Condensate Return System

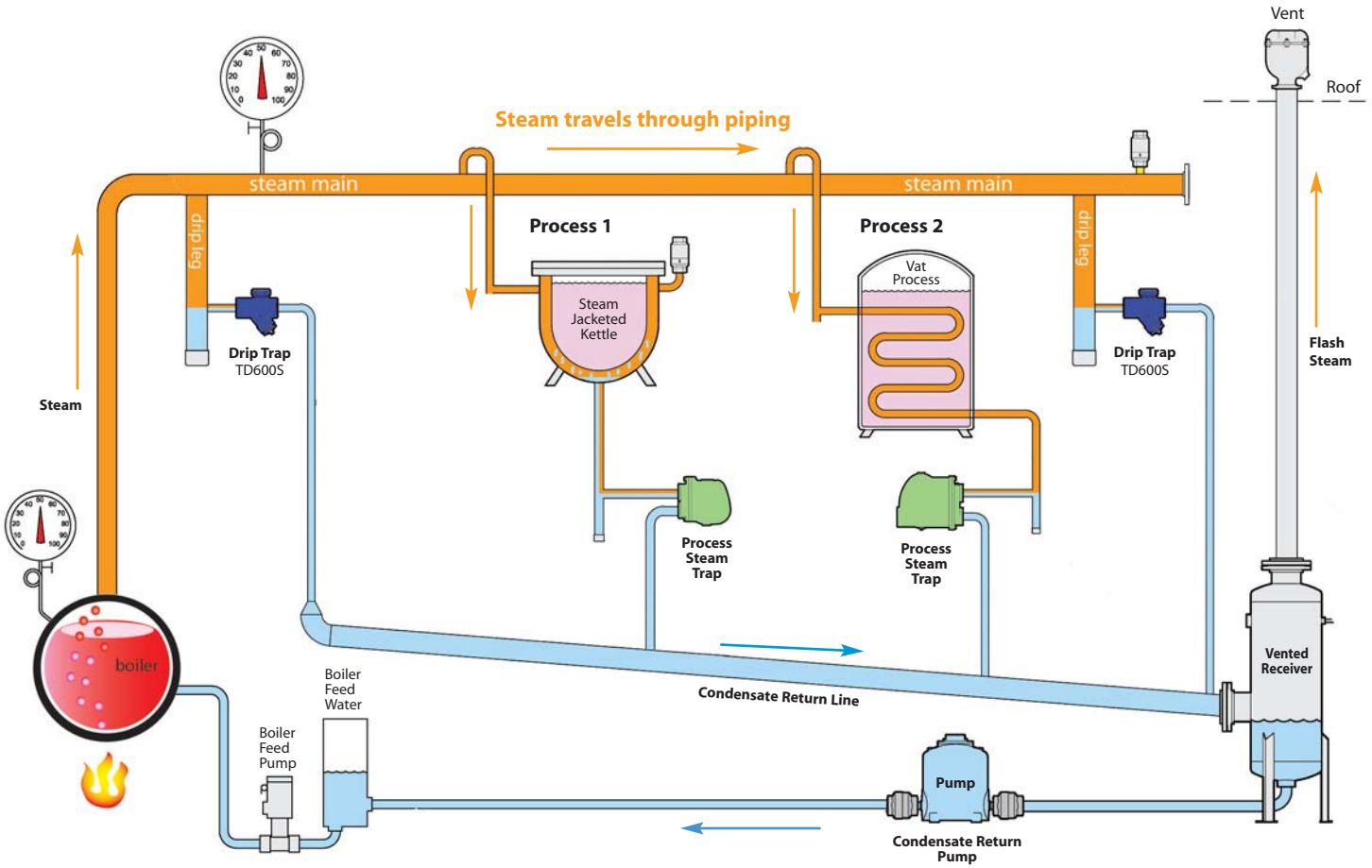
Shown below is a simplified view of a steam system from steam generation to condensate return. Steam generated by the boiler travels through the steam distribution lines supplying steam to various pieces of process equipment. The steam flowing to this equipment is separated from the condensate return 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.

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.

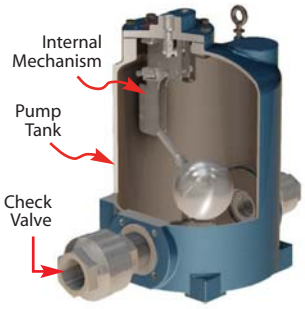
What is the purpose of a Vented Receiver?

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.

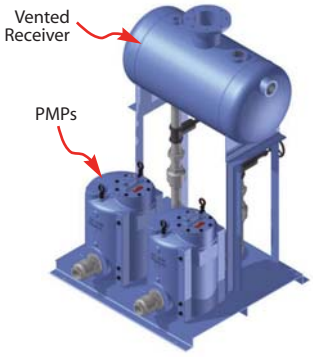
Mechanical & Electric Condensate Return Pumps

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.

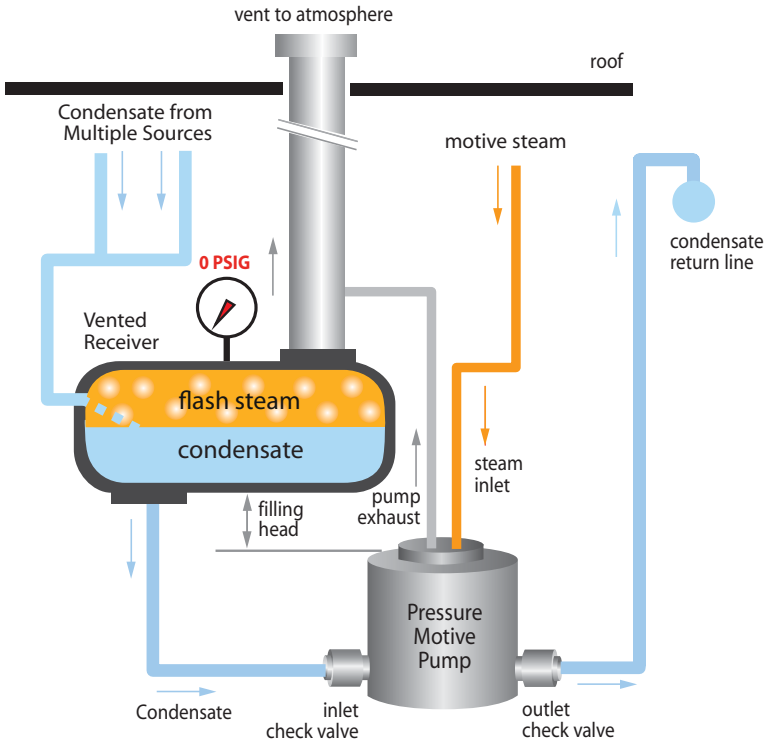
PMPs discharge high temperature condensate that drains from vented receivers. A **stand-alone PMP** pump tank cannot be used as the vented receiver since it is intermittently pressurized with steam or air to pump the condensate. PMPs require a separate vented receiver to collect the condensate and to 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.

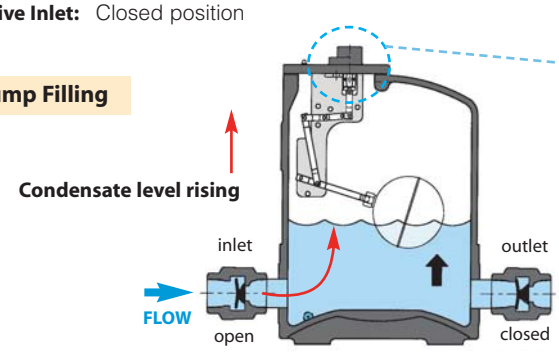


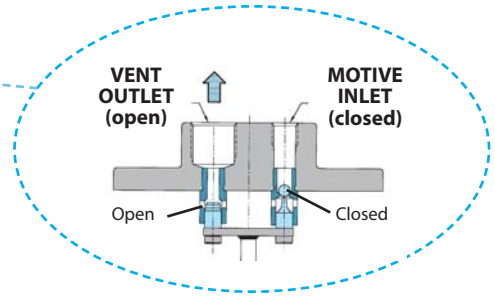
Operation of PMP Pressure Motive Pump

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





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.

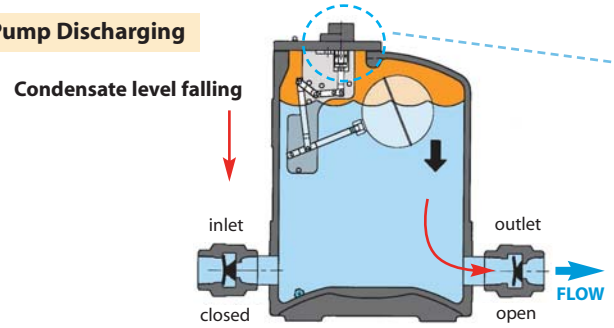
The positions of the **Vent** and **Motive** valves control the filling and discharge of the pump. The Vent valve must be open during the filling cycle to allow air or steam in the pump tank to be displaced as water enters the pump. Since water flows into the pump tank by force of gravity, the pump tank pressure must be neutralized for the pump tank to fill.

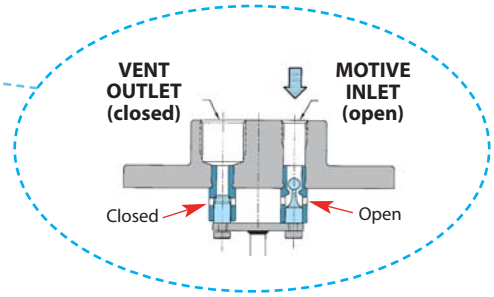
When the pump tank reaches its fill point the vent valve closes and the motive valve opens. The incoming steam pressure rapidly forces the water out of the pump tank through the outlet check valve. When the pump tank empties, the vent valve opens and motive inlet valve closes.

Vent Outlet: Closed

Motive Inlet: Open; steam pressure enters tank and discharges condensate

Pump Discharging



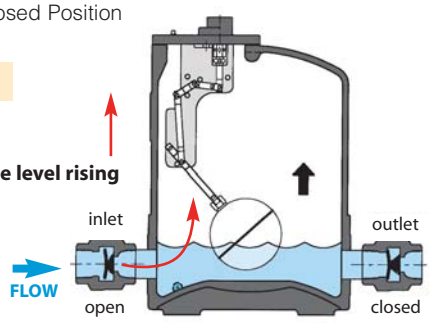


2 When the pump tank has filled to the trip point, the mechanism triggers, opening the motive gas inlet valve and simultaneously closing the vent valve. This allows motive pressure to enter the pump body, which drives the condensate thru the outlet check valve into the condensate return line. During 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



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.

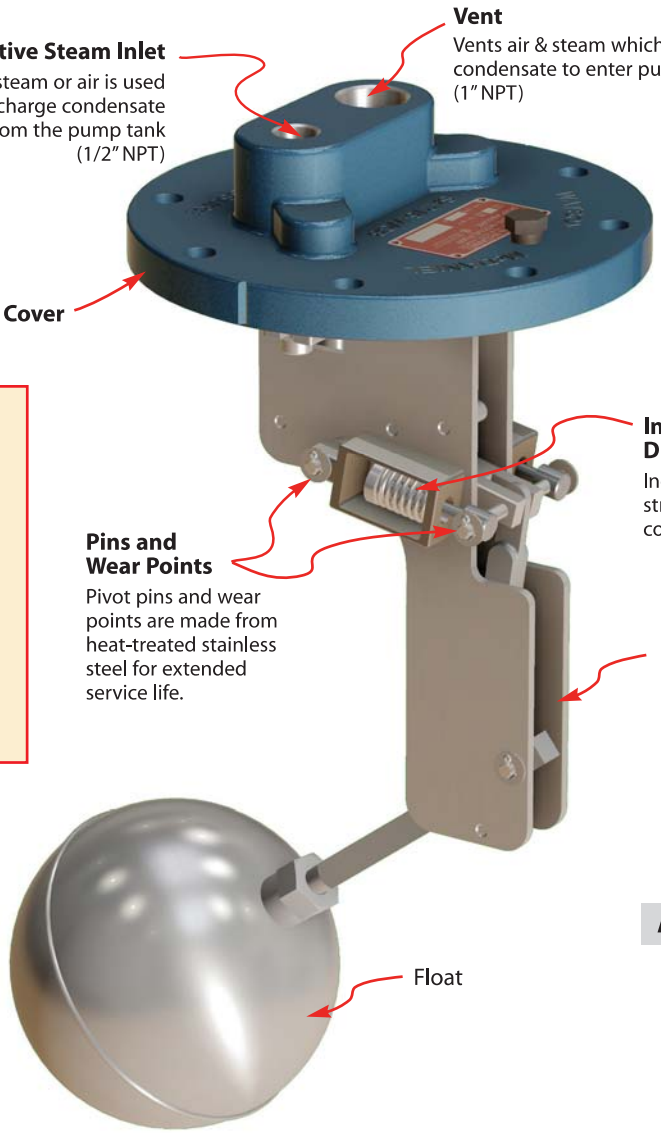
Check Valves

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

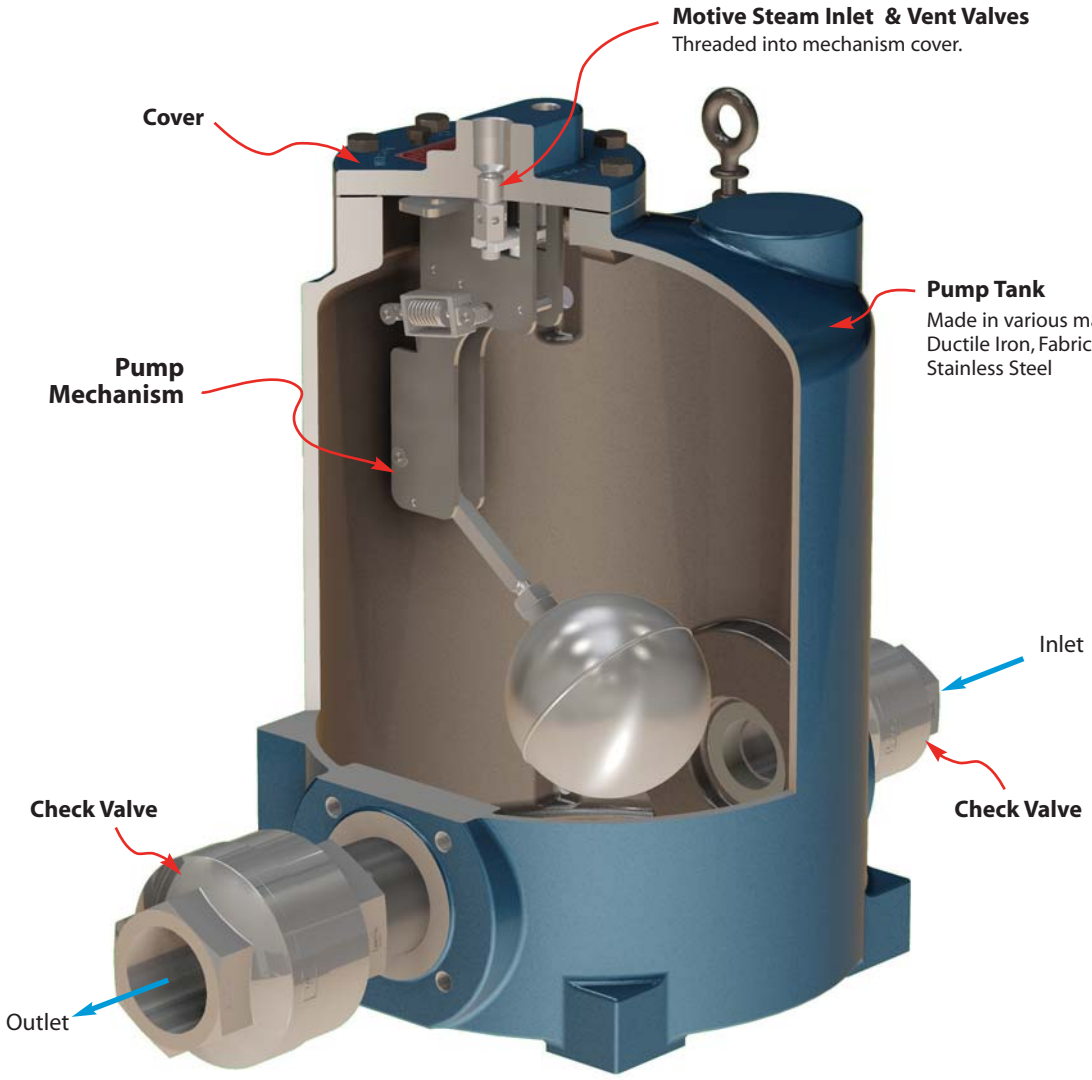
Snap-Assure
U.S. Patent No. 6572340

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)

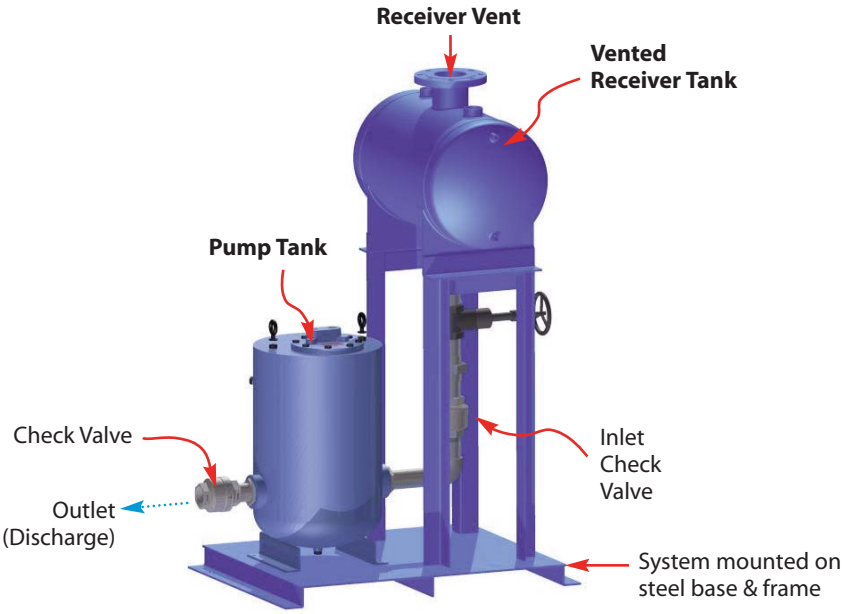
Sump drainers are used to pump water from pits or sumps using steam or air pressure. They are similar to the standard PMP models except that they discharge vertically upwards. This piping configuration allows them to be lowered into a sump or pit.

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.

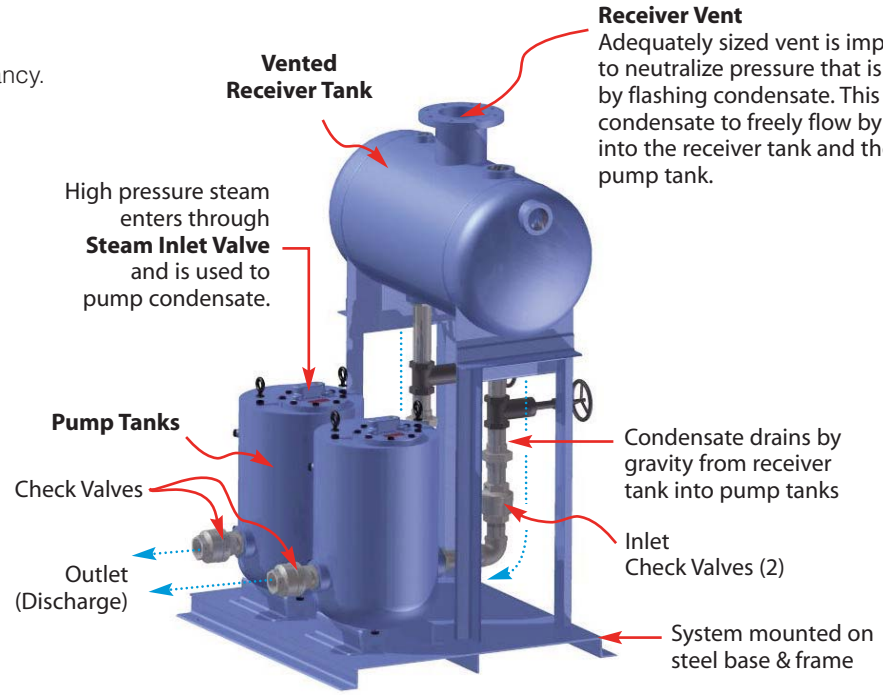
Simplex Pumping System (shown)

Single pump with receiver tank mounted on a common base.

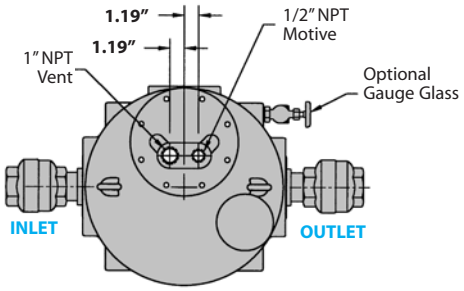


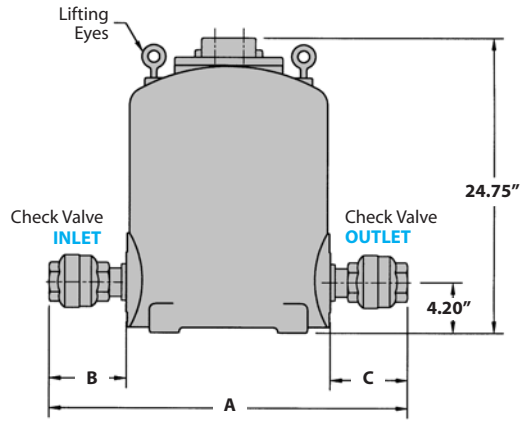
Duplex Pumping System (shown)

More than one pump can be used for increased capacity or system redundancy.



PMPC
Pressure Motive Pump





Model	**PMPC**
Body	**Ductile Iron**
Cover	**Ductile Iron**
Check Valves	**Stainless Steel**
PMO Max. Operating Pressure	**200 PSIG**
TMO Max. Operating Temperature	**388°F**
PMA Max. Allowable Pressure	**200 PSIG @ 650°F**
TMA Max. Allowable Temperature	**650°F @ 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*

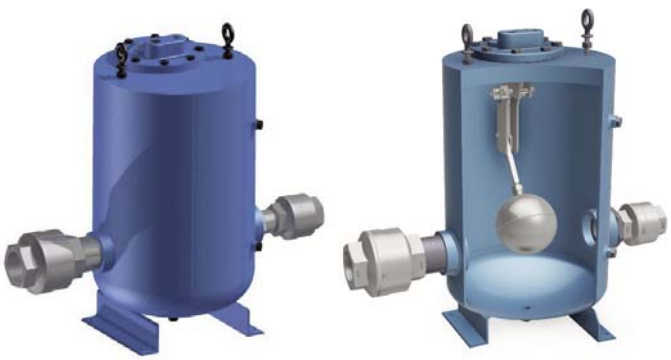
Size (Inlet x Outlet)	Model Code	A	B	C	Weight (lbs)
1" x 1"	PMPC-1X1-N-SS	29 1/2	6	6	360
1 1/2" x 1"	PMPC-1.5X1-N-SS	30 3/4	7 1/2	6	365
1 1/2" x 1 1/2"	PMPC-1.5X1.5-N-SS	31 1/4	7 1/2	7 1/2	367
2" x 1"	PMPC-2X1-N-SS	31	8	6	370
2" x 1 1/2"	PMPC-2X1.5-N-SS	32 1/2	8	7 1/2	380
2" x 2"	PMPC-3X2-N-SS	32 3/4	8	8	385
3" x 2"	PMPC-3X2-N-SS	35 1/4	9 1/4	8	390

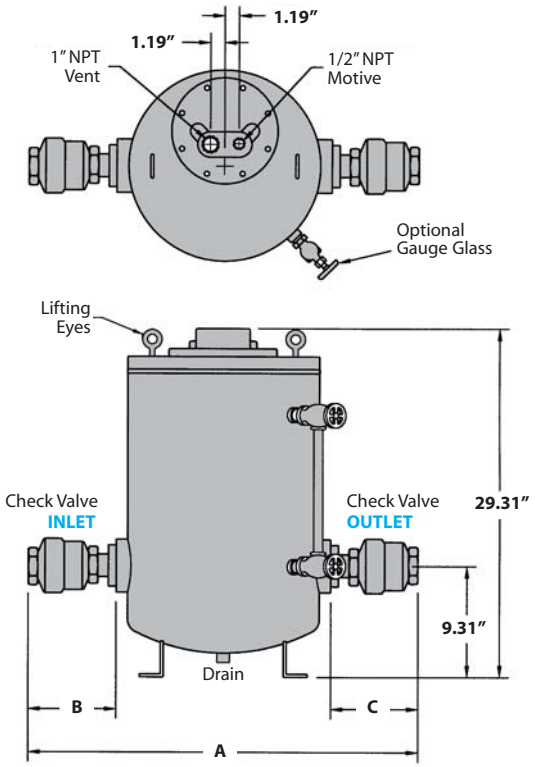
The PMPC Stand Alone Pump consists of pump tank, internal mechanism, and inlet and outlet stainless steel check valves.

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*

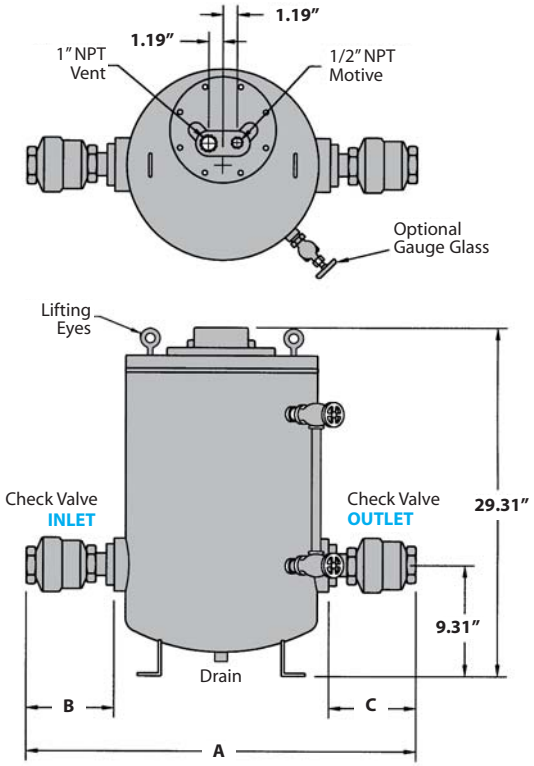
Size (Inlet x Outlet)	Model Code	A	B	C	Weight (lbs)
1" x 1"	PMPF-1X1-N-SS	30 1/2	6	6	215
1 1/2" x 1"	PMPF-1.5X1-N-SS	31 3/4	7 1/2	7 1/2	220
1 1/2" x 1 1/2"	PMPF-1.5X1.5-N-SS	32 1/4	7 1/2	6	223
2" x 1"	PMPF-2X1-N-SS	32	8	6	225
2" x 1 1/2"	PMPF-2X1.5-N-SS	33 1/2	8	7 1/2	230
2" x 2"	PMPF-2X2-N-SS	33 3/4	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



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

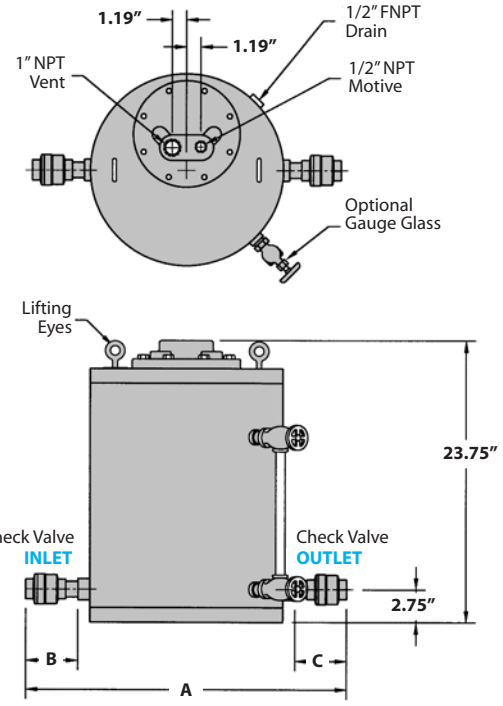
The PMPSS Stand Alone Pump consists of pump tank, internal mechanism, and inlet and outlet stainless steel check valves.

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

PMPLS
Pressure Motive Pump



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 1/2	5 5/8	5 5/8	200
1 1/2" x 1"	**PMPLS-1.5X1-N-SS**	30 3/4	7	5 5/8	205
1 1/2" x 1 1/2"	**PMPLS-1.5X1.5-N-SS**	32 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

PMPNT
Pressure Motive Pump

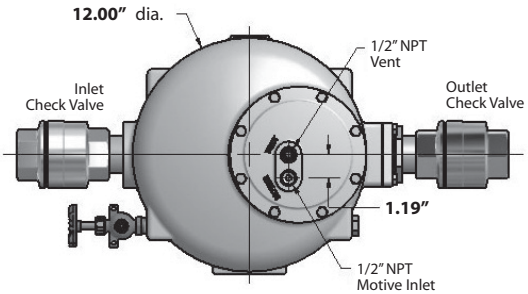
Model	PMPNT	PMPNTS
Body	Ductile Iron	Stainless Steel
Cover	Stainless Steel	Stainless Steel
Sizes	1", 1 1/2" NPT	1 1/2" FLG or NPT
Check Valves	Stainless Steel	Stainless Steel
PMO Max. Operating Pressure	125 PSIG	125 PSIG
TMO Max. Operating Temperature	366°F	366°F
PMA Max. Allowable Pressure	150 PSIG @ 450°F	150 PSIG @ 450°F

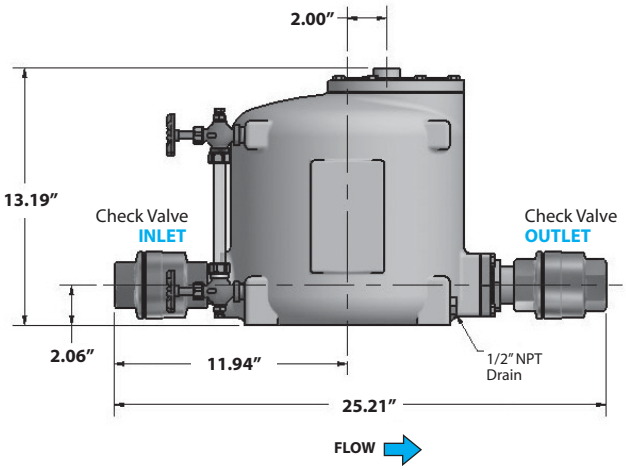
Typical Applications

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.

PMPBP
Pressure Motive Pump

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

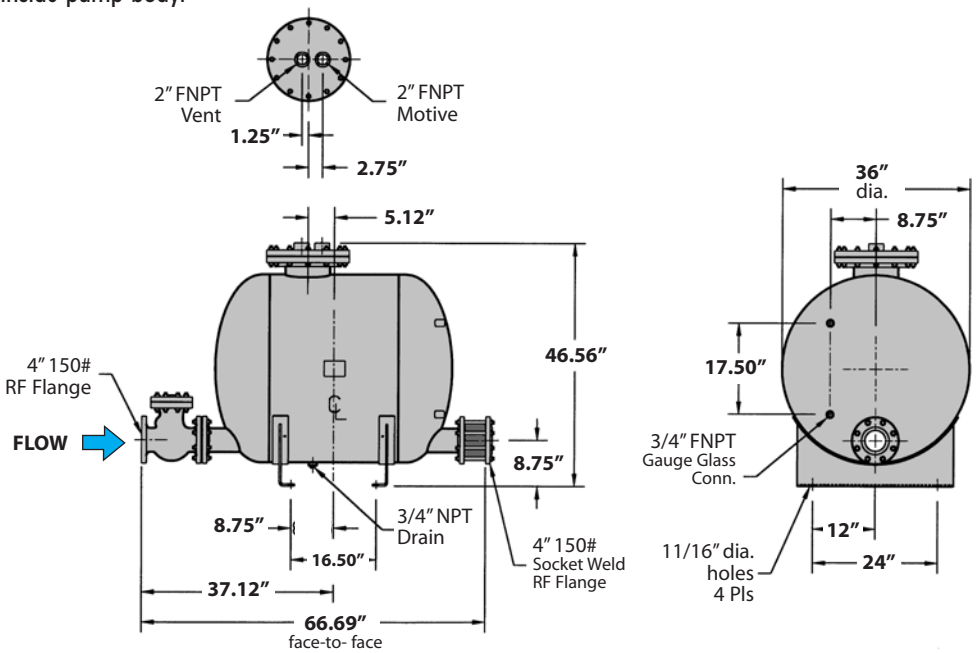
- Cycle counter for measuring the amount of condensate flow through the pump.
- Insulation jackets are available to stop heat losses through the pump body.
- Sight glass for monitoring liquid level inside pump body.

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

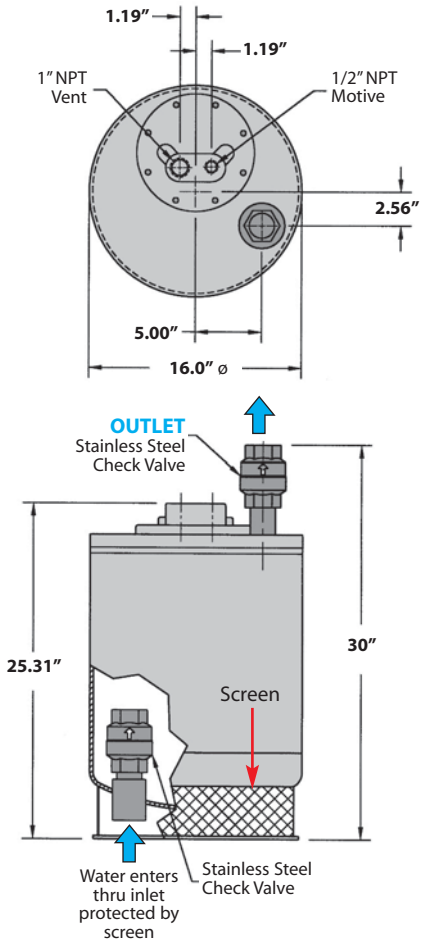
The **PMPSP** Sump Drainer uses the same internal mechanism as the standard PMP models. The piping configuration is such that the liquid is discharged vertically out the top as opposed to horizontally out the side. This allows the unit to be easily positioned inside of a sump area. Condensate or water 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

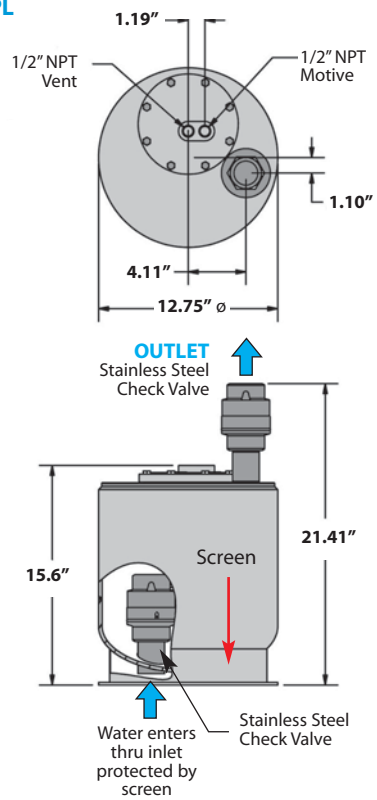
- Equipped with our **Patented "Snap-Assure"** Mechanism which **extends the useful life of the pump**
- Mechanism incorporates **heat-treated stainless steel wear items** for ultimate corrosion resistance
- Dual compression springs made from Inconel-X-750 for high-temperature corrosive service
- Operates 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

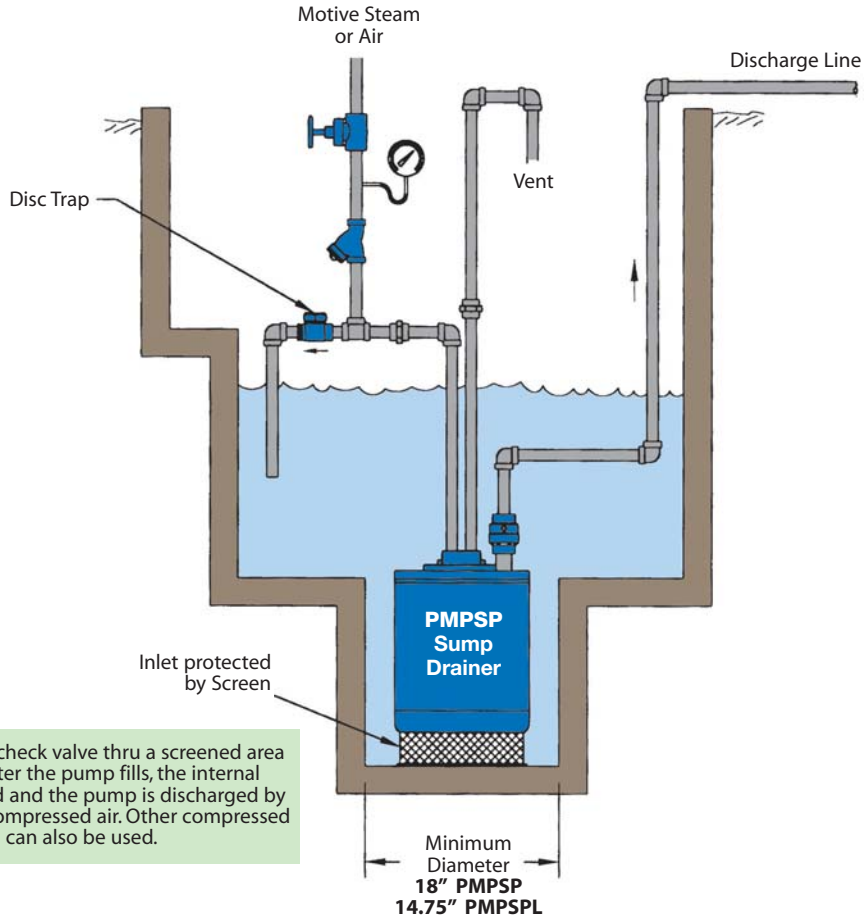
PMPSP



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

PMPC & PMPF
Pressure Motive Pumps

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

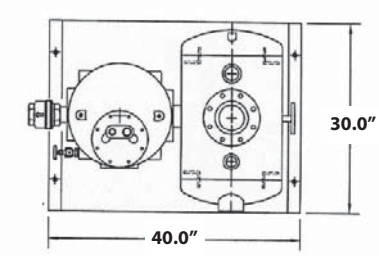
Condensate Return Pressure Motive Pump (PMPs) with a Vented Receiver. Standardized Simplex, Duplex, Triplex, and Quadraplex packaged systems include stand-alone pump(s), check valves and vented receiver, mounted on a steel base and frame. Multiple pumping units can be used for increased capacity or for 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.

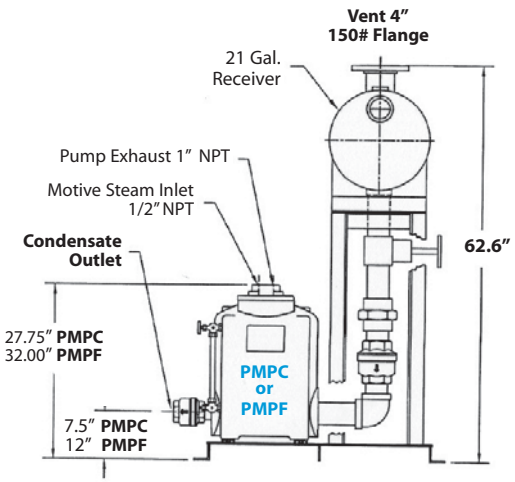
Sample Specifications

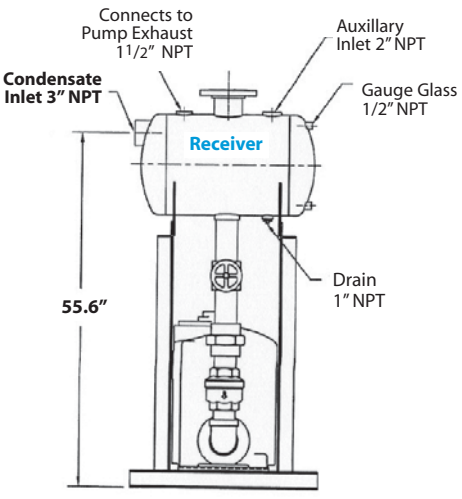
Unit shall be a Watson McDaniel, pre-packaged system to include pressure motive pump(s) with stainless steel check valves, an ASME vented receiver with "UM" code stamp, and interconnecting piping including inlet isolation valve. The carbon steel PMPF shall receive an ASME "UM" code stamp and the ductile 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







PMPC & PMPF
Pressure Motive Pumps

Standard Skid Mounted Systems

ASME Certified

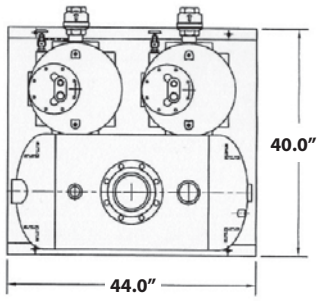
Features

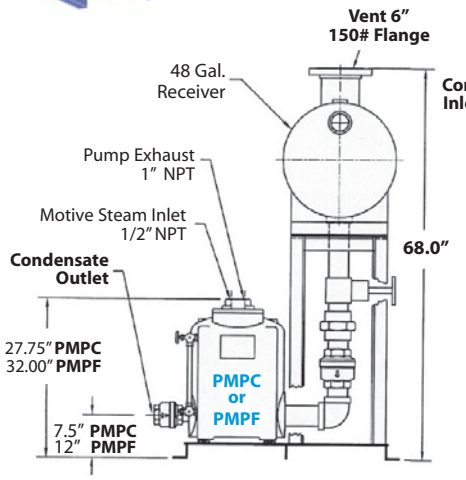
- PMP pump systems reduce installation costs. Only 4 pipe connections are required in the field
- Watson McDaniel ensures that vented receivers and other components are properly sized for optimum system performance
- Watson McDaniel's fully-qualified fabrication facility is ASME code certified. Our engineers can design and build complete custom systems to meet all your requirements

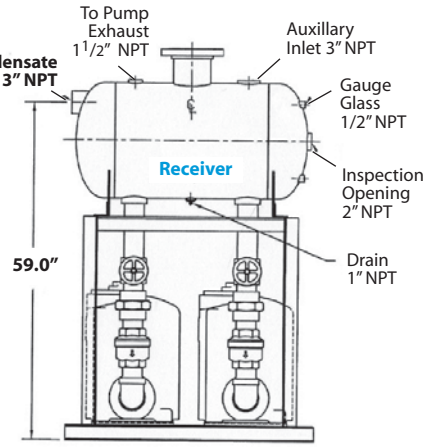
Options

- Gauge glass assembly
- Cycle counter
- Insulation covers
- Motive steam drip trap
- Overflow pipe connection
- Pressure regulator for motive supply line

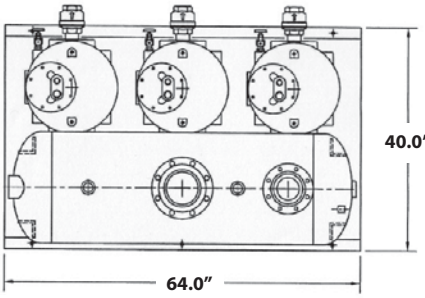
DUPLEX Systems

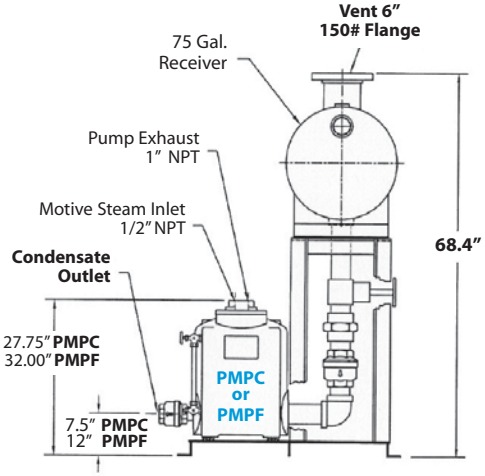


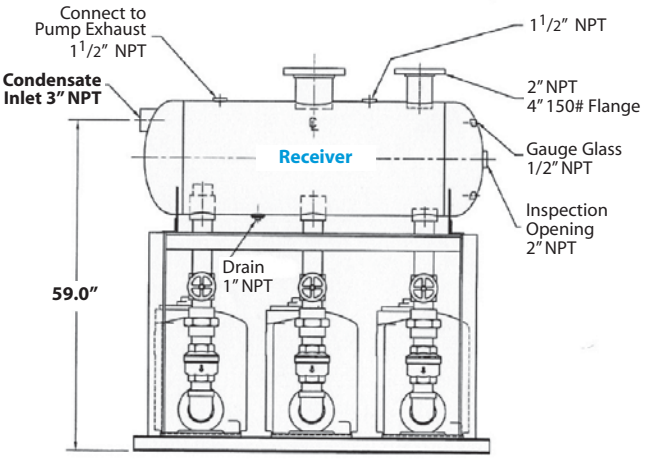




TRIPLEX Systems







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.

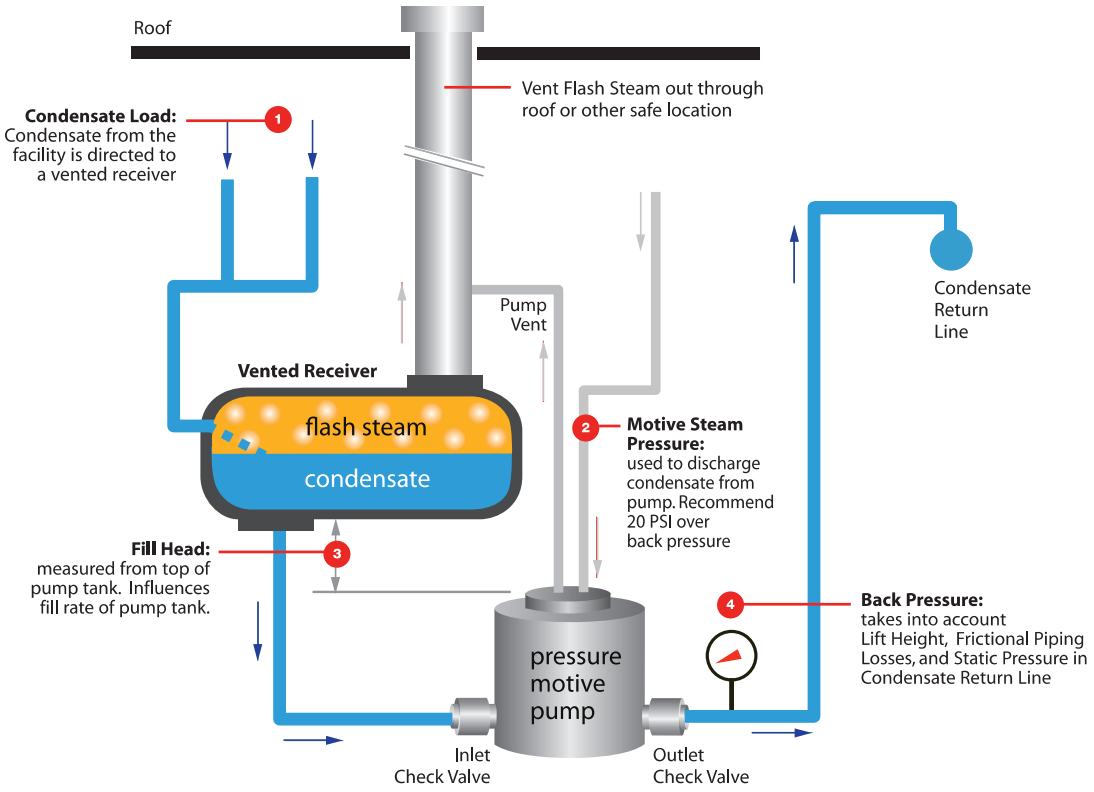
2. **Motive Pressure:** The motive pressure of the steam (or other gas) impacts pump capacity. The sizing chart indicates different flow rates based upon motive steam inlet pressure. It is recommended to regulate the steam inlet pressure to 20 psi above the total back pressure.

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)									PMPBP 4" x 4" 24" Head
			1½" X 1"	1½" X 1½"	2" X 1"	2" X 1½"	2" X 2"	3" x 2"	Duplex 3" x 2"	Triplex 3" x 2"	Quadraplex 3" x 2"	
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		
1½"	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
1½"	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.

Sizing & Selection

Vented Receiver (Open-Loop System)

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**

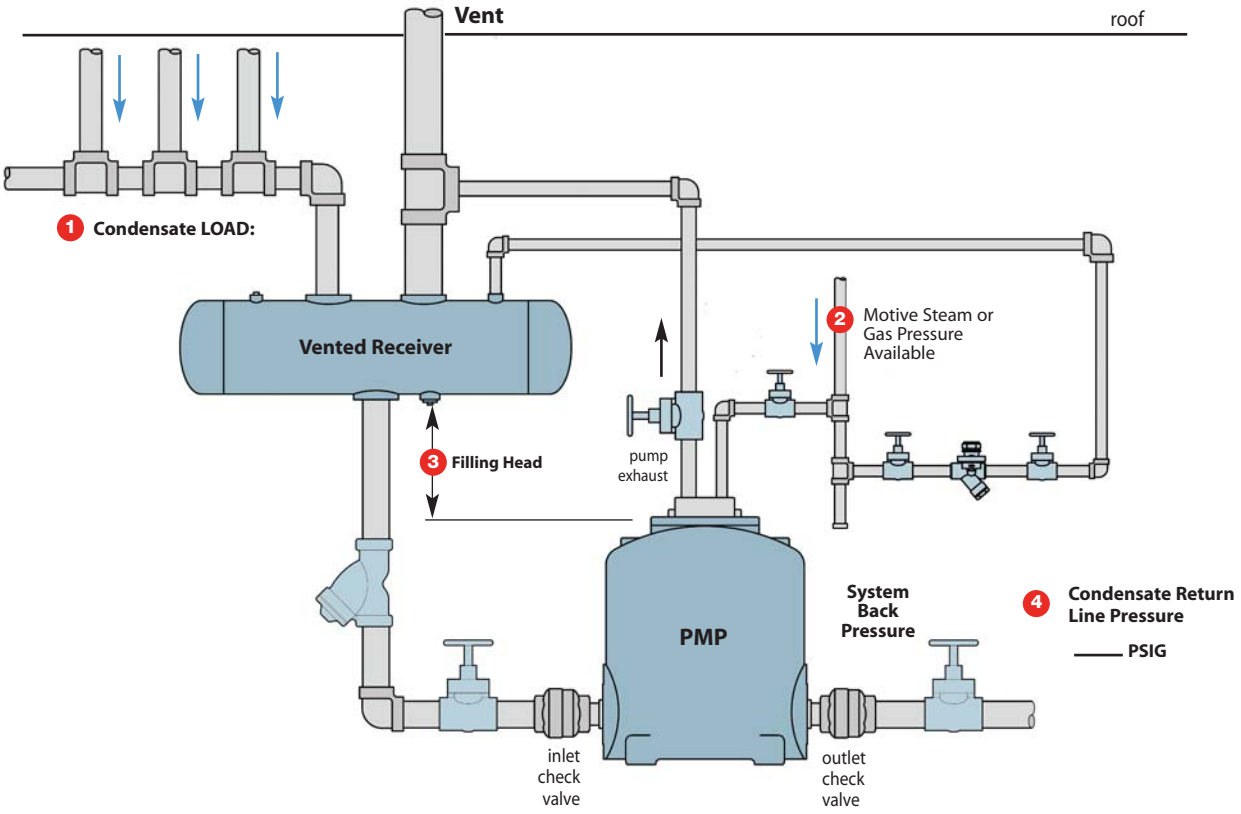
(To find the pressure required to lift condensate in PSIG, multiply Vertical lift in feet by 0.433)

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.	

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″