIDELINES: (see Figure 12)

- Care should be given to the installation of the temperature sensing bulb to ensure full immersion in the liquid. The sensing bulb should be placed as close as possible to the heater tank to ensure accurate temperature control of the process fluid.
- All pressure sensing lines should slope downwards, away from the regulator, to prevent condensate from entering the pilot.
- Eccentric reducers, if required, are used on valve inlets to prevent accumulation of condensate which could become entrained with high-velocity steam, possibly resulting in dangerous waterhammer.
- While a separator is appropriate for protection of the Regulator, it is not always required, as a properly sized drip leg with steam trap may be sufficient. It is recommended for systems where steam is known to be "wet" and the entrained moisture could affect valve performance and/or result in component damage.
- Consider low-cracking pressure (1/4 PSI opening pressure) check valves after steam traps when discharging into condensate return lines. Check valves eliminate the possibility of condensate backing up through the steam trap into the system.
- The vacuum breaker and auxiliary air vent located at the top of the heater tank promotes proper drainage and optimum heat transfer. The vacuum breaker allows system equalization with atmospheric air to allow gravity condensate drainage when vacuum is formed from condensing steam. The air vent improves heat-up times and overall heat transfer by expelling accumulated air on start-up.
- A safety relief valve (SRV) is appropriate where applicable codes dictate their requirement, or anywhere protection of downstream piping and equipment from over-pressurization is desired. The SRV needs to handle the complete volume of steam from the regulator and bypass loop. Consult the factory for appropriate SRV sizing guidelines.

TEMPERATURE CONTROL of a SEMI-INSTANTANEOUS HEATER using a Self-Contained Temperature Regulating Valve

Figure 12:



Semi-Instantaneous Hot Water Heater with W94 Temperature Regulator
(Temperature Regulator Applications)

ENGINEERING

CONDENSATE DRAINAGE • using Pump-Trap

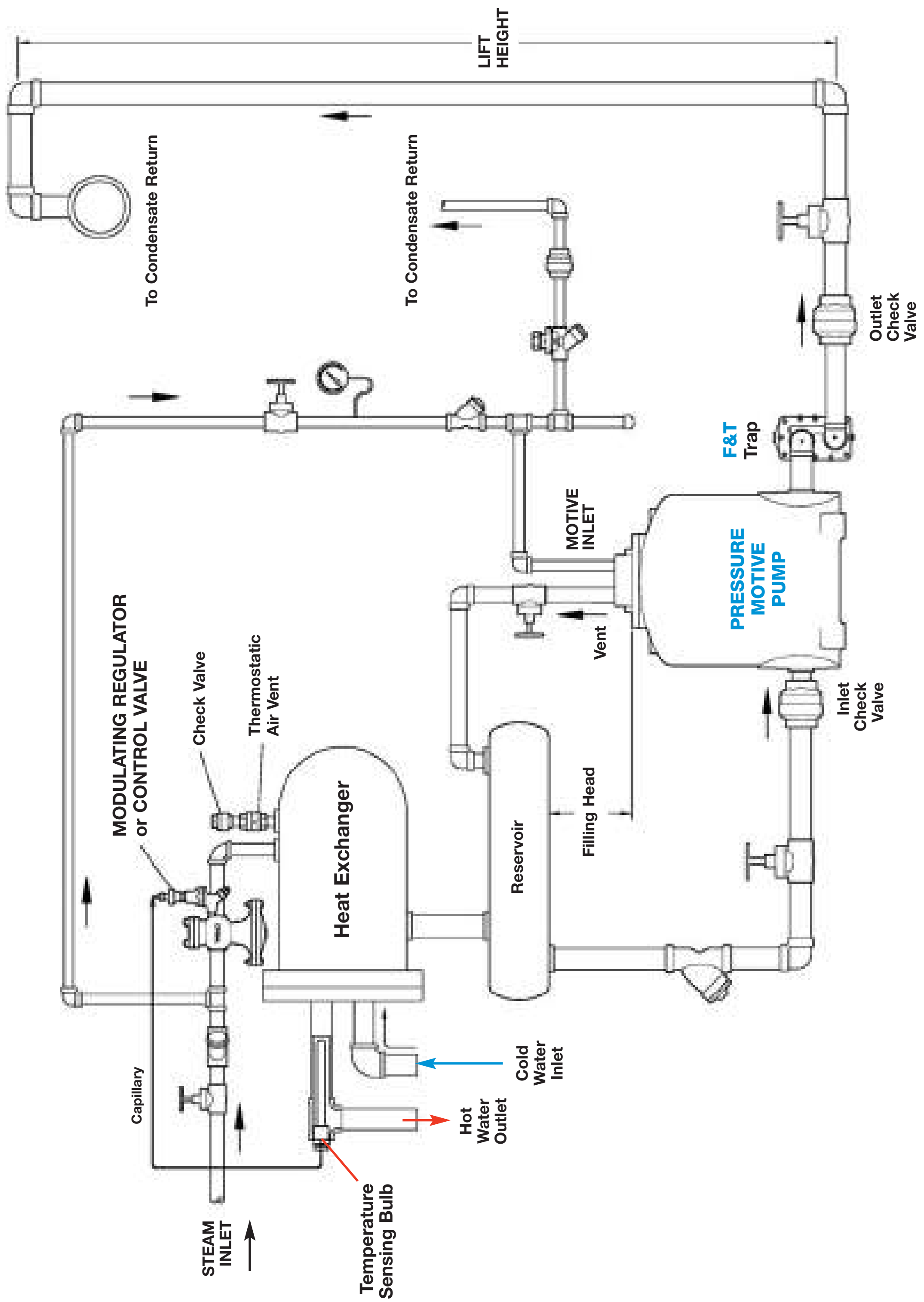
PURPOSE: For removing condensate from below steam heat transfer equipment when a modulating valve is used for control, and condensate discharge is elevated and/or pressurized, resulting in Stall condition.

OPERATION: The Pressure Motive Pump (PMP) is used to overcome the stall condition that exists when steam feeding a single piece of heat transfer equipment is controlled by a modulating steam valve and steam pressure falls below system back pressure as the valve closes. A steam trap is required after the PMP to prevent the loss of live steam when the system is under positive pressure. Operating as a closed loop provides an energy-efficient system by eliminating the need to vent flash steam.

INSTALLATION GUIDELINES: (see Figure13)

- Proper installation and piping of the pump vent line is critical to ensure the system operates correctly. Follow guidelines or consult factory for additional information.
- Maintain proper fill head above the top of the pump to ensure proper function of the pump and system. A suitably sized reservoir or oversized piping should be installed ahead of the pump for accumulation of condensate during the pump's discharge cycle (i.e. when not filling).
- The steam trap after the pump must be sized in conjunction with the pump to ensure proper function as a system. Improper sizing may result in reduced capacity leading to condensate back-up, poor heat transfer and potentially dangerous waterhammer. Consult appropriate sections of this catalog or the factory for guidelines regarding proper sizing of the pump-trap combination.
- While a separator is appropriate for protection of the Regulator, it is not always required, as a properly sized drip leg with steam trap may be sufficient. It is recommended for systems where steam is known to be "wet" and the entrained moisture could affect valve performance and/or result in component damage.
- Low-cracking pressure (1/4 PSI opening pressure) check valves should be installed after steam traps when discharging into condensate return lines. Check valves eliminate the possibility of condensate backing up through the steam trap into the system.
- The thermostatic air vent installed on the heat exchanger promotes optimum heat transfer. The air vent improves heat-up times and overall heat transfer by expelling accumulated air on start-up. When properly sized and installed, the pump-trap combination can operate in sub-atmospheric (i.e. vacuum) conditions; therefore, a vacuum breaker should not be used.

Figure 13:



Drainage of a Single Source of Condensate for a Closed Loop System
(Pump-Trap Applications)

CONDENSATE DRAINAGE from Below Grade • using Pump-Trap

PURPOSE: For drainage of condensate from below process equipment where fill head is limited due to height restrictions and the pump must be installed below grade.

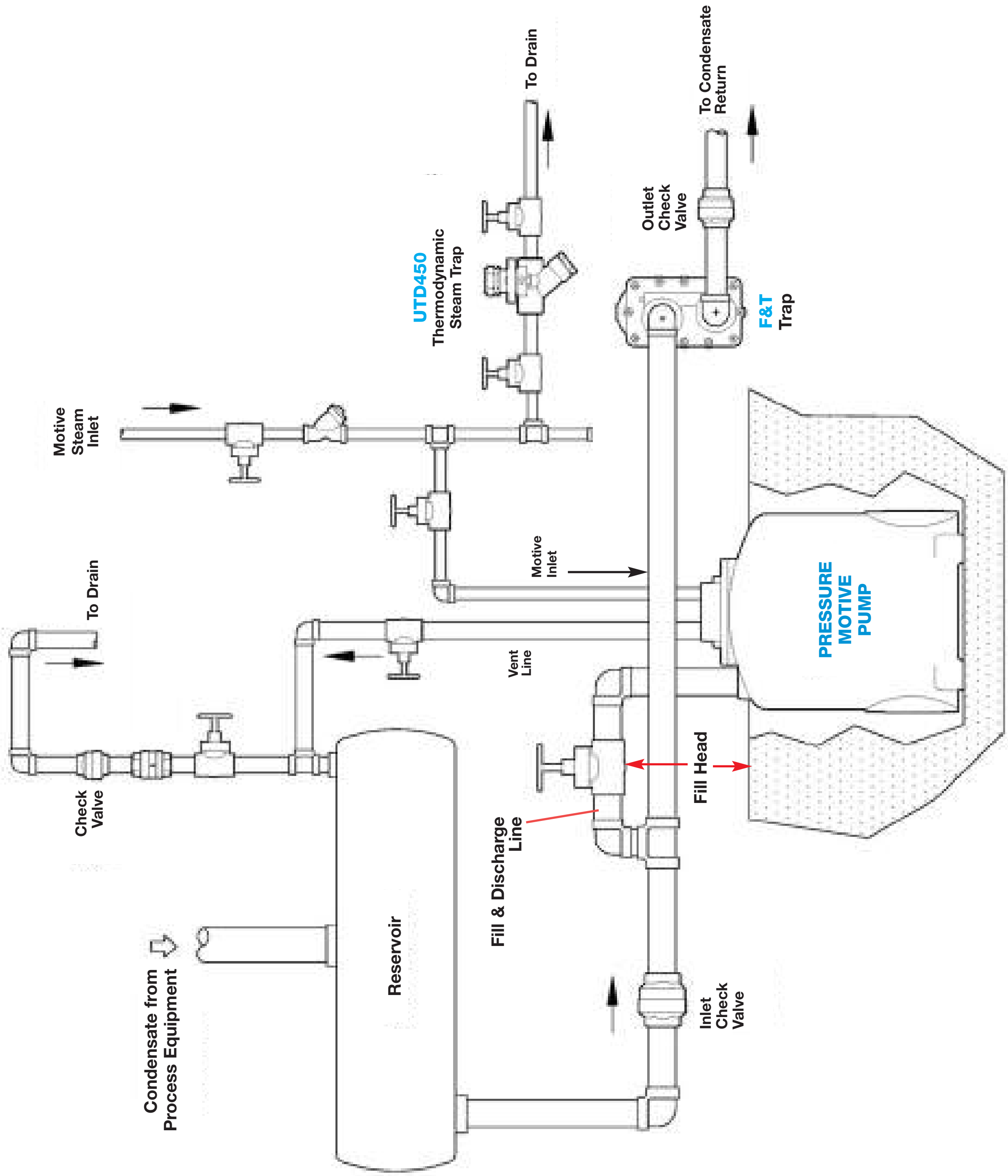
OPERATION: When fill head is restricted and it is more suitable to create a pit below grade than reposition process equipment, the Pressure Motive Pump (PMP) may be modified so both condensate inlet and outlet connections are on top to limit the necessary pit size. When stall exists, condensate will accumulate between the inlet and outlet check valves and eventually drain into and fill the PMP tank. Once the PMP fills and its mechanism trips, high pressure motive steam will enter the pump tank and force condensate back out the same connection. The check valves will direct the flow of pumped condensate into the return piping.

INSTALLATION GUIDELINES: (see Figure 14)

- The positioning of the check valves and PMP fill/discharge line are the key elements which allow the system to function properly. The check valves dictate the proper direction of condensate flow for both fill and discharge cycles of the PMP. The PMP fill/discharge line should be taken off the top, as shown, so condensate only accumulates and fills the pump during stall.
- Proper installation and piping of the pump vent line is critical to ensure the system operates correctly. Follow guidelines or consult factory for additional information.
- Maintain proper fill head above the top of the pump to ensure proper function of the pump and system. A suitably sized reservoir or oversized piping should be installed ahead of the pump for accumulation of condensate during the pump's discharge cycle (i.e. when not filling).
- The steam trap after the pump must be sized in conjunction with the pump to ensure proper function as a system. Improper sizing may result in reduced capacity leading to condensate back-up, poor heat transfer and potentially dangerous waterhammer. Consult appropriate sections of this catalog or the factory for guidelines regarding proper sizing of the pump-trap combination.
- Low-cracking pressure (1/4 PSI opening pressure) check valves should be installed after steam traps when discharging into condensate return lines. Check valves eliminate the possibility of condensate backing up through the steam trap into the system.

CONDENSATE DRAINAGE from Below Grade • using Pump-Trap

Figure 14:



Drainage of Condensate from BELOW GRADE for a Closed Loop System in Situations with Minimal Fill Head
(Pump-Trap Applications)

ENGINEERING

CONDENSATE DRAINAGE using Vertical Reservoir and Pump-Trap

PURPOSE: For drainage of condensate from below process equipment where fill head is limited due to height restrictions and a horizontal reservoir cannot be installed.

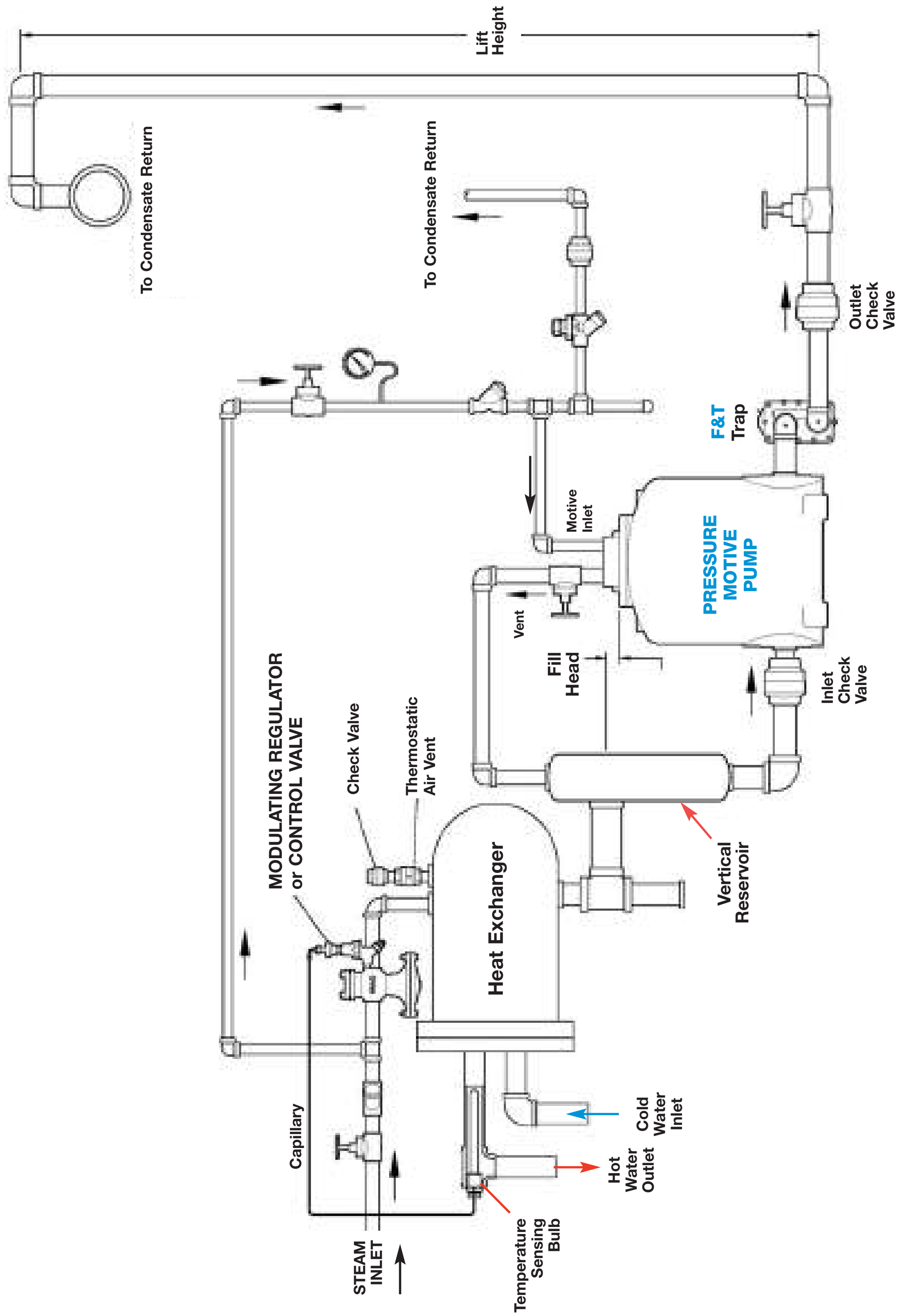
OPERATION: This system functions similarly to the system shown on page 455. However, when fill head is restricted due to heat exchanger height above ground, consider a vertical reservoir in lieu of a horizontal reservoir. This would accommodate condensate back-up as well as provide sufficient vapor space for the adequate venting of the pump while providing sufficient fill head to ensure proper operation of the pump.

INSTALLATION GUIDELINES: (see Figure 15)

- The vertical reservoir must be properly designed and installed to allow adequate condensate back-up during the pump's discharge cycle (i.e. when not filling), unobstructed venting of the pump, as well as sufficient fill head to ensure proper pump and system operation. Consult factory for additional assistance.
- Proper installation and piping of the pump vent line is critical to ensure the system operates correctly. Follow guidelines or consult factory for additional information.
- The steam trap after the pump must be sized in conjunction with the pump to ensure proper function as a system. Improper sizing may result in reduced capacity leading to condensate back-up, poor heat transfer and potentially dangerous waterhammer. Consult appropriate sections of this catalog or the factory for guidelines regarding proper sizing of the pump-trap combination.
- Low-cracking pressure (1/4 PSI opening pressure) check valves should be installed after steam traps when discharging into condensate return lines. Check valves eliminate the possibility of condensate backing up through the steam trap into the system. .
- The thermostatic air vent located on the heat exchanger promotes optimum heat transfer. The air vent improves heat-up times and overall heat transfer by expelling accumulated air on start-up. When properly sized and installed, the pump-trap combination can operate in sub-atmospheric (i.e. vacuum) conditions; therefore, a vacuum breaker should not be used.

CONDENSATE DRAINAGE using Vertical Reservoir and Pump-Trap

Figure 15:



Drainage of Condensate from HEAT EXCHANGER positioned Close to the Ground
(Pump-Trap Applications)

FLASH STEAM RECOVERY

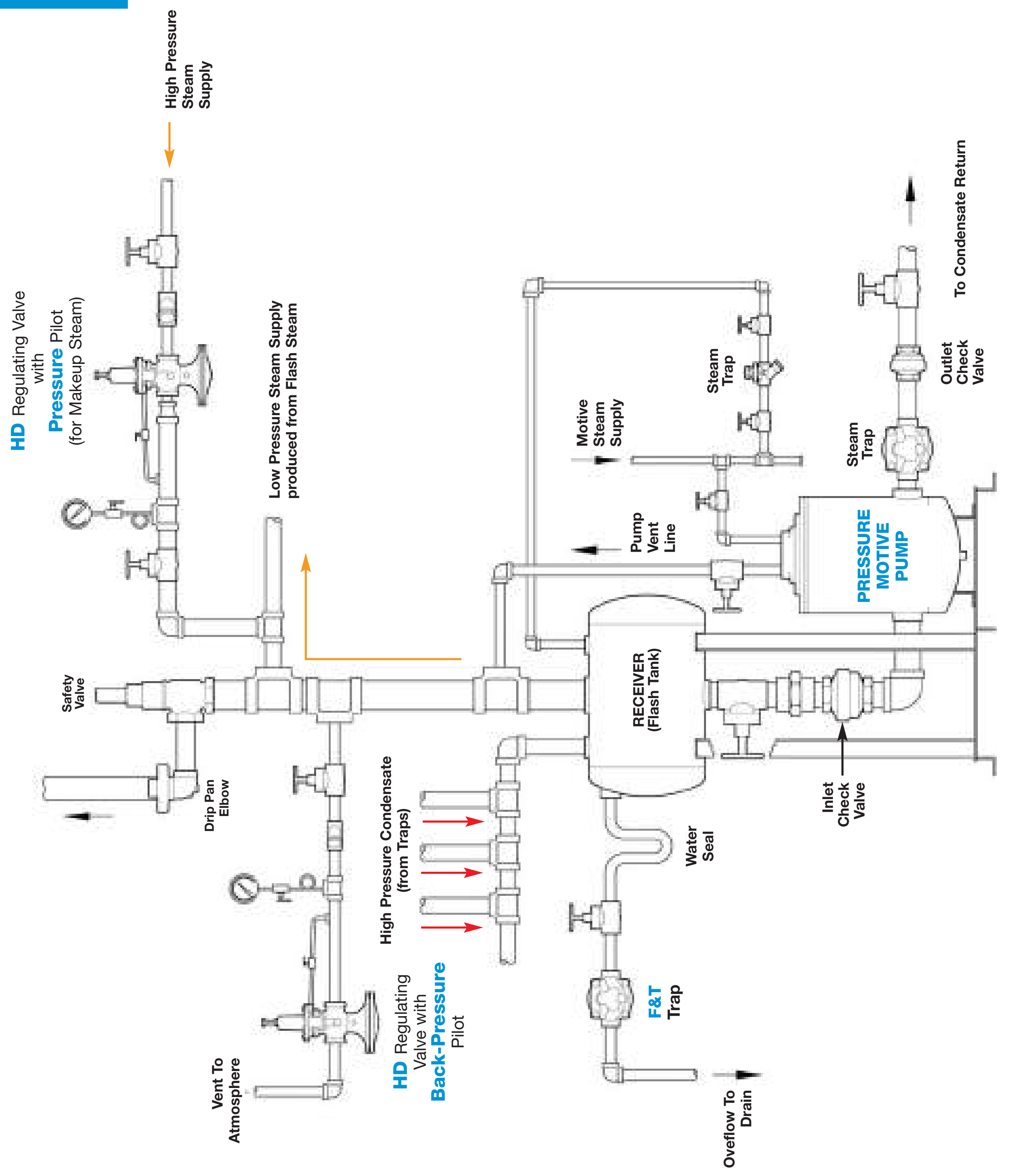
PURPOSE: For recovering flash steam from multiple condensate sources and drainage of the condensate when the total system back pressure is greater than the total of the individual source pressures.

OPERATION: Condensate at various pressures collects in a receiver (flash tank), equalizing the pressures to that of the flash tank. This allows drainage by gravity into the Pressure Motive Pump (PMP), filling the PMP until the internal mechanism reaches its upper trip point and activates the motive steam used for pumping. The flash steam generated from the high pressure condensate may be used to supplement other applications for optimum energy efficiency. The pressure in the receiver tank is maintained by a back pressure regulator and protected by a safety relief valve.

INSTALLATION GUIDELINES: (see Figure 16)

- The key element for proper system operation is the sizing of the receiver tank and receiver vent connection, which must accommodate the flash steam. Consult appropriate sections of this catalog or the factory for guidelines regarding proper sizing of the receiver tank and receiver vent connection.
- Proper installation and piping of the pump vent line is critical to ensure the system operates correctly. Follow guidelines or consult factory for additional information.
- Careful consideration should be given to sizing of the auxiliary components such as the back pressure regulator and safety relief valve.
- Maintain proper fill head above the top of the pump to ensure proper function of the pump and system. A suitably sized receiver or oversized piping should be installed ahead of the pump for accumulation of condensate during the pump's discharge cycle (i.e. when not filling).
- The steam trap after the pump must be sized in conjunction with the pump to ensure proper function as a system. Improper sizing may result in reduced capacity leading to condensate back-up, poor heat transfer and potentially dangerous waterhammer. Consult appropriate sections of this catalog or the factory for guidelines regarding proper sizing of the pump-trap combination.
- While the separator shown upstream is appropriate for protection of the PRV, it is not always required, as a properly sized drip leg with steam trap may be sufficient. It is recommended for systems where steam is known to be "wet" and the entrained moisture could affect valve performance and/or result in component damage.
- Low-cracking pressure (1/4 PSI opening pressure) check valves should be installed after steam traps when discharging into condensate return lines. Check valves eliminate the possibility of condensate backing up through the steam trap into the system.
- A safety relief valve (SRV) is appropriate where applicable codes dictate their requirement, or anywhere protection of downstream piping and equipment from over-pressurization is desired. Consult the factory for appropriate SRV sizing guidelines.

Figure 16:



FLASH STEAM RECOVERY
(Pump-Trap Applications)

REMOVAL OF WATER OR CONDENSATE FROM A PIT

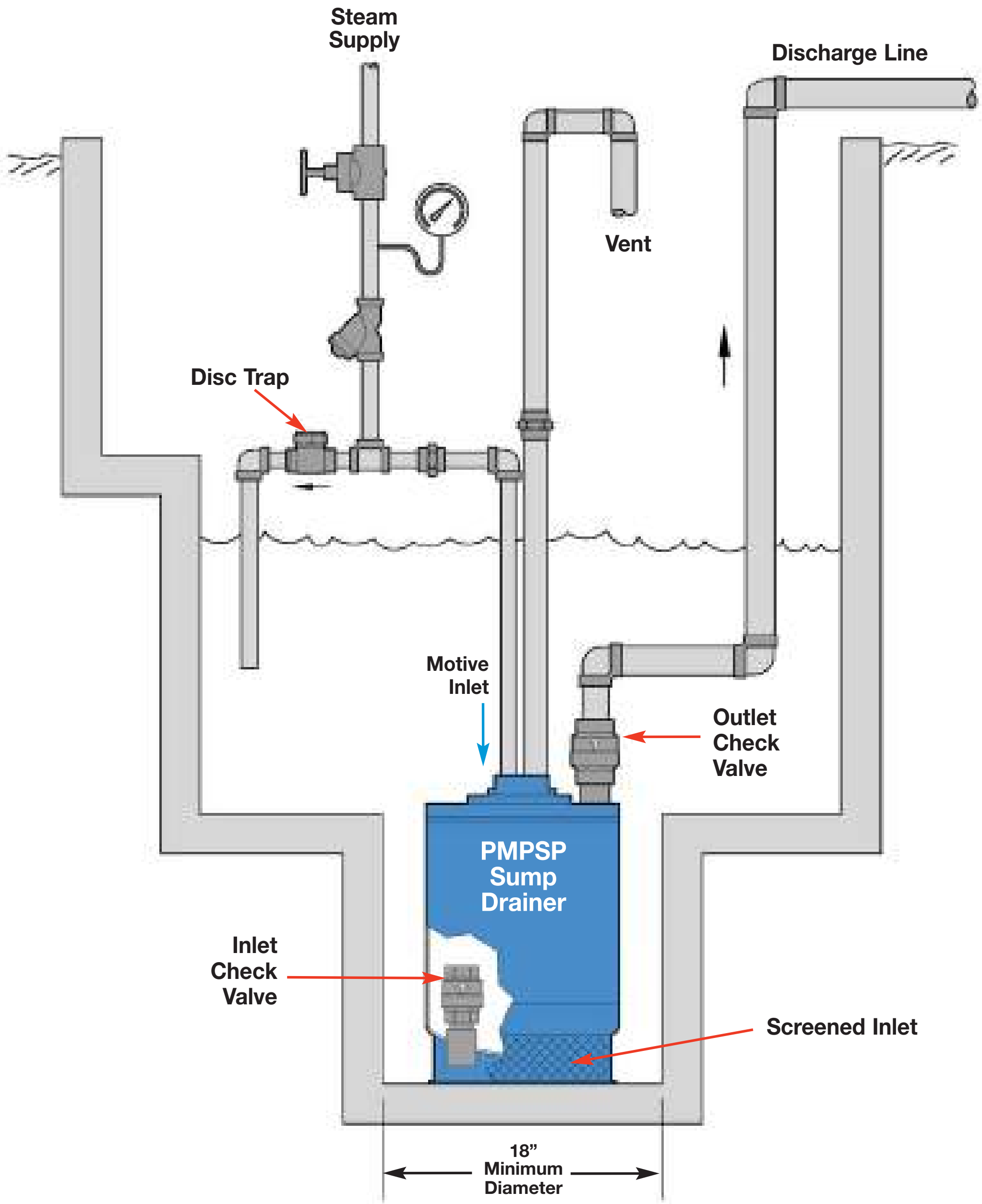
PURPOSE: For drainage of water and condensate from collection pits – especially with minimal horizontal space.

OPERATION: Water enters the inlet check valve through a screened area at the bottom of the PMPSP Sump Drainer. After the pump fills, the internal mechanism is actuated and the water is discharged from the pump by motive steam or compressed air or other gas.

INSTALLATION GUIDELINES: (see Figure 17)

- Make certain vent line is unobstructed and allowed to discharge directly to atmosphere.
- Other compressed gases, such as nitrogen, may be used as a motive source.
- Pit diameter should be at least 18” to ensure proper installation and operation.
- Proper installation and piping of the pump vent line is critical to ensure the system operates correctly. Follow guidelines or consult factory for additional information.
- Note that liquid level in the pit must rise above the pump to allow proper function.

Figure 17: Sump Drainer: "The Pit Boss"



PMPSP Sump Drainer ("The Pit Boss")

HEAT EXCHANGER FORMULAS & EXAMPLE

Formulas for Heat Exchanger System using a Modulating Control Valve

Definition of Terms and Units:

E = Mean Heat Transfer Rate or Heat Load (Btu/hr)

$\mathbf{E_D}$ = Design Heat Load (Btu/hr)

U = Overall Heat Transfer Coefficient (Btu/(hr-ft^2-°F))

A = Heat Transfer Surface Area of Heat Exchanger (ft^2)

$\mathbf{\Delta T_M}$ = Mean Temperature Difference between Steam and Water (°F)

$\mathbf{Q_W}$ = Volumetric Flow Rate of Water (GPM)

$\mathbf{Q_S}$ = Steam Load or Steam Capacity (lbs/hr)

$\mathbf{C_p}$ = Specific Heat Capacity of Water (Btu/(lb-°F))

$\mathbf{T_S}$ = Saturated Steam Temperature (°F)

$\mathbf{T_B}$ = Back pressure Equivalent Saturated Steam Temperature (°F)

$\mathbf{T_o}$ = Outlet Water Temperature (°F)

$\mathbf{T_i}$ = Inlet Water Temperature (°F)

$\mathbf{\Delta T_W}$ = Temperature Rise of Water (°F) = $\mathbf{T_o - T_i}$

$\mathbf{T_{WM}}$ = Mean Water Temperature (°F) = $\mathbf{(T_o + T_i)/2}$

LH = Latent Heat of Saturated Steam (Btu/lb)

$\mathbf{P_1}$ = Control Valve Inlet Pressure (PSIA)

$\mathbf{P_2}$ = Control Valve Outlet Pressure (PSIA)

$\mathbf{\Delta P}$ = Control Valve Differential Pressure (PSI) = $\mathbf{P_1 - P_2}$

$\mathbf{C_v}$ = Control Valve Flow Coefficient

Formula 1: Mean Heat Transfer Rate (E) of Heat Exchanger

$$E = U\,A\,\Delta T_M$$

The Heat Transfer Rate **E** (in Btu/hr) that takes place in a Heat Exchanger (HX) is a function of the Surface Area **A** (ft^2), the average temperature difference $\mathbf{\Delta T_M}$ (°F) between the steam and water, and the overall heat transfer coefficient **U**. The above formula can be used to calculate the heat loads for a HX based on the steam temperature inside the HX shell. This formula, when solved for **A**, can be used to size the HX (see **Formula 2**). Typical **U** values used for a steam to water HX range from 120 for stainless steel to over 200 for copper.

Formula 2: Heat Transfer Surface Area (A) of Heat Exchanger

$$A = \frac{E_D}{U\,\Delta T_M}$$

This formula is used to calculate the surface area (size) of the heat exchanger's internal tube or plates based on the design (maximum) heat load ($\mathbf{E_D}$) and average temperature difference ($\mathbf{\Delta T_M}$) between the steam and water. Since $\mathbf{\Delta T_M}$ is directly proportional to the steam pressure inside the HX shell, the specific steam pressure used to heat the water at $\mathbf{E_D}$ will determine the HX size. From the above formula, it can be seen that $\mathbf{\Delta T_M}$ is inversely proportional to **A** (the surface area). Therefore, the higher the steam pressure, the smaller the HX size, and vice versa.

Formula 3: Mean Temperature Difference (ΔT_M) between Steam and Water

$$\Delta T_M = \frac{(T_S - T_o) + (T_S - T_i)}{2}$$

This formula gives the average of the temperature differences between the steam and water at the outlet of the HX ($\mathbf{T_s - T_o}$) and at the inlet of the HX ($\mathbf{T_s - T_i}$).

Formula 4: Saturated Steam Temperature (T_S) as function of Mean Temperature Difference

$$T_s = \Delta T_M + T_{WM} \qquad \text{Where, } T_{WM} = (T_o + T_i)/2$$

This formula is derived by solving **Formula 3** for $\mathbf{T_S}$. It is useful for determining the steam temperature when the mean temperature difference ($\mathbf{\Delta T_M}$) is known. For example, the steam temperature at minimum load can be determined by solving **Formula 1** for $\mathbf{\Delta T_M}$ when $\mathbf{E = E_{min}}$, and then substituting $\mathbf{\Delta T_M}$ into the above formula. Once $\mathbf{T_S}$ is known, the pressure inside the HX shell can be determined from the Saturated Steam Table.

Formula 5: Heat Load (E)

$$E = Q_w \times 500 \times C_p \times \Delta T_w = Q_w \times 500 \times (T_o - T_i) \qquad [C_p = 1.0 \text{ Btu/(lb-°F)}]$$

The above formula shows that the heat load for the HX depends on the water flow rate ($\mathbf{Q_w}$) and the water temperature rise ($\mathbf{\Delta T_w = T_o - T_i}$).

ENGINEERING

Formulas for Heat Exchanger System using a Modulating Control Valve

Formula 6: **Steam Load (Q_S) as function of Heat Load**

$$Q_S = \frac{E}{LH}$$

The steam load or capacity (**Q_S** in lbs/hr) is dependent on the heat load (**E** in Btu/hr) and the latent heat (**LH** in Btu/lb) the steam contains. The Latent Heat of saturated steam is dependent on the steam pressure. Consult the Saturated Steam Table in Engineering Section. LH is typically approximated to 1,000 Btu/lb.

Formula 7: **Steam Load (Q_S) as function of Water Flow Rate**

$$Q_S = \frac{Q_W \times 500 \times (T_o - T_i)}{LH} \qquad Q_S = \frac{Q_W \times \Delta T_W}{2}$$ (approximation for LH = 1,000 Btu/lb)

This formula is derived by substituting the right side of **Formula 5** for **E** in **Formula 6**. It can be used for calculating the steam load directly from the flow rate of water to be heated.

Formula 8: **Water Flow Rate (Q_w) as function of Heat Load**

$$Q_W = \frac{E}{500 \times (T_o - T_i)}$$

This formula is derived by solving **Formula 5** for **Q_w**. It is useful for determining the water flow rate thru the HX at the stall point (**$Q_{w\text{-stall}}$**). This is explained in the following HX example (see part M).

Formula 9: **Percent Stall Load**

$$\%\ \text{Stall Load} = \frac{T_B - T_{WM}}{T_S - T_{WM}} \times 100 \qquad \text{Where } T_{WM} = \frac{T_o + T_i}{2}$$

This formula is used to calculate the percentage of Full Heat Load (**E_D**) at which heat exchanger stall will occur. Since water flow rate is proportional to heat load (see **Formula 8**), the % Stall Load can be used to calculate the water flow rate at stall (see **Formula 10**).

Formula 10: **Water Flow Rate at Stall ($Q_{w\text{-stall}}$)**

$$Q_{w\text{-stall}} = Q_{w\text{-full load}} \times (\%\ \text{Stall Load})/100$$

Where, **$Q_{w\text{-full load}}$** = Water flow rate at design (maximum) heat load (**E_D**) = Maximum water flow rate

This formula is used in conjunction with **Formula 9** to calculate the water flow rate at which heat exchanger stall will occur without having to know the size of the HX.

Formula 11: **Control Valve Steam Capacity (Q_S) at Sub-Critical Flow**

For $\Delta P < 0.42\ P_1$: 11a: $Q_S = 2.1\ C_v \sqrt{\Delta P (P_1 + P_2)}$ 11b: $C_v = \dfrac{Q_S}{2.1 \sqrt{\Delta P (P_1 + P_2)}}$

These formulas are applied when the pressure drop across the control valve (**ΔP**) is less than the critical pressure drop (**0.42** P_1).

Formula 12: **Control Valve Steam Capacity (Q_S) at Critical Flow**

For $\Delta P \geq 0.42\ P_1$: 12a: $Q_S = 1.71\ C_v\ P_1$ 12b: $C_v = \dfrac{Q_S}{1.71\ P_1}$

When the pressure drop across the valve (**ΔP**) is greater than or equal to the critical pressure drop (**0.42 P_1**), the steam capacity (**Q_S**) depends only on the valve inlet pressure (**P_1**). The flow rate at this condition is called the critical flow. For a constant inlet pressure, the critical flow is the maximum capacity of the valve. The above formulas are derived from **Formula 11a** by using the critical pressure drop (**$\Delta P = 0.42\ P_1$**) and differential pressure (**$\Delta P = P_1 - P_2$**) formulas to eliminate **ΔP** and **P_2** from the equation.

Note: Formulas 11 and 12 are simplified versions of the steam flow equation.

HEAT EXCHANGER FORMULAS & EXAMPLE

Heat Exchanger Example:

Heating Water with Steam using a Modulating Control Valve

Basic overview of system:

A shell and tube heat exchanger (**HX**) is used to heat 100 GPM of water from 50°F to 140°F using saturated steam at 100 PSIG to the inlet side of the control valve. A modulating control valve, in conjunction with a temperature sensor and electronic controller, is used to regulate the flow of steam into the HX. At the design load of 100 GPM, the valve will supply the HX with 50 PSIG steam. At times of lower demand, the flow rate of water can be reduced to a minimum of 25 GPM. The HX is constructed with stainless steel and has an overall heat transfer coefficient of 120 Btu/(hr-ft^2-°F). The condensate produced from the condensing steam in the HX will drain thru a float-type steam trap located directly below the exchanger outlet and into a condensate return line with total back pressure of 10 PSIG.

OBJECTIVES: (see Figure 18)

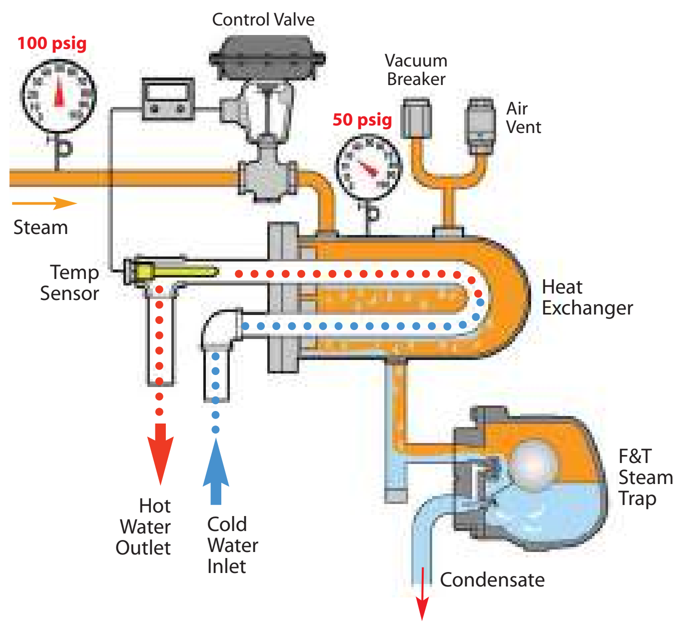
1) Select an appropriately sized **HX** that will effectively heat water from an estimated start temperature of 50°F to a final temperature of 140°F. The system must operate effectively in the flow rate range of 25 GPM to 100 GPM.

2) Select the appropriately sized **Control Valve** to effectively deliver steam to the HX.

3) Select the appropriately sized **Steam Trap** for draining condensate from the HX. The selection is based on steam pressure and condensate load in the HX.

4) Discuss advantages of using a **Pumping Trap** so the steam system can operate in vacuum during low demand, why a pumping trap may be a necessity if the condensate return line has back pressure or the condensate must be lifted after the HX, and how to select the proper size Pumping Trap.

Figure 18: Heat Exchanger System with Steam Trap at Maximum Load



HEAT EXCHANGER SIZING

The basic formula describing the heat transfer in a heat exchanger is $\mathbf{E = U \times A \times \Delta T_M}$, where **E**(Btu/hr) is the average heat transfer rate, **U** is the overall heat transfer coefficient, **A**(ft^2) is the heat transfer surface area (size) of the HX and $\mathbf{\Delta T_M}$ is the average temperature difference between the steam and water being heated.

A) What is the design heat load (E_D) for this application?

The first step in sizing a HX is to calculate the maximum heat load (Btu/hr) required to heat the water. The design heat load (**E_D**) of the heat exchanger is the maximum heat load that needs to be transferred by the steam to the water based on the given conditions. The maximum heat load occurs at the maximum water flow, which is 100 GPM. Using ***Formula 5***:

$$\mathbf{E_D = Q_w \times 500 \times C_p \times \Delta T_w}$$

$$= 100 \text{ GPM} \times \frac{500 \text{ lbs/hr}}{1 \text{ GPM}} \times 1.0 \text{ Btu/(lb-°F)} \times (140°\text{F} - 50°\text{F})$$

$$= 50{,}000 \text{ lbs/hr} \times 1.0 \text{ Btu/(lb-°F)} \times 90°\text{F}$$

$$= \mathbf{4{,}500{,}000 \text{ Btu/hr}}$$

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B) What is the mean temperature difference (ΔT_M) between the steam and the water being heated?

From the HX formula we can see that in order to determine the size of the HX required to heat the water, we must first know the steam temperature (which is directly related to steam pressure) in the HX during the period of maximum demand. The steam pressure in the HX is dependent on the pressure drop across the control valve. **For optimal control in heating applications, it is typical to target a 50% pressure drop across the valve at the maximum steam load.** Therefore, at full load, the pressure drop across the control valve is 50 PSIG and the steam pressure supplied to the heat exchanger is also 50 PSIG.

As the steam (primary fluid) passes thru the heat exchanger, it transfers its latent heat energy to the water (secondary fluid) and condenses without a change in temperature. Therefore, the condensate leaving the heat exchanger is at the same temperature as the steam entering. From the saturated steam table, the steam temperature (**T_S**) of 50 PSIG saturated steam is 298°F. The water inlet temperature (**T_i**) is 50°F and the water outlet temperature (**T_o**) is 140°F.

We now have enough information to calculate the mean temperature difference between the steam (primary fluid) and water (secondary fluid). ***Formula 3*** is used to calculate the mean temperature difference (**ΔT_M**) which is the average of the temperature differences at both ends of the HX:

$$\Delta T_M = \frac{(T_S - T_o) + (T_S - T_i)}{2} = \frac{(298 - 140) + (298 - 50)}{2} = \frac{158 + 248}{2} = \frac{406}{2} = \mathbf{203°F}$$

C) What is the Overall heat transfer coefficient (U) of the heat exchanger?

The U value of the HX depends on several factors, including type of HX, the quality of the steam used, if any fouling is expected, if the flow of water is turbulent or laminar, and the material of construction. The higher the U value, the better the heat transfer, and the smaller the HX needs to be. Typical U values range from 120 for a stainless steel HX to over 200 for copper. For this example, a Stainless Steel HX was selected for longevity purposes and so a U value of 120 will be used to determine the HX size.

D) What is the minimum heat transfer surface area (A) of the heat exchanger that can meet the design heat load?

The size of a HX is dependent on the steam pressure inside its shell. The higher the steam pressure, the smaller the HX for a given heat load. 50 PSIG was chosen because the supply pressure is 100 PSIG and this gives a 50% pressure drop across the control valve, as previously discussed. If a lower steam pressure is used, this would require a larger HX, and vice versa.

In a heat exchanger, the mean heat transfer rate is proportional to the mean temperature difference between the two fluids, as given by ***Formula 1***. Rearranging this equation gives ***Formula 2***, where **E** has been replaced by **E_D**, the design heat load. Using ***Formula 2*** and the mean temperature difference determined above, gives the heat transfer surface area:

$$A = \frac{E_D}{U\,\Delta T_M} = \frac{4{,}500{,}000 \text{ Btu/hr}}{120 \text{ Btu/(hr-ft}^2\text{-°F)} \times 203°F} = \mathbf{185\ ft^2}$$

Therefore, for a perfectly sized heat exchanger, the heat transfer area of the tube is 185 square feet. In practice, the heat exchanger is usually oversized by at least 15% to account for fouling of the heating surfaces over time or to allow for an increase in the maximum heat load.

Heat Exchanger Example:

Heating Water with Steam using a Modulating Control Valve

CONTROL VALVE SIZING

E) What is the flow of steam (steam capacity) thru the control valve at the design heat load?

Formula 6 gives the mass flow rate of steam based on the heat load and the latent heat of saturated steam (LH). From the saturated steam table, the latent heat of 50 PSIG steam is 912 Btu/lb. Therefore, the steam capacity is:

$\mathbf{Q_S = E_D / LH}$ = 4,500,000 Btu/hr / 912 Btu/lb = **4,934 lbs/hr**

F) How must the control valve be sized?

The valve must be sized for the maximum steam capacity of the application, which occurs at the maximum (design) heat load of the heat exchanger. We first need to determine if the pressure drop across the valve at the maximum flow rate is above or below the critical pressure drop, so that we can apply the correct formula:

Valve Inlet Pressure (P_1) = Steam Supply Pressure = 100 PSIG + 14.7 = **114.7 PSIA**

Valve Outlet Pressure (P_2) = Heat Exchanger Pressure = 50 PSIG + 14.7 = **64.7 PSIA**

Differential Pressure (ΔP) = $P_1 - P_2$ = 114.7 – 64.7 = **50 PSI**

Critical Pressure Drop ($\Delta P_{critical}$) = 0.42 P_1 = 0.42 (114.7) = **48.2 PSI**

Since the pressure drop across the valve (50 PSI) is greater than the critical pressure drop (48.2 PSI), the steam flow thru the valve is critical. Therefore, we apply ***Formula 12b*** to calculate the valve coefficient:

$\mathbf{C_v = Q_S / (1.71 \times P_1)}$ = 4,934 / (1.71 x 114.7) = 4,934 / 196.1 = 25.2

Therefore, the control valve must have a flow coefficient of at least 26.

G) What Watson-McDaniel Control Valve should be selected for this application?

Refer to the Control Valves section of this catalog. The Watson McDaniel **HB-Series 2-Way Pneumatic Control Valve** is used for heating and cooling applications. Since this is a heating application with steam, a Normally-Closed, Air-To-Open (ATO) valve should be selected. (This is a fail-safe feature in case the air signal to the valve actuator becomes interrupted. If the air signal is lost, the valve will automatically close and block the flow of steam.)

Referring to the HB Control Valve Selection chart, a full-port valve with Cv value of 42 should be selected. The Model Number for this valve with NPT ports is **HB-17-N-ATO**. This valve has a 2" NPT connection size, stainless steel body and trim, and a pressure-temperature rating of 300 PSIG @ 450°F.

Heat Exchanger Example:
Heating Water with Steam using a Modulating Control Valve

H) What is the maximum close-off pressure of the control valve selected in Part G?

From the HB Control Valve Selection chart, the maximum close-off pressure for the selected valve is 85 PSI ΔP if no positioner is used, and 135 PSI ΔP if a positioner is used.

I) For the selected control valve, is a positioner required to completely shut off the flow of steam to the heat exchanger?

When the control valve is completely closed, the pressure drop across the valve is at its maximum value:

$$\Delta P_{MAX} = \text{Steam Supply Pressure} - \text{Heat Exchanger Pressure}$$
$$= 100 \text{ PSIG} - 0 \text{ PSIG}$$
$$= 100 \text{ PSI}$$

Thus, the control valve must have a close-off pressure capability of at least 100 PSI. Without a positioner, the maximum close-off pressure of the valve is 85 PSI. Therefore, a valve positioner is necessary to provide the required closing force to the actuator diaphragm.

In a normally-closed valve, the valve is held closed by a spring force. The spring pressure is set so that the valve will stay closed against an inlet pressure of 85 PSIG. The opening action is performed by the 3-15 PSIG air signal to the actuator diaphragm. When the air signal is 15 PSIG, the valve will completely open against the spring pressure. When the air signal is 3 PSIG, the valve will stay closed provided that the inlet pressure does not exceed 85 PSIG. If the inlet pressure exceeds 85 PSIG, the valve will open and a positioner will then be required to decrease the air signal pressure below 3 PSIG to allow the valve to fully close.

Heat Exchanger Example:
Heating Water with Steam using a Modulating Control Valve

STEAM TRAP SIZING

J) What type and size of steam trap should be chosen for this application?

Initially we will assume that the condensate from the HX is being discharged to a condensate return line at atmospheric pressure (0 PSIG). At full-load, the steam pressure at the inlet of the trap is 50 PSIG. We have already calculated the maximum condensate load that would be generated at this pressure to be around 5,000 lbs/hr (see Part E). If this was the only set of conditions, selection of the steam trap would be fairly simple. We simply look at the capacity chart and choose a steam trap that will pass at least 5,000 lbs/hr at 50 PSI differential pressure. (See the capacity chart below for the FTE Series Float & Thermostatic steam traps.)

However, at different flow rates of water, the HX will have very different pressures. At a flow rate of ~58 GPM, the pressure in the HX drops to 0 PSIG and the HX is still producing condensate at the rate of ~2,700 lbs/hr. This condensate still needs to be drained from the HX but how can this happen with NO differential pressure? The purpose of having an extended drip leg under the HX is to give the trap a certain amount of head pressure. If the trap is mounted 14 inches below the HX, this will correspond to ½ PSI of head pressure. The trap must then be able to pass at least 2,700 lbs/hr of condensate at ½ PSI ΔP.

CAPACITIES – *Condensate (lbs/hr)*

Model Code	PMO (PSIG)	Pipe Size	Orifice Size	Differential Pressure (PSI) 1/4	1/2	1	2	5	10	15	20	30	50	75	100	125	200	250	300
FTE-20-17-N*	20	2″	.937″	6100	7800	9300	11800	15900	19500	22500	26000								
FTE-50-17-N	50	2″	2.125″	12800	16900	20100	25300	33000	40200	43500	46000	47800	52500						
FTE-50-18-N	50	2½″	2.125″	20400	25700	31000	37000	46300	55100	60300	65100	72000	82100						
FTE-125-18-N	125	2½″	2.125″	20400	25700	31000	37000	46300	55100	60300	65100	72000	82100	90400	97700	105000			
FTE-200-16-N	200	1½″	.375″	950	1350	1900	2200	2700	3300	3900	4400	5300	6400	7600	8500	9400	11900		
FTE-200-17-N	200	2″	.75″	2700	4100	5700	7400	9900	11800	13400	14400	16400	19000	21500	23000	24500	29200		
FTE-200-18-N	200	2½″	1.5″	7200	12300	17400	21500	27600	32600	36000	39300	43100	49200	54700	58800	61900	74000		
FTES-50-18-N	50	2½″	2.125″	20400	25700	31000	37000	46300	55100	60300	65100	72000	82100						
FTES-125-18-N	125	2½″	2.125″	20400	25700	31000	37000	46300	55100	60300	65100	72000	82100	90400	97700	105000			
FTES-300-18-N	300	2½″	1.5″	7200	12300	17400	21500	27600	32600	36000	39300	43100	49200	54700	58800	61900	74000	86000	100550

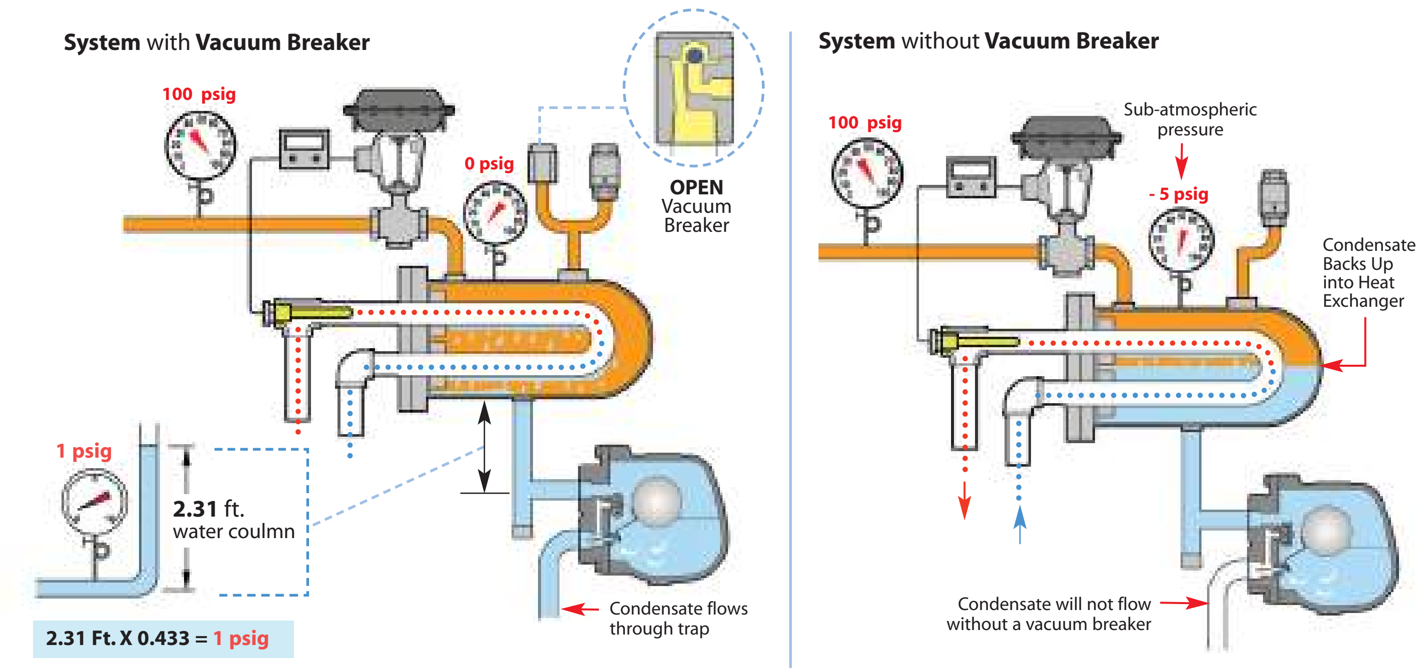
** Single seat orifice. All others are double seated.*

As a general rule, for HX applications using steam pressures over 30 PSIG, the steam trap should be sized for 2.5X maximum condensate load at full differential pressure. Therefore, to provide an appropriate safety margin, we must select a trap that can pass 2.5 x 5,000 = 12,500 lbs/hr of condensate at 50 PSI ΔP. In addition, the steam trap must be able to handle the maximum possible inlet pressure which is 100 PSIG (the steam supply pressure). Referring to the FTE capacity chart above; the best trap to select is the **FTE-200-17-N**. This trap can pass 19,000 lbs/hr at 50 PSI ΔP and 4,100 lbs/hr at ½ PSI ΔP, which meets the above criteria.

Heat Exchanger Example:
Heating Water with Steam using a Modulating Control Valve

Now, what happens when the water flow rate thru the HX reduces to the point that the steam pressure goes into vacuum? This occurs at water flow rates below about 58 GPM down to the minimum of 25 GPM. Since the HX will be operating in vacuum, the condensate would not effectively drain regardless of the steam trap size chosen. This is why a vacuum breaker must be added to the top of the HX. The vacuum breaker draws in air to neutralize the pressure in the HX which allows the condensate to drain (see Figure 19).

Figure 19: **Heat Exchanger System with Steam Trap shown with and without Vacuum Breaker**



The HX can be properly drained using a steam trap as long as there is no BACK PRESSURE in the condensate return line. If there is back pressure in the condensate return line, a Pumping Trap must be used.

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Heat Exchanger Example:

Heating Water with Steam using a Modulating Control Valve

PUMP-TRAP SIZING

K) If the condensate return line has a total back pressure of 10 PSIG, can a steam trap be used to drain the heat exchanger?

At full-load conditions, the steam pressure is 50 PSIG and the condensate load is ~5,000 lbs/hr. Since the total back pressure of the return line is 10 PSIG, the differential pressure across the steam trap is 40 PSI. An appropriately sized steam trap can handle this situation. However, when the steam pressure is reduced to 10 PSIG or lower, due to lower heat demand, the differential pressure across the steam trap will be 0 PSIG or less. Without positive differential pressure across the trap, the condensate cannot drain from the HX. During this situation, the condensate will back up into the HX shell. Therefore, a steam trap will not be effective in discharging condensate from the HX under **all** conditions.

L) If the water flow rate is reduced, less heat energy per unit of time is needed to heat the water and therefore the heat load will also reduce. This will cause a reduction in steam flow and pressure in the heat exchanger. If the steam pressure falls to or below the system back pressure, the condensate will begin to back up into the heat exchanger, causing the system to stall. Why is it important to prevent stall from occurring?

Condensate flooding the heat exchanger space will cause poor temperature control, accelerated corrosion and potentially damaging waterhammer. These factors can cause rapid or premature failure of the unit, leading to costly repairs and downtime.

M) For the heat exchanger size (surface area) calculated in Part D, what is the flow rate of water at which stall will occur?

We will use two methods to calculate the water flow rate at stall and then compare the two methods.

Method 1: Based on Heat Exchanger Size

Stall occurs at the point where the steam pressure equals the back pressure. The steam pressure at stall is therefore 10 PSIG. From the saturated steam table, this is equivalent to a steam temperature (**Ts**) of 239°F. ***Formula 3*** can now be used to calculate the mean temperature difference between the steam and water:

$$\Delta T_M = \frac{(T_S - T_o) + (T_S - T_i)}{2} = \frac{(239 - 140) + (239 - 50)}{2} = \frac{99 + 189}{2} = \frac{288}{2} = 144°F$$

The heat load at stall is then calculated from ***Formula 1***:

$\mathbf{E_{stall} = U\ A\ \Delta T_M}$ = 120 Btu/(hr-ft^2-°F) x 185 ft^2 x 144°F = 3,196,800 Btu/hr

Finally, the volumetric flow rate of water at stall is calculated from ***Formula 8:***

$$\mathbf{Q_{w\text{-}stall} = E_{stall} / [500 \times (T_o - T_i)]}$$

$$= \frac{3{,}196{,}800}{[500 \times (140 - 50)]} = \frac{3{,}196{,}800}{(500 \times 90)} = \frac{3{,}196{,}800}{45{,}000}$$

= **71 GPM**

Method 2: Based on % Stall Load Formula

$\mathbf{T_S}$ = Steam temperature at full-load = 298°F (50 PSIG steam)

$\mathbf{T_B}$ = Back pressure equivalent saturated steam temperature = 239°F (10 PSIG steam)

$\mathbf{T_{WM}}$ = Mean water temperature = $\frac{T_o - T_i}{2} = \frac{140 + 50}{2} = 95°F$

Using ***Formula 9***:

$$\textbf{\% Stall Load} = \frac{T_B - T_{WM}}{T_S - T_{WM}} \times 100 = \frac{239 - 95}{298 - 95} \times 100 = .71 \times 100 = 71\%$$

The water flow rate at stall is then calculated using ***Formula 10***:

$\mathbf{Q_{stall} = Q_{w\text{-}full\ load} \times (\%\ Stall\ Load)/100}$ = 100 GPM x 71/100 = **71 GPM**

Heat Exchanger Example:
Heating Water with Steam using a Modulating Control Valve

Comparison of Methods:

Both methods gave the same result for the water flow rate at which stall will occur: 71 GPM. This means that at flows at or below 71 GPM, the steam pressure in the system is insufficient to push the condensate thru the steam trap and into the return line. The condensate will therefore back up into the heat exchanger unless something is done to prevent it.

The main difference between the two methods is that the heat exchanger size was needed to calculate the stall flow rate using **Method 1**, but not needed using **Method 2**.

N) How can stall (condensate back-up) be prevented?

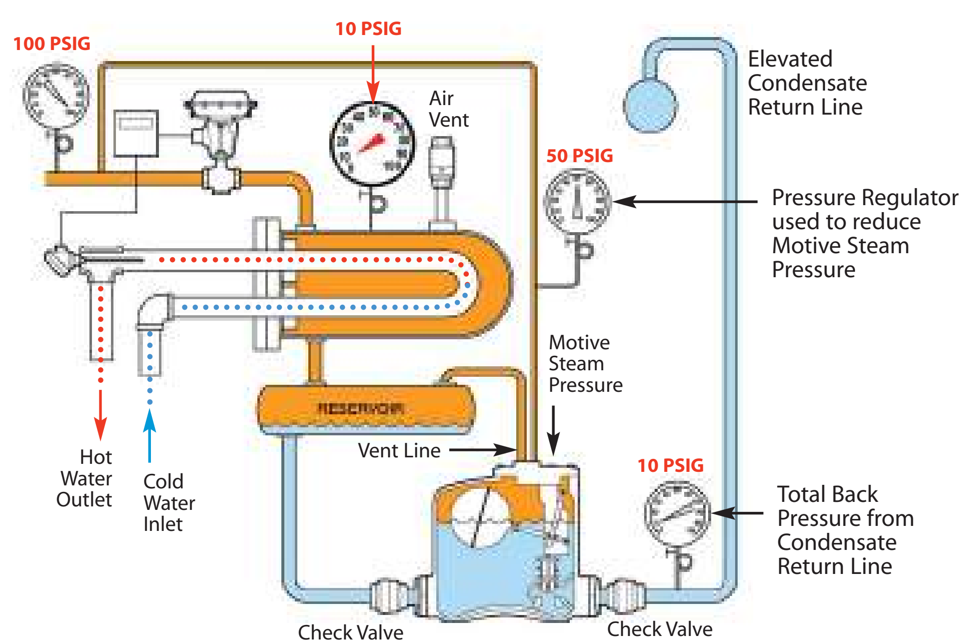
Stall can be prevented by replacing the steam trap with a pump-trap (i.e., a pressure motive pump and steam trap combination). Pump-traps are available with either internal or external steam traps, depending on capacity requirements.

When there is sufficient steam pressure to push the condensate thru the trap, the pump is not used and the pump-trap is operating in **trap mode**. The condensate will pass thru the pump body and thru the trap. The trap must be sized to handle the condensate at full-load conditions as well as when the trap differential pressure is slightly above 0 PSI (i.e., just above the stall point). In addition, the orifice size of the trap should be optimized to handle the high instantaneous discharge flow rate when the pump is operating. This will reduce the discharge time of the pump and its overall fill/discharge cycle. Watson McDaniel pump-traps have the trap size optimized for all conditions.

When the steam pressure drops to or below the back pressure, the condensate will start to fill the pump tank. When the float in the tank reaches the upper trip point, the mechanism will open the steam valve while simultaneously closing the vent valve. High pressure steam will then force the condensate thru the trap and into the condensate return line. Check valves are used with the pump to prevent the backflow of condensate. When the pump is emptied, the float mechanism will then simultaneously close the steam valve and open the vent valve so the pump can fill on the next cycle. When the pump is being used, the pump-trap is operating in **pump mode**. The pump must be sized to handle the condensate load at the stall point. That is, when the steam pressure is equal to the back pressure.

When sizing Pressure Motive Pumps in closed-loop return systems, a condensate **reservoir** should be installed on the inlet side of the pump and below the HX, as shown in Figure 20. This will enable the condensate to collect while the pump is in the discharge cycle, thus preventing liquid backup into the HX. The reservoir should be located 12" above the top of the pump tank to provide adequate filling head. The reservoir must have sufficient size (volume) to provide adequate vapor space for the condensate to collect during the pump's discharge cycle and for the pump to vent during its filling cycle. The vent line also acts as a balancing line to allow condensate to drain into the pump tank while the HX is operating in vacuum.

Figure 20: Heat Exchanger System with Pump-Trap at Stall Load



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Heat Exchanger Example:
Heating Water with Steam using a Modulating Control Valve

O) If a pump-trap is used to prevent stall, what capacity must the pump have?

The maximum condensate load that the pump must discharge occurs at the stall point (i.e., when the steam pressure is equal to the total back pressure of the condensate return line). This can be determined from the steam load at the stall point, using ***Formula 6***. The heat load at stall was determined in Part M to be 3,196,800 Btu/hr. The steam temperature at stall was also determined in Part M to be 239˚F. From the steam table, the latent heat of steam at 239˚F is 953 Btu/lb. The steam capacity is:

$\mathbf{Q_S = E_{stall} / LH}$ = 3,196,800 Btu/hr / 953 Btu/lb = **3,354 lbs/hr**

The maximum condensate load at stall conditions is therefore 3,354 lbs/hr and the pump must be sized to remove condensate at this rate.

P) What Watson-McDaniel Pump-Trap should be selected for this application?

Referring to the pump-trap capacity chart when operating in **Pump Mode**, it can be seen that model **WPT3** (pump with external trap mounted on common base) can meet the condensate load at stall (3,354 lbs/hr) when the motive steam pressure is 50 PSIG and the total back pressure is 10 PSIG. Under these conditions, this model has a maximum capacity of 4,080 lbs/hr. Since the steam supply pressure is 100 PSIG, a pressure regulator can be used to reduce the pressure to 50 PSIG for the motive steam line.

MINIMUM LOAD & OPERATION IN VACUUM

Q) What is the minimum heat load of the application?

The minimum heat load occurs at the minimum water flow of 25 GPM. Using ***Formula 5***:

$$\mathbf{E_{min} = Q_w \times 500 \times C_p \times \Delta T_w}$$
$$= 25 \text{ GPM} \times \frac{500 \text{ lbs/hr}}{1 \text{ GPM}} \times 1.0 \text{ Btu/(lb-°F)} \times (140°F - 50°F)$$
$$= 12{,}500 \text{ lbs/hr} \times 1.0 \text{ Btu/(lb-°F)} \times 90°F$$
$$= \mathbf{1{,}125{,}000 \text{ Btu/hr}}$$

R) What is the steam temperature in the heat exchanger at the minimum load?

Use ***Formula 1*** to calculate the mean temperature difference between the steam and water:

$$\mathbf{\Delta T_M = E_{min} / (U\ A)} = 1{,}125{,}000 \text{ Btu/hr} / (120 \text{ Btu/(hr-ft}^2\text{-°F)} \times 185 \text{ ft}^2) = 50.7°F$$

The steam temperature is then given by ***Formula 4***:

$$\mathbf{T_S} = \mathbf{\Delta T_M} + \mathbf{T_{WM}} = \mathbf{\Delta T_M} + \mathbf{\frac{T_o + T_i}{2}} = 50.7 + \frac{140 + 50}{2} = 50.7 + \frac{190}{2} = 50.7 + 95 = \mathbf{146°F}$$

S) What is the steam pressure in the heat exchanger at the minimum load?

From the steam table (using extrapolation), the steam pressure corresponding to 146°F saturated steam is 22.7 in Hg Vacuum which is equivalent to -11.1 PSIG. Therefore, the steam pressure inside the heat exchanger is below atmospheric pressure.

This is another advantage in the use of a pump-trap. If a steam trap is used to drain condensate, the system could not operate in vacuum since the condensate would never drain out. Therefore, a vacuum breaker is used which essentially mixes the steam with air to achieve the proper temperature differential for a particular size HX. This added air facilitates corrosion by forming carbonic acids. Some of this air is eventually discharged thru the air vent on top of the HX but some mixes with the condensate. A pump-trap can discharge condensate when the HX is operating in vacuum, which precludes the use of a vacuum breaker and thus air is prevented from entering the system.

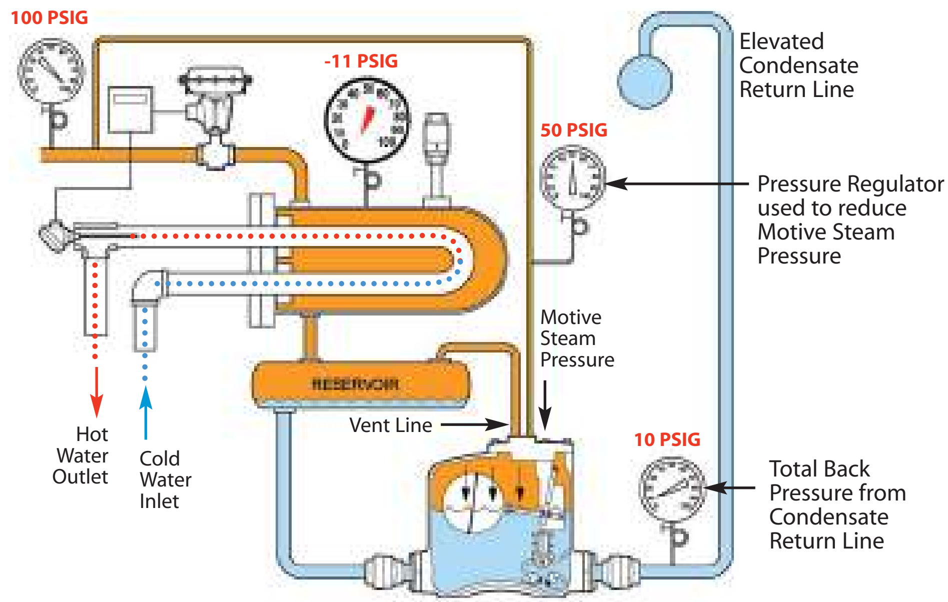
Heat Exchanger Example:
Heating Water with Steam using a Modulating Control Valve

T) What is the flow of steam (steam capacity) thru the control valve at the minimum load?

From the steam table (using extrapolation), the latent heat of steam (LH) corresponding to 146°F saturated steam is 1,011 Btu/lb. Using ***Formula 6***, the steam capacity is:

$\mathbf{Q_S = E_{min} / LH}$ = 1,125,000 Btu/hr / 1,011 Btu/lb = **1,113 lbs/hr**

Figure 21: **Heat Exchanger System with Pump-Trap at Minimum Load**



SUMMARY of HEAT EXCHANGER SYSTEM

The following table summarizes the above results and shows how the heat load and the pressure, temperature, latent heat and flow of steam vary as a function of the water flow rate. It can be seen that the system is operating in **Trap Mode** between water flow rates of 100 and 71 GPM, and in **Pump Mode** between 71 and 25 GPM. Also, at flow rates below ~58 GPM, the steam pressure inside the HX is below atmospheric pressure (0 PSIG).

Flow Rate Water (GPM)	Heat Load (Btu/hr)	Steam Usage (lbs/hr)	Steam Pressure in HX (PSIG)	Steam Temp in HX (°F)	Latent Heat of Steam (Btu/lb)	Condensate Generated (lbs/hr)	Trap Differential Pressure (PSI)	System Condition	
100	**4,500,000**	**4,934**	**50**	**298**	**912**	**4,934**	**40**	Trap Mode	**(Maximum Heat Load)**
94.7	4,262,400	4,633	40	287	920	4,633	30		
88.3	3,973,800	4,278	30	274	929	4,278	20		
80.9	3,640,800	3,873	20	259	940	3,873	10		
71.0	**3,196,800**	**3,354**	**10**	**239**	**953**	**3,354**	**0**	(Stall Point)	**Steam Pressure = Back Pressure**
57.7	2,597,400	2,678	0	212	970	2,678	---	**Pump Mode**	
47.9	2,153,400	2,191	-5	192	983	2,191	---	(Vacuum)	
25	**1,125,000**	**1,113**	**-11**	**146**	**1,011**	**1,113**	---		**(Minimum Heat Load)**

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Product Cross Reference

Watson McDaniel

Steam Traps

THERMODYNAMIC TRAPS

Manufacturer		Watson McDaniel		Armstrong		Spence Nicholson		Hoffman		Spirax Sarco		Yarway		TLV	
Desc.	Size	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim
Standard 600 PSI															
Disc Trap	3/8″	TD600	2″	CD-33		NTD600	2″	TD6523	2″	TD-52	2″	29	2″		
	1/2″		2.7″		3.31″		2.68″	TD6524	2.75″		2.7″		2.25″		
	3/4″		2.8″		3.31″		2.81″	TD6526	2.75″		2.8″		2.87″		
	1″		3.3″		3.31″		3.31″	TD6528	3.25″		3.3″		3.37″		
Low Capacity Disc Trap	1/2″	TD600L	2.7″	CD-33L	3.31″	S610L	3.25″			TD-52L	2.7″				
	3/4″		2.8″		3.31″		3.25″				2.8″				
Low Capacity Disc Trap w/ Strainer	1/2″	TD600LS	3.1″	CD-33SL	3.31″					TD-42L	3.1″				
	3/4″		3.5″		3.31″						3.5″				
	1″		3.7″		3.31″						3.7″				
Disc Trap with Strainer	1/2″	TD600S	3.1″	CD-33S	3.5″	NTD600S	2″	TD6424 TD6426	3.06″ 3.06″	TD-42H	3.1″	129Y	2.76″	A3N P46SS	3.87″ 2.75″
	3/4″		3.5″		3.5″		2.68″	TD6428	3.25″		3.5″		2.95″	A3N P46SS	4.06″ 2.75″
Disc Trap with Strainer & Blowdown	1/2″	TD600SB	3.5″	CD-33SB	3.5″	NTD600SB	2″			TD-42HB	3.1″	129YB	2.76″	A3N P46SS	3.87″ 2.75″
	3/4″		3.7″		3.5″		2.68″				3.7″		2.95″	A3N P46SS	4.06″ 2.75″
Low Cap. Disc Trap w/ Strainer & Blowdown	1/2″	TD600LSB	3.1″	CD-33SBL						TD-42LB	3.1″				
	3/4″		3.5″		3.5″						3.5″				
	1″		3.7″								3.7″				
Repairable In-line															
Disc Trap with Strainer	1/2″	TD700S	3.16″			S610	3.25″					721	3.15″	A46S A50S P46SRN	3.12″
	3/4″		3.55″										3.54″	A46S A50S P46SRN	3.12″
	1″		6.31″										3.93″	A46S A50S P46SRN	3.43″
Disc Trap with Strainer & Blowdown	1/2″	TD700SB	3.16″									721	3.15″	A46S A50S P46SRN	3.12″
	3/4″		3.55″										3.54″	A46S A50S P46SRN	3.12″
	1″		6.31″										3.93″	A46S A50S P46SRN	3.43″
High-Pressure Repairable In-line															
Disc Trap with Strainer	1/2″	TD700HS	3.15″									721HP	3.15″		
	3/4″		3.54″										3.54″		
	1″		6.31″										3.93″		
Disc Trap w/ Strainer & Blowdown	1/2″	TD700HSB	3.15″										3.15″		
	3/4″		3.54″										3.54″		
	1″		6.31″										3.93″		
High-Pressure Repairable In-line – 900 PSI															
Disc Trap with Strainer	1/2″	TD900S	3.6″							TD62	3.6″	460D3	4.81″	A65SS	3.12″
	3/4″		3.6″								3.6″		4.81″		3.12″
Ultra High-Pressure Repairable In-line – 3600 PSI															
Disc Trap	1″	TD3600	6.5″							TD120	3.9″		4.81″		3.43″
	1/2″		6.2″								6.2″				
	3/4″		6.2″								6.2″				
	1″		6.2″								6.2″				

Steam Traps (continued)

THERMOSTATIC TRAPS

Manufacturer		Watson McDaniel		Armstrong		Spence Nicholson		Spirax Sarco		Hoffman		TLV	
Desc.	Size	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim
Non-Repairable													
Thermostatic 300 PSI	1/2″	WT1000	2.5″					TSS300	2.5″			LV21	2.18″
	3/4″		2.5″						2.5″				2.18″
Thermostatic 650 PSI	1/2″	WT2000C	3.75″	WT-1	4.5″	TA	3.75″	DTS300	2.5″				
	3/4″		3.75″	TTF-1	4.69″		3.93″		2.5″				
Repairable													
Thermostatic 250 PSI	1/2″	WT2500	3″			N450	3″						
	3/4″		3″				3″						
Thermostatic 650 PSI	1/2″	WT3000	4.5″			N650	5″						
	3/4″		4.5″				5″						
Thermostatic 650 PSI with Strainer	1/2″	WT3000S	4.5″			N650Y	5″	TM600N	5.25″			L21S L32S	3.12″
	3/4″		4.5″				5″		5.25″			L21S L32S	3.12″
Thermostatic 650 PSI with Strainer & Blowdown	1/2″	WT3000SB	4.5″			N650Y	5″						
	3/4″		4.5″				5″						
Thermostatic 300 PSI	3/4″	WT4000	4.5″			N450	3″						
	1″		4.5″				3″						
Thermostatic 300 PSI with Strainer	3/4″	WT4000S	4.5″			N450Y	3″						
	1″		4.5″				3″						
Thermostatic 300 PSI w/ Strainer & Blowdown	3/4″	WT4000SB	4.5″			N450Y	3″						
	1″		4.5″				3″						
Thermostatic 125 PSI, Angle*	1/2″	TA125	2.81″	TS-3	3.12″	N125	2.75″	RTA-125	2.8″	17C	3.24″	RT3A	3.12″
	3/4″		3.06″		3.5″		3.18″		3″	8C	3.12″		3.06″
Adjustable Bi-Metallic													
1/2″		WT5000	2.75″									LEX3N-TZ LEXW3N-TZ LEXF3N-TZ	2.75″
3/4″			3.12″									LEX3N-TZ LEXW3N-TZ LEXF3N-TZ	3.12″
1″			3.12″									LEX3N-TZ LEXW3N-TZ LEXF3N-TZ	3.12″

* Right Angle (90˚) Ports

Steam Traps (continued)

FLOAT & THERMOSTATIC TRAPS

Manufacturer		Watson McDaniel		Armstrong		Hoffman		Spence Nicholson		Spirax Sarco		TLV	
Desc.	Size	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim
Ductile Iron – Repairable In-Line													
In-Line	1/2"	FTT	4.8"	BI2	2.75"	FTI	5.5"	FTE10	5.06"	FT14	4.8"	J3X	4.75"
	3/4"		4.8"	BI3	2.75"		5.5"		5.06"		4.8"		4.75"
	1"		4.8"	BI4	3"		5.5"		5.06"		4.7"		4.75"
	1.5"		10.6"	BI6	4.18"				11.12"		10.6"	JS7X	11"
	2"		11.9"	BI8	6"				12.12"		11.9"	J87	21.31"
High Capacity	1.5"	FTE	3"					HC	3"	FTB	3"		
	2"		4.5"	J&L	6.62"	FT-X-8	6.3"		6.62"		4.5"		
	2.5"		7.25"	K&M	11.31"	FT-C-10	9.5"		9.5"		7.25"		
Cast Iron – Repairable In-Line													
15 PSI	3/4"	WFT-015	3.3"	15-B3	2.75"	FT015H-3	3.93"	FTN	3.31"	FT-15	3.3"	SJ3-1	3.31"
	1"		3.3"	15-B4	3"	FT015H-4	3.93"		3.31"		3.3"	SJ3-1	5.12"
	1.25"		3"	15-B5	3"	FT015H-5	3"		3"		3"	SJ5-1	3"
	1.5"		3"	15-B6	4.18"	FT015H-6	3"		3"		4.25"	SJ6-1	4.93"
	2"		4.9"	15-B8	6"	FT015H-8	4.94"		4.94"		4.9"	SJ6-1	4.93"
30 PSI	3/4"	WFT-030	3.3"	30-B3	2.75"	FT030H-3	3.31"	FTN	3.31"	FT-30	3.3"	SJ3-2	5.12"
	1"		3.3"	30-B4	3"	FT030H-4	3.31"		3.31"		3.3"	SJ3-2	5.12"
	1.25"		3"	30-B5	3"	FT030H-5	3"		3"		3"	SJ5-2	3"
	1.5"		3"	30-B6	4.18"	FT030C-6	3"		3"		4.25"	SJ6-2 SJ7-2	4.06"
	2"		4.9"	30-B8	6"	FT030C-8	4.94"		4.94"		4.9"	SJ6-2 SJ7-2	4.93"
75 PSI	3/4"	WFT-075	3.3"	75-A3	2.75"	FT075H-3	3.31"	FTN	3.31"	FT-75	3.3"	SJ3-5	5.12"
	1"		3.3"	75-A4	3"	FT075H-4	3.31"		3.31"		3.3"	SJ3-5	5.12"
	1.25"		3"	75-A5	3"	FT075C-5	3"		3"		4.25"	SJ5-5	3"
	1.5"		3"	75-A6	4.18"	FT075C-6	3"		3"		4.25"	SJ6-10 SJ7-10	4.93"
	2"		4.9"	75-A8	6"	FT075C-8	4.94"		4.94"		4.9"	SJ6-10 SJ7-10	4.93"
125 PSI	3/4"	WFT-125	3.3"	125-A3	2.75"	FT125H-3	3.31"	FTN	3.31"	FT-125	3.3"	SJ3-10	5.12"
	1"		3.3"	125-A4	3"	FT125H-4	3.31"		3.31"		3.3"	SJ3-10	5.12"
	1.25"		3"	125-A5	3"	FT125C-5	3"		3"		4.25"	SJ5-10	3"
	1.5"		3"	125-A6	4.18"	FT125C-6	3"		3"		4.25"	SJ6-10 SJ7-10	4.93"
	2"		4.9"	125-A8	6"	FT125C-8	4.94"		4.94"		4.9"	SJ6-10 SJ7-10	4.93"
175 PSI	3/4"	WFT-175	3"	175-A3	2.75"	FT175H-3	3.31"			FT-200	3.3"	SJ3-14	5.12"
	1"		3"	175-A4	3"	FT175H-4	3.31"				3.3"	SJ3-14	5.12"
	1.25"		3"	175-A5	3"	FT175C-5	3"				4.25"	SJ5-14	3"
	1.5"		3"	175-A6	4.18"	FT175C-6	3"				4.25"	SJ6-14 SJ7-14	4.93"
	2"		4.5"	175-A8	6"	FT175C-8	4.94"				4.9"	SJ6-14 SJ7-14	4.93"
250 PSI	3/4"	WFT-250	3"							FT-200	3.3"	SJ3-14	5.12"
	1"		3"								3.3"	SJ3-14	5.12"
	1.25"		3"								4.25"	SJ5-14	3"
	1.5"		3"								4.25"	SJ6-14 SJ7-14	4.93"
	2"		4.5"								4.9"	SJ6-14 SJ7-14	4.93"
H Pattern 15 PSI	3/4"	FT3	4.12"			FT015H-3	3.31"						
	1"	FT4	4.12"			FT015H-4	3.31"						
	1.25"	FT6	5"			FT015H-5	3"						
	1.5"	FT7	6.37"			FT015H-6	5.25"						
	2"	FT8	6.5"			FT015H-8	7.46"						
H Pattern 30 PSI	3/4"	FT33	4.12"			FT030H-3	3.31"						
	1"	FT34	4.12"			FT030H-4	3.31"						
	1"	FT35	5"										
	1.25"	FT36	5"			FT030H-5	3"						
	1.5"	FT37L	6.37"			FT030H-6	5.25"						
	2"	FT38	6.5"										
H Pattern 75 PSI	3/4"	FT73	4.12"			FT075H-3	3.31"						
	1"	FT74	4.12"			FT075H-4	3.31"						
	1"	FT75	5"										
	1.25"	FT76	5"										
	1.5"	FT77L	6.37"										
	2"	FT78	6.5"										

Steam Traps (continued)

FLOAT & THERMOSTATIC TRAPS (continued)

Manufacturer		Watson McDaniel		Armstrong		Hoffman		Spence Nicholson		Spirax Sarco		TLV	
Desc.	Size	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim
Carbon Steel													
In-Line	3/4"	FT600	6.1"	CS	6.75"			FTE44 NFT650	5.12" 5.5"	FT450	6.1"	JH3X	5.12"
	1"		6.5"	CS	8.37"			FTE44 NFT650	5.12" 11"	FT450	6.5"	JH3X	5.25"
	1.5"		9.8"	CS	11"			FTE44 NFT650	11.12" 13.75"	FT450	9.8"	JH7.2X	16"
	2"		11.8"	CS	11"			FTE44 NFT650	12.12" 13.75"	FT450	11.8"	JH8RX	23.25"
	3"		27.55" 39"							FT450	27.55" 39"	JL10 JL16	10.32"
	4"		39"							FT450	39"	J10	23.43" 24.06"
Offset	2.5"	FTES	8.4"	LS	11.31"					FTB	9.25"		
Stainless Steel													
In-Line	3/4"	FT601	6.1"							FT46	5.8"		
	1"		6.5"								6.2"		
	1.5"		9.8"								9"		
	2"		11.8"								9"		
	3"		27.55" 39"										
	4"		39"										

INVERTED BUCKET (IB) TRAPS

Manufacturer		Watson McDaniel		Armstrong		Hoffman		Spence Nicholson		Spirax Sarco	
Desc.	Size	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim
Cast Iron											
IB Trap	1/2"	IB1031	5"	800	5"					B1H	5"
	3/4"		5"		5"						5"
	1/2"	IB1032	5"	811	5"	B1-2	6.93"				
	3/4"		5"		5"	B1-3	6.93"			B2	6.6"
	1"		5"		5"						
	1/2"	IB1033	6.5"	812	6.5"	B2-2	6.93"				
	3/4"		6.5"		6.5"	B2-3	6.93"			B2	6.6"
	3/4"	IB1034	7.75"	813	7.75"	B3-3	9.44"			B2	6.6"
	1"		7.75"		7.75"	B3-4	9.44"			B3	7.9"
IB Trap with Strainer	1/2"	IB1041	5"	880	5"			80S	5.06"		5"
	3/4"		5"		5"				5.06"		5"
	1/2"	IB1042	5"	881	5"	B1S-2	6.93"	81S	5.06"		
	3/4"		5"		5"	B1S-3	6.93"		5.06"	B2S	6.6"
	3/4"	IB1044	7.12"	883	7.87"	B3-3	9.44"	82S	7.00"	B2S	6.6"
	1"		7.12"		7.87"	B3-4	9.44"	83S	8.12"	B3S	7.9"
	1.25"	IB1038S	7.12"							B4S	9.3"
	1.5"		7.12"								

STAINLESS STEEL INVERTED BUCKET (SS IB) TRAPS

Manufacturer		Watson McDaniel		Armstrong		Spence Nicholson		Spirax Sarco	
Desc.	Size	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim
SS IB Trap	1/2"	SIB	4.55"	1810	4.31"	TSBT-LS/MS	4.31"	SIB30	4.3"
	3/4"		4.55"		4.31"		4.31"		4.3"
SS IB Trap Hi Cap.	1/2"	SIBH	4.55"	1811	4.31"		4.31"	SIB30H	4.3"
	3/4"		4.55"		4.31"		4.31"		4.3"

Steam Traps (continued)

UNIVERSAL CONNECTORS

Manufacturer		Watson McDaniel		Armstrong		Spence Nicholson		Spirax Sarco		TLV	
Desc.	Size	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim
Universal Connector	1/2″	UC450	2.92″	IS-2	3.5″	UMTC	3.5″	UPC	2.4″		
	3/4″		2.92″		3.5″		3.5″		2.9″		
	1″		5.66″		3.5″		3.5″		3.6″		
Universal Connector w/ Str	1/2″	UC450S	3.31″			UMTCY	3.5″			FS	3.12″
	3/4″		3.31″				3.5″				3.12″
	1″		6.06″				3.5″				3.75″
Universal Connector w/ Str/BD	1/2″	UC450SB	3.31″							FS	3.12″
	3/4″		3.31″								3.12″
	1″		6.06″								3.75″
Universal Connector w/ Str	1/2″	UC450S-LR UC450S-RL	3.31″	IS-2	3.5″			USC	3.2″		
	3/4″		3.31″		3.5″				3.5″		
	1″		3.62″		3.5″				3.9″		
Universal Connector w/ Str/BD	1/2″	UC450SB-LR UC450SB-RL	3.31″					USCB	3.2″		
	3/4″		3.31″						3.5″		
	1″		3.62″						3.9″		

Str = Strainer; BD = Blowdown Valve

UNIVERSAL STEAM TRAP MODULES

Description	Watson McDaniel	Armstrong	Spence Nicholson	Spirax Sarco	TLV
Standard Thermodynamic	TD450		UMT-TD10		
Standard Thermodynamic LC	TD450L		UMT-TD10L		
SM Thermodynamic	TD450SM	CD-3300		UTD52H	FP32
SM Thermodynamic LC	TD450LSM			UTD52L	
SM Thermodynamic LC/HP	TD600LSM-HP			UTD52L-HP	
Thermostatic	UT450	WT-2000 TT-2000	UMT450T	UBP32	FL21 FL32
Float & Thermostatic	UFT450	FT-4000		UFT14	FS3 FS5
Inverted Bucket	USIB450	2010	USBT	UIB30	
Inverted Bucket HP	USIB450H	2011	USBT	UIB30H	
Bi-Metallic	UB450	AB-2000		USM21	FX-1

SM = Side Mount; LC = Low Capacity; HP = High Pressure

SANITARY / CLEAN STEAM TRAPS

Description	Watson McDaniel	Armstrong	Spence Nicholson	Spirax Sarco	TLV
Thermostatic Repairable, Angle*	FDA400		CDH		
Thermostatic Repairable	FDA500	TC-C	CDS	BT6	SS5P
Thermostatic	FDA600	TC-R	DS100	BTM7	
Thermodynamic	FDA800		NTD230L	BTD52L	P10

* Right Angle (90°) Ports

Pressure Motive Pumps

PRESSURE MOTIVE PUMPS

Description	Watson McDaniel	Armstrong	Spence Nicholson	Spirax Sarco	Hoffman	TLV
Ductile Iron	PMPNT	PT104		PPEC		GP10L
Upright Ductile Iron	PMPC	PT3500	P3	PPC PTC	PCC	GP10 GP14
Upright Carbon Steel	PMPF	PT400	P3 Classic Vertical	PPF PTF	PCS	GP10F GP14F
Low Profile Carbon Steel	PMPLS	PT200	P3 Little Boy	PPEC		GP10L
Hi-Cap 4"x4" Carbon Steel	PMPBP	PT516	Big Boy	PTF4		
Pump-Trap Combination						
1"x1" PMPM & FTE-200	WPT1	Double Duty 4		APT-10		GT10L-1
1 1/4"x1 1/4" PMPM & FTE-200	WPT2					
1 1/2"x1 1/2" PMPLS & FTE-200	WPT3	Double Duty 6		APT-14		GT10L-1-1/2
2"x2" PMPC & FTE-200	WPT4			APT-14HC		
3"x2" PMPC & FTE-200	WPT5					
1", 1 1/2" PMP w/ Internal Trap	PMPT	Double Duty 4		APT-14		GL10L-1

SKID MOUNTED PUMP SYSTEMS

Watson McDaniel	Armstrong	Spirax Sarco Pivitrol	Spence Nicholson Condensate Commander
PMPM Simplex, 6" x 36" Receiver	SPT-104LBRP-6 (4 Gallon)	PPEC Simplex	
PMPM Simplex, 8" x 36" Receiver	SPT-104LBRP-8 (7 Gallon)		
PMPM Simplex, 10" x 36" Receiver	SPT-104LBRP-10 (10 Gallon)	PPEC SImplex, 12 Gallon	
PMPM Duplex, 21-Gallon Receiver	DPT-104LBRP-12 (22 Gallon)	PPEC Duplex	
PMPC Simplex, 6" x 36" Receiver	SPT-200LBRP-6	PTC Simplex	
PMPC Simplex, 8" x 36" Receiver	SPT-200LBRP-8		
PMPC Simplex, 10" x 36" Receiver	SPT-200LBRP-10		
PMPC Simplex, 21-Gallon Receiver	SPT-200LBRP-16 (30 Gallon)	PTC Simplex, 31 Gallon	
PMPC Duplex, 21-Gallon Receiver	DPT-200LBRP-12	PTC Duplex, 31 Gallon	
PMPC Duplex, 75-Gallon Receiver	DPT-200LBRP-24 (85 Gallon)	PTC Duplex, 65 Gallon	
PMPF Simplex, 10" x 36" Receiver	SPT-400LBRP-10	PTF Simplex, 12 Gallon	
PMPF Simplex, 21-Gallon Receiver	SPT-400LBRP-16	PTF Simplex, 31 Gallon	Classic Vertical Simplex, 25 Gallon
PMPF Duplex, 21-Gallon Receiver	DPT-400LBRP-12	PTF Duplex, 31 Gallon	Classic Vertical Duplex, 25 Gallon
PMPF Duplex, 75-Gallon Receiver	DPT-400LBRP-24	PTF Duplex, 65 Gallon	Classic Vertical Duplex, 65 Gallon
PMPF Triplex, 116-Gallon Receiver	TPT-400LBRP (24" x 72")	PTF Triplex, 135 Gallon	Classic Vertical Triplex, 115 Gallon
PMPF Quadraplex, 116-Gallon Receiver	QPT-400LBRP (24" x 72")	PTF Quadraplex, 185 Gallon	Classic Vertical Quadraplex, 250 Gallon
PMPC Simplex, 10" x 36" Receiver	SPT-3500LBRP-10	PTC Simplex	
PMPC Simplex, 21-Gallon Receiver	SPT-3500LBRP-16	PTC Simplex, 31 Gallon	
PMPC Duplex, 21-Gallon Receiver	DPT-3500LBRP-12	PTC Duplex, 31 Gallon	
PMPC Duplex, 75-Gallon Receiver	DPT-3500LBRP-24	PTC Duplex, 65 Gallon	
PMPC Triplex	TPT-3500LBRP	PTC Triplex	
PMPC Quadraplex	QPT-3500LBRP	PTC Quadraplex	
PMPF Simplex, 10" x 36" Receiver	SPT-300LBRP-10	PTF Simplex	
PMPF Simplex, 21-Gallon Receiver	SPT-300LBRP-16	PTF Simplex, 31 Gallon	Classic Vertical Simplex, 25 Gallon
PMPF Duplex, 21-Gallon Receiver	DPT-300LBRP-12	PTF Duplex, 31 Gallon	Classic Vertical Duplex, 25 Gallon
PMPF Duplex, 75-Gallon Receiver	DPT-300LBRP-24	PTF Duplex, 65 Gallon	Classic Vertical Duplex, 65 Gallon
PMPF Triplex	TPT-300LBRP	PTF Triplex	Classic Vertical Triplex
PMPF Quadraplex	QPT-300LBRP	PTF Quadraplex	Classic Vertical Quadraplex
PMPBP Simplex, 116-Gallon Receiver	SPT-516RP (24" x 72")	PTF4 Simplex	Big Boy Simplex
PMPBP Duplex, 280-Gallon Receiver	DPT-516RP (30" x 84")	PTF4 Duplex	Big Boy Duplex

Pressure & Temperature Regulators

PILOT-OPERATED REGULATING VALVES

Description	Watson McDaniel	Armstrong	Spence Nicholson	Spirax Sarco	Hoffman	Fisher Controls
External Pilot-Operated Main Valve, Ductile Iron	**HD**	GP	E	25	2100	92
Pressure Pilot	**PP**	GP-2000	D	P	SPS	92B
Temperature Pilot	**PT/PTU**	OB-2000	T124 T14	T	STPA	
Temperature Pilot w/ Dial	**PTRP**		T14			
Air Pilot	**PA**	GP-2000K	A	A	AP	
Back Pressure Pilot	**BP**	GP-2000R	Q	BP		
Solenoid Pilot	**SP**	GP-2000	M	E		
Pneumatic Temperature Controller	**PTL/PTR**	OBK-2000	T61/62/63/64			
Differential Pressure Pilot	**PDP**		Type N			

SELF-CONTAINED PRESSURE REDUCING VALVES

Description	Watson McDaniel	Armstrong	Spence Nicholson	Spirax Sarco	Hoffman	Watts	TLV
Cast Iron, Steam, Water & Air Service	**O-Series**	GD30 GD6(N)	D-50	BRV	754	152	
Ductile Iron, Piston Actuated High-Capacity Steam & Air Service	**402/403**	GP-1000 GP-18/28 GP-1					COSR ACOSR
Bronze & Cast Iron Water, Air & Oil Service	**B-Series**	GD-200	D-34		740	223	

TEMPERATURE REGULATING VALVES

Description	Watson McDaniel	Trerice	Powers	Spence Nicholson	Hoffman
Direct Acting, Heating w/ Dial	**H175*** **H175T****	91000 91400	11	2000	1140
Reverse Acting, Cooling w/ Dial	**C153*** **C153T****	91000 91400	11	2000	1140R
Heating or Cooling, w/o Dial	**W91**	91000	11	2000	1140 1140R
Heating or Cooling, w/ Dial	**W94**	91400	11	2000	1140 1140R

* Watson McDaniel Models 175 & 153 were upgraded to Model W91.

** Watson McDaniel Models 175T & 153T were upgraded to Model W94.

BACK PRESSURE / RELIEF VALVES

Description	Watson McDaniel	Fisher Controls
Bronze & Cast Iron Water, Air & Oil Service	**3040**	98H
Bronze Water Service	**R-Series & 10691**	

Liquid Drainers

LIQUID DRAINERS

Description	Size	Watson McDaniel	Armstrong	Spirax Sarco	Hoffman
High Capacity Float Type					
Ductile Iron	1.5″	WLDE		FAB	
	2″	WLDE	JD & L	FAB	
	2.5″	WLDE	KD & L	FAB	
Float Type					
Ductile Iron	1/2″ - 2″	WLD1400		CA14	
				FAI	
				CA10S	
Cast Iron	3/4″ - 2″	WLD1900	21	FA	793
Carbon Steel	2.5″	WLDES-300	LS	FAB	
	3/4″ - 4″	WLD600	LS	FA450	
			MS		
Stainless Steel	3/4″ - 4″	WLD601		CA46S	
				CAS14	
	1/2″, 3/4″	WLD1800	11-LD		
		WLD1800R	32-LD		
Thermodynamic Type					
Stainless Steel	1/2″	WLD1703S		TDA52	656A
Inverted Bucket Type					
Cast Iron	3/4″, 1″	WLD1500	1-LD		

Air Eliminators, Air Vents & Vacuum Breakers

AIR ELIMINATORS & AIR VENTS

Description	Watson McDaniel	Armstrong	Spirax Sarco	Hoffman	Spence Nicholson
Float-Type Air Eliminators					
Cast Iron	AV813W	21AR	13WS	792	
Stainless Steel	AE1800	11AV			
		22AV			
	AE1800R	32AV			
Thermostatic Air Vents					
Stainless Steel	AV2000C	TTF-1	VS204		TAV
			VS206 (Cast Iron)		
Brass	AVT125	TS-2	T202	17C	
		SV-12A		8C	

VACUUM BREAKERS

Description	Watson McDaniel	Spirax Sarco	Hoffman
Stainless Steel	WVBSS	VB21	62
Brass		VB14	

Notes











Watson McDaniel

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