SHIPCO® PUMPS

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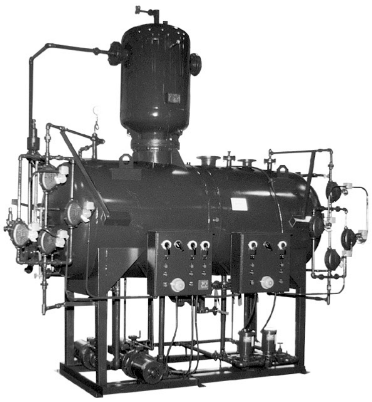
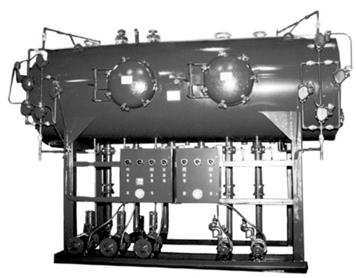
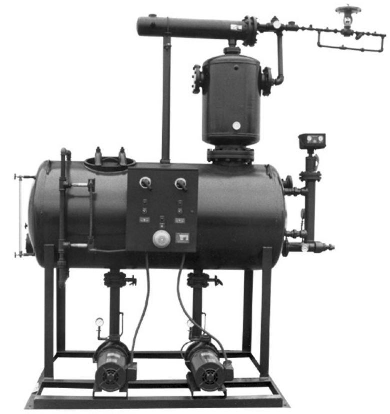
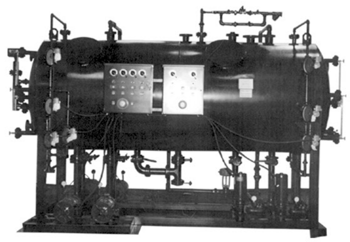
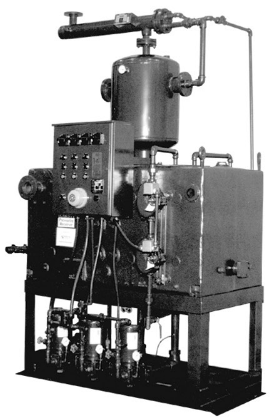
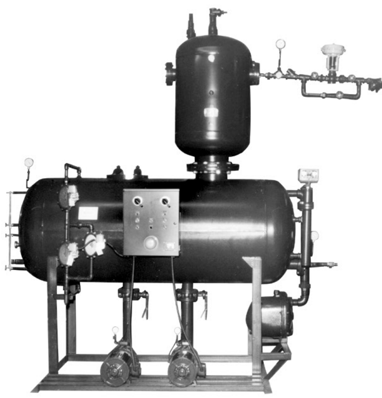
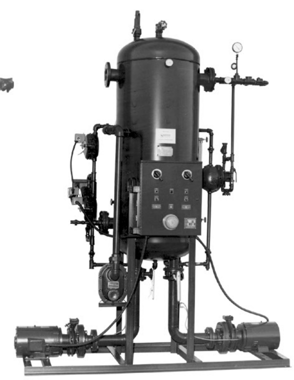
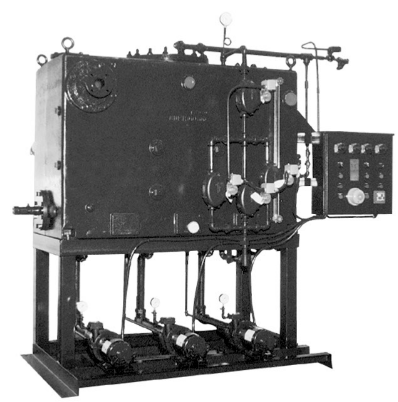
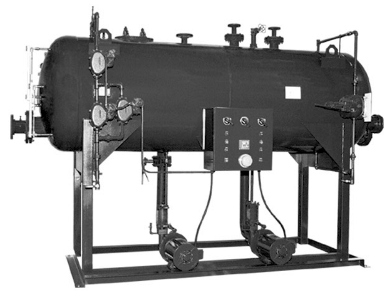
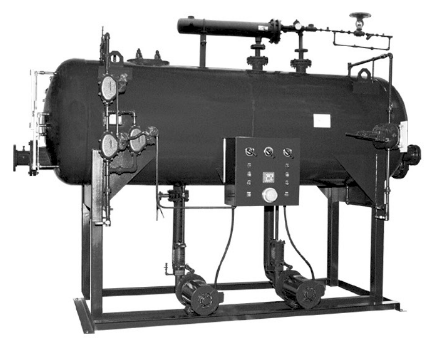









SHIPCO® DEAERATOR SERIES

PRIDE · QUALITY · CRAFTSMANSHIP

Why a Deaerator? What Does It Do?

A deaerator is a special kind of boiler feed pump that minimizes the corrosiveness of the boiler feed water and pumps this water into the boiler as needed. It reduces the corrosiveness by heating the water, thus removing harmful dissolved gases (oxygen and carbon dioxide) by driving them out of solution.

Since corrosion, like other chemical reactions, increases with temperature, a higher rated deaerator is needed for higher temperature boilers. The temperature and pressure of boiling water rise simultaneously; it is therefore important to use the best type of deaerator for high pressure boilers to protect the boiler and the system from corrosion while minimizing boiler chemicals.

Lower priced, less effective deaerators can be a good compromise for low pressure boilers. Standard industry ratings are .005 for the highest rated, and .03 for the less expensive deaerators (Rating .005 = .005 cubic centimeters of oxygen remain per liter of feed water). This .005 rating is equivalent to about 7 parts per billion by weight, which is a minute amount of remaining oxygen. The .03 cc/liter rating represents about 44 parts per billion of oxygen in the water by weight.

Actual performance can vary a lot and depends on the force of the boiling water (temperature and turbulence), and the steadiness of the flow into the deaeration compartment (transients), as well as other factors which will be mentioned in "How a SHIPCO® Deaerator Works."

Good performance depends on hard boiling, therefore the generated steam must be highly condensed before the gases are vented to atmosphere to avoid loss of steam. Design and proper controls are equally important for the efficient operation of the deaerator. Properly operated deaerators require drastically fewer oxygen scavenging boiler treatment chemicals.

In summary deaeration achieves the following:

- Removes air (oxygen and carbon dioxide)
- Raises feed water temperature (reduces boiler shock)
- Improves heat transfer (air acts as an insulator, hindering heat transfer in the system).
- Saves money (limits chemicals, limits boiler re-tubing, saves return lines, heat exchangers & process equipment).

Fundamentals for Outstanding Deaerator Design

1) Temperature
2) Time
3) Turbulence
4) Thin Film
5) Transients
6) Venting
7) Vent Condensing

Use 5 T's and 2 V's as an aid to remember these very important requirements.

Heat is required to raise the water **temperature** in your deaerator to full saturation temperature for the internal pressure of the deaerator. The temperature must remain at the boiling point to ensure oxygen removal.

Time is required to remove all traces of dissolved oxygen. The more time allowed in each step of the deaerating process the more effective the deaerator becomes.

Turbulence is required to vigorously scrub all the gas bubbles. Steam added at the bottom of the unit through the steam manifold assembly causes steam bubbles to rise and carry any remaining tiny air bubbles to the surface. This process helps overcome surface tension that retains dissolved gases.

A **thin film** is required to decrease the distance tiny bubbles must travel to be released. By reducing the time required to accomplish release, the quantity that can be handled by a given size unit is increased. This increase is accomplished by spraying the water through nozzles and then by continuing the process over a series of baffles.

By controlling all **transients** with modulating controls and allowing returns to enter a surge tank with pumps running continuously, temperature and capacity variations are minimized. Quick and sudden changes can cause air to redissolve very rapidly.

Venting of the liberated non-condensible gases with the escape of some steam to atmosphere must occur. If these gases were not allowed to escape, deaeration could not happen.

Lastly, **vent condensing** or adding a shell and tube vent condenser/preheater to the vent of a deaerator can heat low temperature water hotter before spraying, and condense nearly all of the steam from the vent, increasing the efficiency of the deaerator.

How a SHIPCO® Deaerator Works — Advantages and Important Features

The principle on which a deaerator works is Henry's Law, expressed graphically on page 3. At the chosen pressure the amount of dissolved gases goes to zero when the water is at the boiling temperature for that particular pressure. Since it takes time for a bubble of oxygen to form and rise, boiling the water hard shortens this time. It is therefore possible to have a deaerator work at vacuum, atmospheric pressure, or a higher pressure. Atmospheric and low pressure (5 PSI) are most often used. SHIPCO® manufactures both of these deaerators.

Atmospheric Advantages:

- No ASME Code tank expense
- No float drainer for overflow
- No safety valve
- Less steam loss at partial load
- No orifice in vent
- Shell & tube vent condenser/preheater advantage for larger temperature rise heating requirements

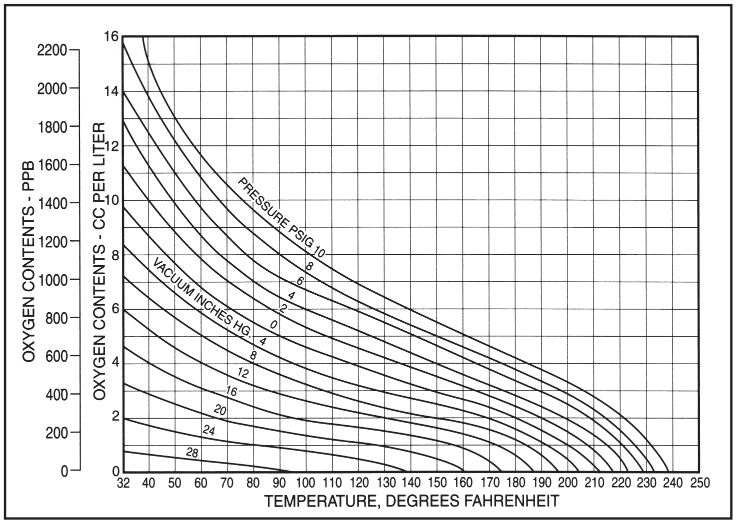
Pressurized Advantage

- Faster response of pressure pilot

A steam manifold is boiling the water hard near the bottom of the tank with volumes of steam rising. The incoming water is sprayed into the top of the tank just below the vent, condensing the steam and heating the incoming water. It then cascades through the baffles further heating the water, condensing more steam, and releasing oxygen which travels up toward the vent with the steam. The water, then mostly deaerated, drops to the surface where the bubbling steam purges the last of the oxygen. The deaerated water is stored until the boiler calls for water and it is pumped from the bottom of the tank to the boiler.

Important Features

1) A path in one direction for the steam to carry the oxygen toward the vent, effectively isolating it from the deaerated water.
2) Spring-loaded spray nozzles that provide a fine spray at varying flow rates for rapid heating and oxygen removal.
3) A series of baffles further providing for heating of water, condensing of steam, and release of oxygen, as well as providing the one-direction pathway.
4) A steam manifold with narrow slits to provide good distribution of fine steam bubbles to scrub the last of the oxygen from the stored water. It will operate relatively quietly above 160°F.
5) This scrubbing heater (a little above the bottom) assures the pumps are getting the most thoroughly deaerated water in the unit. Since heat rises, steam added at the bottom is more effective in heating the bottom as opposed to just adding heat at a higher level. Furthermore, the rising steam bubbles are very effective in carrying any remaining tiny air bubbles to the surface.
6) Noticeably better deaeration can be obtained when flows increase or decrease gradually. Sudden increases and decreases, such as a large on and off flow from a condensate pump, will hinder performance unless a surge tank is used with modulated flows from the surge tank to the deaerator tank. A system with 80% to 100% make-up water can operate efficiently without a surge tank as the water flow can be modulated from the domestic water supply, but larger percentages of pumped returns require a surge tank for best performance.
7) A shell and tube vent condenser/preheater, if added to the vent of the deaerator, increases the efficiency of the deaerator by heating low temperature water hotter before spraying, and condensing nearly all of the steam from the vent.



Deaerator Boiler Feed Pump Selection & Sizing

Selection is based on gallons per minute (GPM), pounds per square inch (PSIG), net positive suction head (NPSH) and receiver size.

Determine GPM

The evaporation rate of one boiler horsepower is .069 gallons per minute.

Other conversion equivalents: One boiler horsepower equals 33,475 BTU/hr. or 34.5 lbs./hr. or 139.4 sq. ft. EDR.

Boiler feed pumps for on-off operation are sized at two (2) times this evaporation rate.

Boiler feed pumps for continuous operation (generally 15 motor HP and larger) are sized at one and a half ($1^1/_2$) times this evaporation rate. In addition, extra flow for recirculation with deaerator boiler feed pumps may have to be added. The SHIPCO® centrifugal Model "P" and "D" pumps do not require any additional flow. SHIPCO® pumps with motors 5 HP and less have a bleed line that serves this function, and in pumps with motors $7^1/_2$ HP and larger a bypass orifice is used in a recirculation line for this purpose.

Boiler feed pumps are sized based on the maximum number of boilers each pump is feeding.

Determine PSIG

The deaerator boiler feed pumps are sized to overcome the **operating** pressure of the boiler + friction loss in pipe + valve loss + feed valve loss (if any) + stack economizer (if any) + vertical lift from pump to boiler + safety margin of approximately 10 PSIG. The amount of these values, added together, are normally expressed in feet of head. To convert feet of head to PSIG, 2.31 ft. = 1 PSIG.

Generally, the feed valve loss is 20 PSIG and the stack economizer loss is 20 PSIG when estimating the pump discharge pressure. Stack economizer requires a continuously running pump in the system. The standard guidelines are:

- High-pressure boilers running on–off from a boiler level controller add 20 PSIG to the operating pressure (not the design pressure).
- High-pressure boilers running continuously pumping through a modulating valve add 30 PSIG to the

operating pressure (always better to get pressure drop through valve).

- High-pressure boilers running continuously pumping through a modulating valve and a stack economizer add 50 PSIG to the operating pressure.
- Low-pressure boilers (running between 1 to 15 PSIG) generally use pumps with a discharge pressure of 20 PSIG.

If the boilers run at more than one pressure setting (like a night setback), an additional pump(s) or VFD's are needed to handle this pressure and the steam control regulator must be sized for this nighttime low-pressure setback.

When and Why Variable Frequency Drives (VFD's) are Used

Applications Appropriate for VFD's

Some instances in a boiler-feed or deaerator steam system makes use of VFD's practical.

Steam systems oftentimes have boilers that operate at lower operating pressures than the boilers' safety relief valve is designed to meet. The ASME code requires the pumps discharge design pressure to be the safety relief valves setpoint – plus 3%. Design engineers frequently fail to lower the relief valve setpoint on the boiler to match the lower "actual" operating pressure. A VFD is recommended when operating the boiler(s) at a pressure more than 30 PSIG below the safety relief valve setting.[1]

A VFD can electronically "ramp down" a centrifugal pump[2] to the lower required discharge pressure to match the "real time" boiler operating pressure and keep the pump's **NPSH requirement** (NPSHr) in check or "hold the pump on curve." Failure to "ramp the pump down" with a VFD will allow the centrifugal pump to seek its own operating pressure and thus the pump starts to cavitate based on a lower operating pressure.

SHIPCO® provides an automatic flow control valve (as opposed to utilizing manual balancing valves) as a standard of design recommendations. When the pressure difference between boiler design pressure and the boiler's actual operating pressure reaches a significant differential (which we consider 30 PSIG), using a VFD reduces energy consumption. The automatic flow control valve is limited in the amount of pressure differential it can compensate. As a rule, we do not like to go beyond 60 PSIG differential in depending on automatic flow control valve function as the mechanism for resistance. When the auto flow control valve opens, it allows the pump flow rate (GPM) to increase and thus the pump's NPSHr also increases and the pump starts to cavitate.

Continuously run applications can use the modulating feed water valve to help keep the centrifugal pump on its curve. When significant pressure differences discussed previously occur (e.g., on boiler blow down situations or boiler start-up situations when immediate demand is high) the modulating valve will open fully. The automatic flow control valve may not be able to absorb the differential pressure when the modulating valve is fully open. When those significant pressure differences occur and the automatic flow control valve starts opening up, the pump flow (GPM) increases rapidly and in turn causes the pump NPSHr to increase. When this happens, a centrifugal pump can cavitate. When utilizing a VFD, the pump user can "ramp up" and "ramp down" the pump discharge pressure to immediately respond and address these significant pressure differentials.

1. Check all local and state codes, regulations, and laws on boiler operation to verify that it is legal to operate boiler at a lower pressure than originally designed.
2. SHIPCO® PUMPS does not recommend these same instructions when a turbine pump is being used due to entirely different design characteristics of a turbine impeller and its relevant pump curve.

SHIPCO® PUMPS Recommendations

Based on the factors already discussed and our troubleshooting experience as a pump manufacturer, it is SHIPCO's® position that the best applications for VFD's in feed water service is where the following conditions exist:

In order to reduce energy costs and increase energy efficiency on steam systems that have significant varying boiler operating pressures (night or summer setback, factory shutdowns/slowdowns, significant process load variances, wood burning boilers), the use of a VFD can save energy. When the motor RPM is controlled electronically so the pump discharge pressure will more efficiently match the boiler operating pressure in "real time," the horsepower required is reduced by a factor in proportion to cube of the speed reduction (see pump affinity laws).

A VFD is recommended when operating the boiler(s) at a pressure more than 30 PSIG below the safety relief valve setting.

Protecting a centrifugal pump from cavitation in a high-pressure system on applications where severe pressure differentials between boiler operation points and original boiler design points exist, and an auto flow control valve is being used to provide artificial back-pressure on the pump.

Boiler feed water and deaerator applications where the centrifugal pump discharge pressure is 75 PSIG and higher and where the relief valve setting on the boiler is not changed to closely match the operating conditions of the boiler and steam system.

Continuously running feed water centrifugal pump applications where the motor horsepower is 15 horsepower or larger.

SHIPCO®, as a pump manufacturer, strongly encourages engineers of steam systems to consider the variables discussed in this article and how they affect the operation of the steam system being designed at the outset and not retroactively.

Most importantly to us, this includes picking the appropriate feed water pump for the condition points at which the pump will be expected to perform during its operation cycles. This will not only reduce overall initial costs of a project, but will extend the life of the mechanical equipment significantly and will reduce or eliminate substantial maintenance and replacement costs of pumps.

Determine NPSH

NPSH stands for Net Positive Suction Head. The **available NPSH** is essentially the measure of how close the water in the suction passage of the pump is to boiling, with the attendant formation of steam within the impeller, thus diminishing the pump's performance.

Since we have a deaerator where the water is at the saturation point or boiling point, the **available NPSH** is at zero, located at the bottom of the steam manifold.

Various physical designs of pumps have various **NPSH requirements**. In order for any pump to operate successfully, the NPSH **available** must be **greater** than the NPSH **requirements.** With a deaerator the only way you can increase the NPSH available is to elevate the tank a greater distance than the pump requires. For example, a pump with an NPSH requirement of 4 ft. must be elevated at least 4 ft. plus a safety factor (usually 1 to 2 ft.). The SHIPCO® model "P" pump requires only 2 ft. of NPSH at the best efficiency point; therefore, our standard elevation is 4 ft. or 48 inches.

Suction strainers hurt NPSH calculations since you can't measure the pressure drop through a strainer. In addition, if it works it will destroy the pump by causing it to run dry. For this reason suction strainers are **never** used with centrifugal pumps like the SHIPCO® model "P" or "D" pumps. Suction strainers are only used when turbine pumps are supplied since even a little dirt and debris will cause this style of pump to go bad due to the close tolerances within the design. The standard rule of thumb is to add one additional foot of stand elevation to compensate for this suction strainer.

Determine Receiver Size

The receiver size on a deaerator is based on the total load of all boilers being fed by the unit at any one time. The receiver size is generally based on 10 minutes of net storage when using a single compartment with returns.

If the system utilizes a surge tank with the deaerator, then the surge tank will be sized to handle the 10 minutes of net storage time required, with the deaerator being sized for only 5 minutes of net storage.

A deaerator without returns (100% make-up) requires only 5 minutes of net storage.

As demonstrated, the selection of the receiver size may vary based on the characteristics of the system.

Surge Tank Pump Selection & Sizing

When Is a Surge Tank Used?

General Guidelines

- On systems with **80% or more make-up** a surge tank is **not required**.
- On systems with **more than 20% returns** a surge tank is **required** to achieve good deaeration.

What Is a Surge Tank?

A surge tank is another name for a boiler feed tank. It acts exactly like a boiler feed tank except that it feeds a deaerator in lieu of a boiler. With a surge tank the make-up water is added into this tank and blended with the return water to avoid shocking the deaerator with extreme temperature and capacity variations. In addition, the pumps on the surge tank **must run continuously**, pumping the water directly into the modulating transfer or the make-up valve on the deaerator. The second transfer pump on a SHIPCO® surge tank is a standby pump that is activated by a low-level switch on the deaerator (-2T or -2C Type Units). This standby pump runs automatically in case the lead pump fails or can't keep up.

A surge tank is <u>not</u> a condensate pump since a condensate pump turns on and off based on the water level in its receiver. When a condensate style unit is used as a surge tank, it defeats the entire purpose of a surge tank by allowing large variations in capacity and temperature into the system. The main purpose of the surge tank is to level out the transients or control the fluctuations in capacity and temperature so the deaerator runs as smoothly and effectively as possible.

If controlling these variations in temperature were not important, no need would exist to use expensive controls that modulate on the deaerator.

What Does a Surge Tank Look Like?

Since a surge tank is another name for a boiler feed tank, as mentioned earlier, the tank can take many shapes and forms. The tank can be made of stainless steel, close grained cast iron (with a 20-year warranty against corrosion failure) to prevent against corrosion failure, Plasite #7156 lined, or simply black steel.

The surge tank can be an integral part of the deaerator, like a two-compartment style (look under its specific tab), or be free standing by itself (called a two-tank or -2T system).

Where surge tanks are in a free-standing by itself situation (-2T systems), the free-standing surge tank can be elevated or mounted on the floor like many of the types throughout the entire catalog (see Reference Chart A on page 6). Yes, the surge tank may be placed on the floor. This is possible because at 150, 180 or even 200˚F the water temperature is low enough that NPSH is not a major concern. For example, with 194˚F water you have 10.46 feet of NPSH available at sea level. If you look at the pump curves in the catalog under Model D or P, the pumps, if properly selected, are 2 ft., 4 ft. or 6 ft. NPSH at the best efficient point on the curve; hence, the NPSH available is greater than the pump NPSH requirement based on 194˚F water in tank.

All floor-mounted units should be sold and specified with SHIPCO® bronze isolated valves that are factory tested for servicing the pump.

CHART A	
Vertical Floor Mounted	EMV tab
Floor or Elevated Cast Iron	DMC/PMC/PMEC tab
Rectangular Steel Tanks	DMS/PMS/PMES tab
Cylindrical Steel Floor Mounted – pump on end	CS-B tab
Cylindrical Steel Floor or Elevated – pump on side	CS & CES tab
Dished Head Steel Floor or Elevated	SHM & SHEM tab
ASME Code Stamped Units	HT tab

Determine Transfer Pump (gallons per minute) GPM

All deaerator units are rated in lbs/hr of steam. The transfer pumps on the surge tank units are sized based on this rating. Lbs/hr divided by 500 equals the evaporation rate in GPM for these pumps. The pumps are sized as follows:

If transfer pumps are feeding a deaerator on a free-standing by itself surge tank (-2T) system, the pump rate in GPM equals the evaporation rate or the total load rating on the deaerator. For example, if deaerator system is rated 10,000 lbs/hr, then each transfer pump should be rated for 20 GPM.

If transfer pumps feeding a deaerator with the surge tank are part of the complete unit like our two-compartment model (-2C), the transfer pumps are sized differently based on being an atmospheric or pressurized deaerator.

If a pressurized two-compartment deaerator unit is used (-2C), the pump rate equals the evaporation rate or the total load rating on the deaerator (as mentioned earlier).

If an atmospheric two-compartment deaerator is used (.005 DA-2C or .03 DA-2C), the pump rate in GPM equals the evaporation rate of the deaerator multiplied by 1.5. For example, if deaerator is rated 10,000 lbs/hr, then each transfer pump should be rated for 30 GPM (20 GPM x 1.5). This is to allow recirculation of water through the vent condensers. *In addition, this is the only type of surge tank where NPSH is a concern and pumps should have an NPSH requirement lower than the height of the stand to be safe.*

Recirculation for these continuously running transfer pumps may be required. The SHIPCO® Model P and D pumps have as standard a bleed line that does not require any additional recirculation when pumping liquids lower in temperature than the saturation or boiling point.

Determine Pump Discharge Pressure PSIG

Surge tank pumps are sized as follows:

A) To overcome the operating pressure of the deaerator
B) Spray nozzles
C) Friction loss in pipe
D) Vertical lift between deaerator and surge tank
E) Safety margin generally 5 PSIG
F) Pressure drop associated with transfer valve

The amount of these values, or these values added together, is normally expressed in feet of head. To convert to pounds per square inch, or PSIG, 2.31 ft. = 1 PSIG.

Generally the surge tank is located beside the deaerator or when it is part of the deaerator itself; therefore, a transfer pump discharge of 25 PSIG, if feeding an atmospheric deaerator, or 35 PSIG, if feeding a pressurized deaerator, is used as our standard since our standard transfer modulating valves are sized for 100% of the deaerator load with a 10 PSIG drop across valve.

How to Size and What Style of Make-Up to Use

Since the purpose of a surge tank is to gather all the returns from the system and mix the make-up water with the returns to blend the temperature, the make-up valve should be a standard close closing solenoid valve activated by a float switch in the tank. By using a modulating make-up valve you are wasting money on an expensive valve and controller that serve no purpose unless your system is larger than 75,000 lbs/hr.

The make-up valve capacity should be sized for 100% of the total load of the system so you have emergency backup. In addition, make sure that your city water supply pressure is adequate for the pressure drop through this valve.

What Special Equipment Should I Have?

If purchasing a high quality deaerator with high and low water alarms and pump low water cut-off, your surge tank should be equipped with the same alarms and cut-offs. In addition, since surge tanks are vented to atmosphere, they will corrode. Surge tanks should be cast iron, Plasite lined with #7159 or made of 300 series stainless steel for about the same price.

Determine Receiver Size

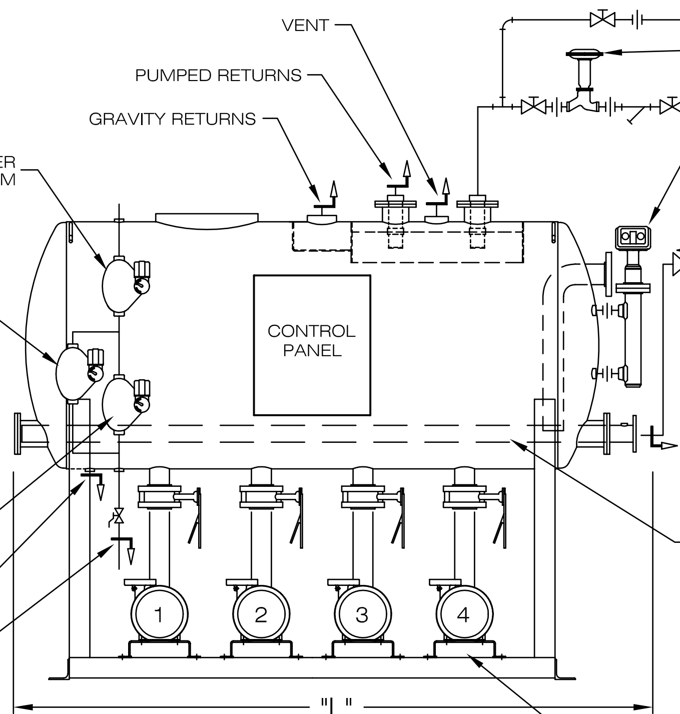
The receiver on a surge tank is sized based on the total load of all boilers in the system or the deaerator rating, the same sizing as that of a standard boiler feed unit. The receiver size is generally based on **10 minutes of net storage** as a general rule of thumb just like the deaerators.

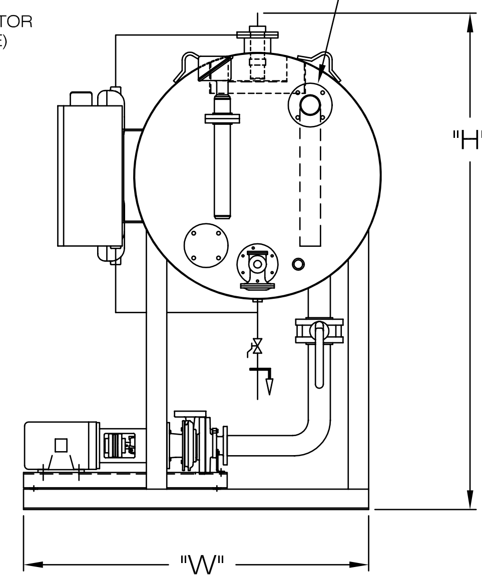
The suggested specifications, Installation, Operation and Maintenance Manuals, Dimension Prints, Piping Details and Bulletins are located for your convenience behind the appropriate catalog tab.

Special HS Systems Deaerators

.005 DA-ISTP-2THS, .005 DA-STP-2THS,
.005 DA-ISTP-2CHS or .005 DA-STP-2CHS

Pressurized two-compartment or two-tank units where most if not all the returns coming back are above the saturation point. Condensate returns are not vented to atmosphere.





SELECTED CAPACITIES AND OVERALL DIMENSIONS

STANDARD RECEIVER SIZE	THICK	NET RECEIVER GALLONS	SYSTEM SIZE based on 10 min. Storage Capacity		APPROXIMATE OVERALL DIMENSIONS *		
			Boiler Horsepower	lb/hr Steam	Length	Width	Height
36 x 60	3/16	215	290	10,000	102	94	100
36 x 72	3/16	257	350	12,000	114	94	100
36 x 84	3/16	293	435	15,000	126	94	100
42 x 72	3/16	380	550	19,000	116	98	102
42 x 84	3/16	438	640	22,000	128	98	102
42 x 96	3/16	482	695	24,000	140	98	102
48 x 84	1/4	538	780	27,000	130	100	110
48 x 96	1/4	594	870	30,000	142	100	110
48 x 120	1/4	715	1,045	36,000	166	100	110
54 x 120	5/16	987	1,450	50,000	170	104	116
60 x 120	5/16	1,273	1,855	64,000	172	106	124
60 x 144	5/16	1,479	2,145	74,000	196	106	124
66 x 120	5/16	1,641	2,375	82,000	174	110	130
66 x 144	5/16	1,907	2,755	95,000	198	110	130
72 x 120	3/8	2,036	2,955	102,000	174	122	136
72 x 144	3/8	2,375	3,480	120,000	198	122	136

* Base footprint is approximate and varies depending on pump selection. Consult factory for customization.

Most times width can be reduced using vertical style pumps.

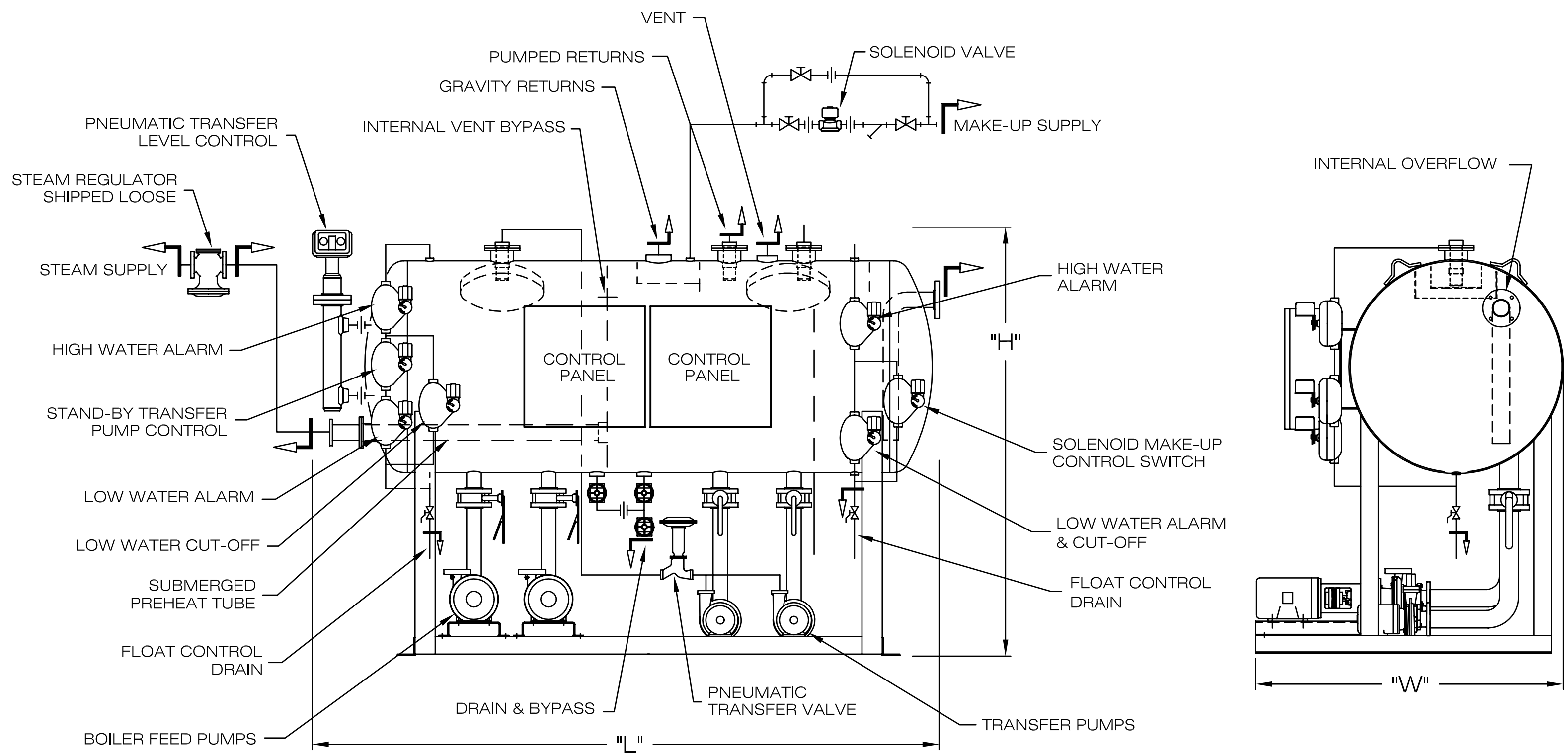
"H" DIMENSION BASED ON 48" ELEVATION

INDICATES WHERE SHIPCO PIPING ENDS

"ALL DIMENSIONS ARE APPROXIMATE"

NOTE "A"
MAKE-UP CONNECTION IF SINGLE TANK DESIGN
TRANSFER CONNECTION IF TWO TANK DESIGN

.03 DA
.03 DA-2T
ATMOSPHERIC DESIGN



SELECTED CAPACITIES AND OVERALL DIMENSIONS

STANDARD RECEIVER SIZE	THICK	NET RECEIVER GALLONS	SYSTEM SIZE based on 10 min. Storage Capacity		APPROXIMATE OVERALL DIMENSIONS *		
			Boiler Horsepower	lb/hr Steam	Length	Width	Height
36 x 60	3/16	230	145	5,000	102	94	100
36 x 72	3/16	257	175	6,000	114	94	100
36 x 84	3/16	293	220	7,500	126	94	100
42 x 72	3/16	380	275	9,500	116	98	102
42 x 84	3/16	438	320	11,000	128	98	102
42 x 96	3/16	482	350	12,000	140	98	102
48 x 84	1/4	538	390	13,500	130	100	110
48 x 96	1/4	594	435	15,000	142	100	110
48 x 120	1/4	715	520	18,000	166	100	110
54 x 120	5/16	987	725	25,000	170	104	116
60 x 120	5/16	1,273	930	32,000	172	106	124
60 x 144	5/16	1,479	1,070	37,000	196	106	124
66 x 120	5/16	1,641	1,190	41,000	174	110	130
66 x 144	5/16	1,907	1,360	47,000	198	110	130
72 x 120	3/8	2,036	1,480	51,000	174	122	136
72 x 144	3/8	2,375	1,740	60,000	198	122	136
72 x 168	3/8	2,675	1,940	67,000	222	122	136
72 x 192	3/8	3,000	2,175	75,000	246	122	136
72 x 204	3/8	3,250	2,350	81,000	258	122	136
84 x 144	3/8	3,365	2,440	84,000	202	130	148
84 x 168	3/8	3,828	2,775	95,000	226	130	148
84 x 192	3/8	4,285	3,100	107,000	250	130	148
96 x 204	3/8	5,686	4,115	142,000	266	136	160

* BASE FOOTPRINT IS APPROXIMATE AND VARIES DEPENDING ON PUMP SELECTION. CONSULT FACTORY FOR CUSTOMIZATION.

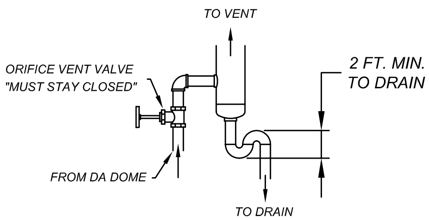
MOST TIMES WIDTH CAN BE REDUCED USING VERTICAL STYLE PUMPS.

"H" DIMENSION BASED ON 48" ELEVATION

INDICATES WHERE SHIPCO PIPING ENDS

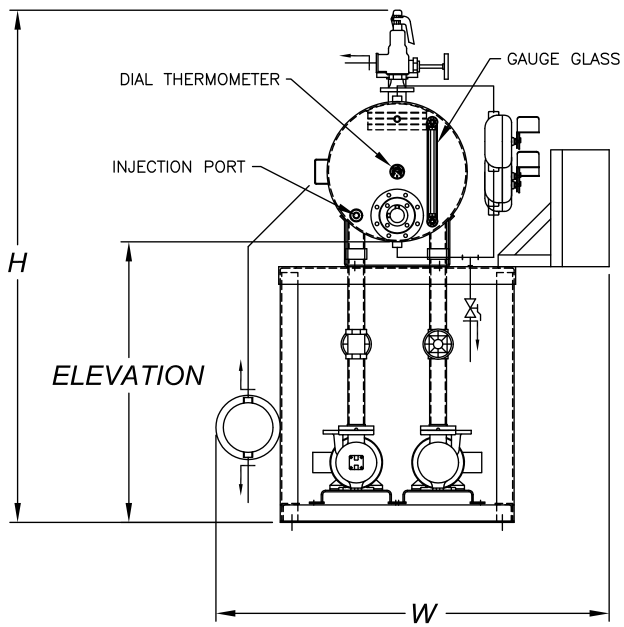
"ALL DIMENSIONS ARE APPROXIMATE"

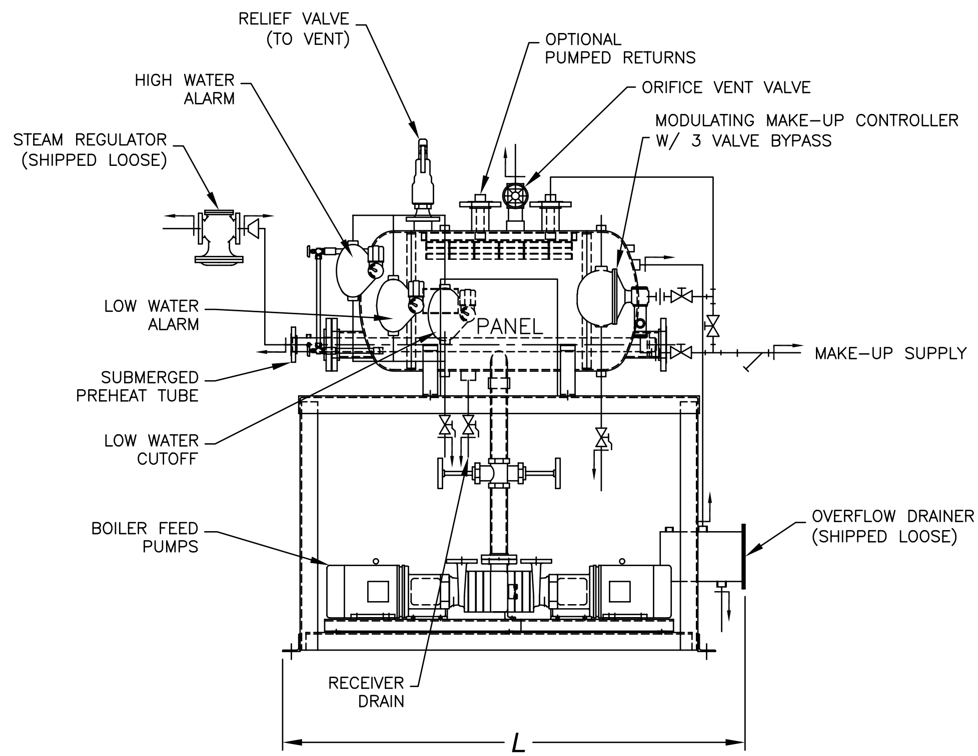
.03 DA-2C
ATMOSPHERIC DESIGN



SUGGESTED VENT PIPING

NOTE "A"
MAKE-UP CONNECTION IF SINGLE TANK DESIGN
TRANSFER CONNECTION IF TWO TANK DESIGN





SELECTED CAPACITIES AND OVERALL DIMENSIONS

STANDARD RECEIVER SIZE	NET RECEIVER GALLONS	SYSTEM SIZE based on 10 min. Storage Capacity		APPROXIMATE OVERALL DIMENSIONS *		
		Boiler Horsepower	lb/hr Steam	Length	Width	Height
24 x 24	36	52	1,795	74	68	88
24 x 30	42	60	2,070	74	68	88
24 x 36	48	70	2,415	74	68	88
24 x 48	60	87	3,000	80	68	88
24 x 60	72	104	3,590	86	68	88
30 x 36	85	123	4,245	74	72	94
30 x 48	110	160	5,520	80	72	94
30 x 60	135	196	6,760	86	72	94
36 x 48	160	232	8,005	80	76	100

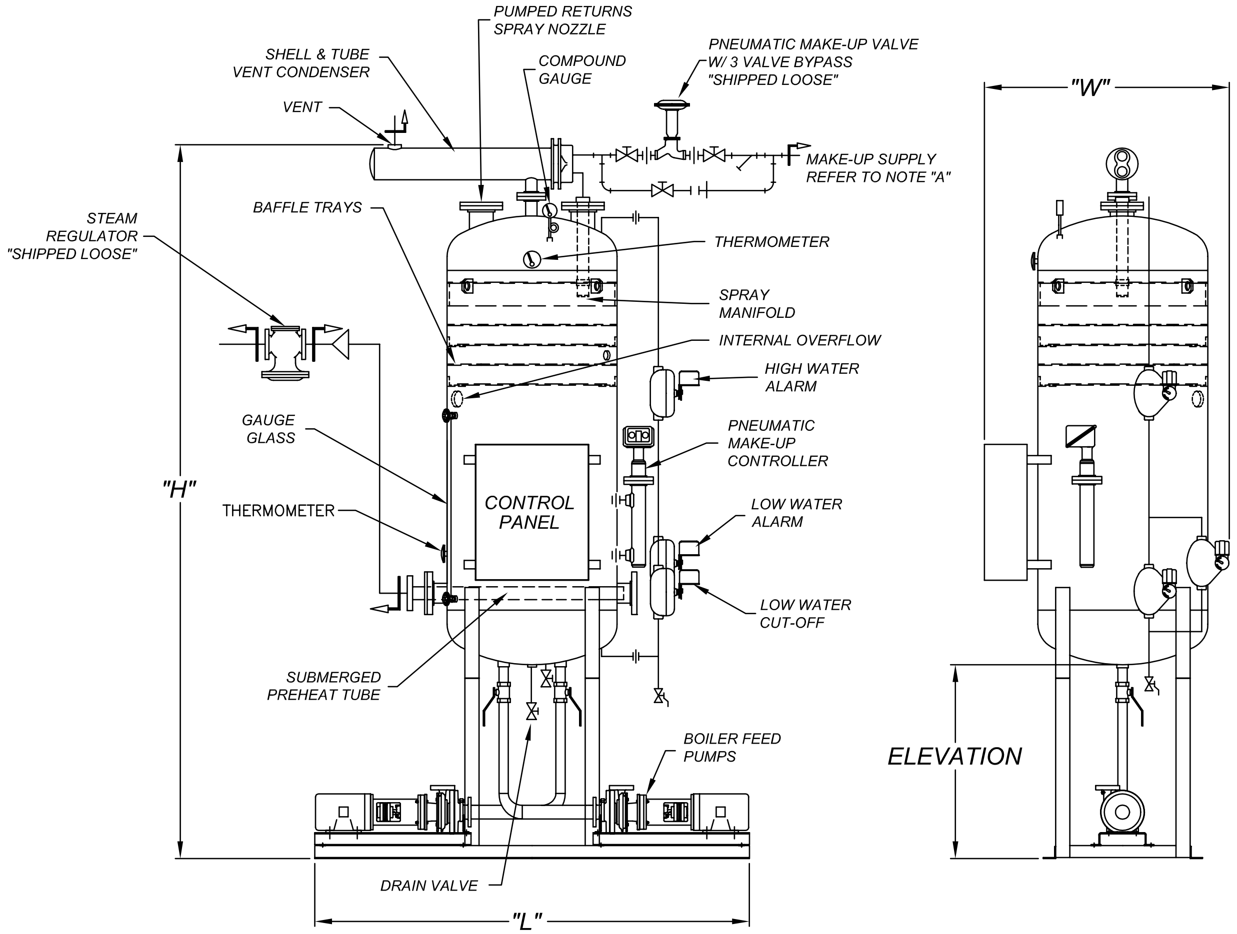
"H" DIMENSION BASED ON 48" ELEVATION

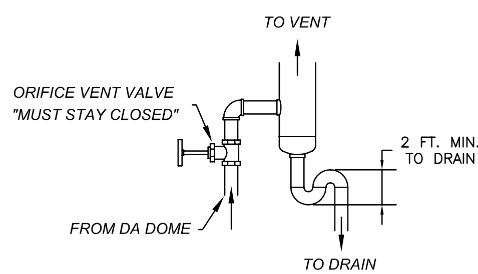
INDICATES WHERE SHIPCO PIPING ENDS

"ALL DIMENSIONS ARE APPROXIMATE"

* BASE FOOTPRINT IS APPROXIMATE AND VARIES DEPENDING ON PUMP SELECTION. CONSULT FACTORY FOR CUSTOMIZATION. MOST TIMES WIDTH CAN BE REDUCED USING VERTICAL STYLE PUMP.

.005 DA-SCP PRESSURIZED DESIGN





SUGGESTED VENT PIPING

SELECTED CAPACITIES AND OVERALL DIMENSIONS

STANDARD RECEIVER SIZE	THICK	NET RECEIVER GALLONS	SYSTEM SIZE based on 10 min. Storage Capacity		APPROXIMATE OVERALL DIMENSIONS *		
			Boiler Horsepower	lb/hr Steam	Length	Width	Height
24 x 48	3/16"	38	55	2,000	50	50	132
24 x 60	3/16"	60	90	3,000	50	50	144
30 x 60	3/16"	95	145	5,000	56	56	147
36 x 60	3/16"	132	205	7,000	62	62	150
42 x 60	3/16"	180	260	9,000	68	68	155

* BASE FOOTPRINT IS APPROXIMATE AND VARIES DEPENDING ON PUMP SELECTION. CONSULT FACTORY FOR CUSTOMIZATION.

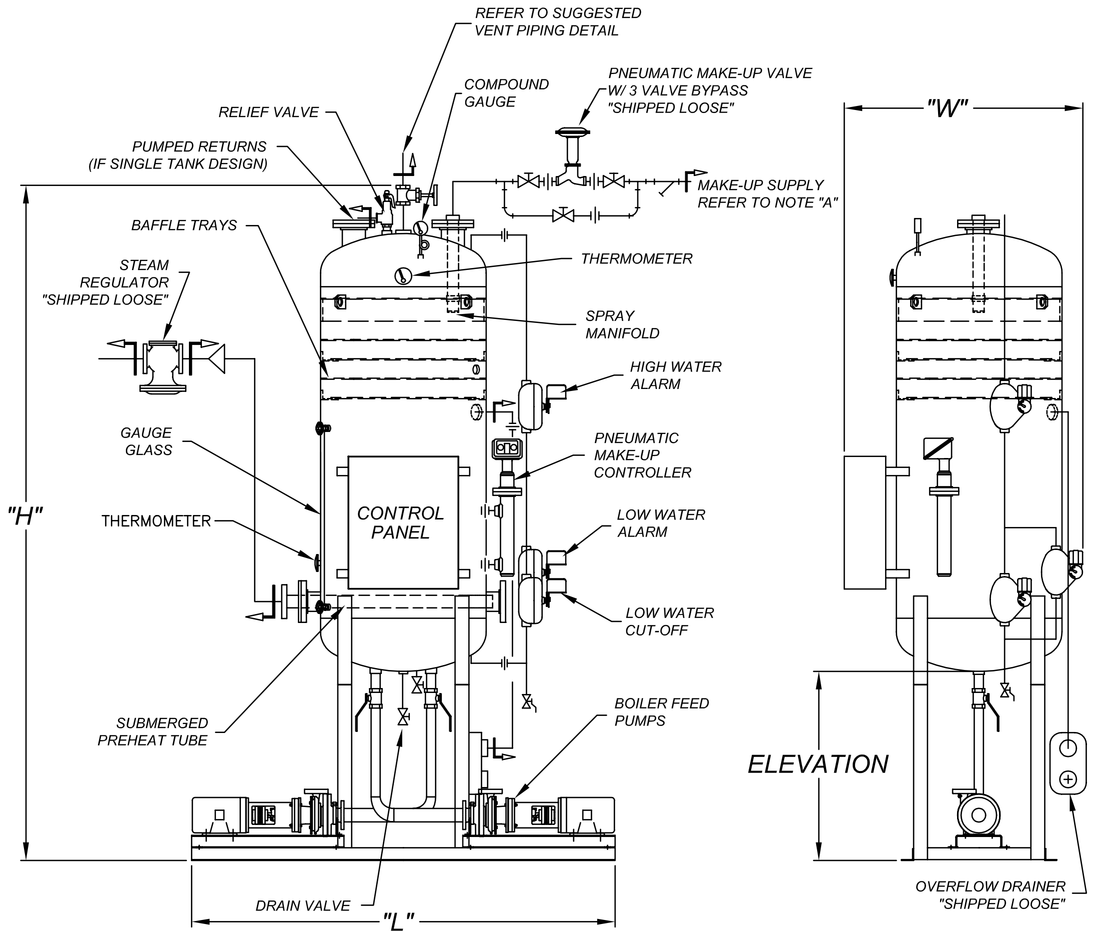
MOST TIMES WIDTH CAN BE REDUCED USING VERTICAL STYLE PUMP.

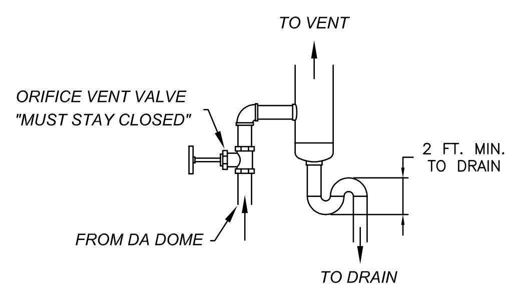
"H" DIMENSION BASED ON 48" ELEVATION

INDICATES WHERE SHIPCO PIPING ENDS

"ALL DIMENSIONS ARE APPROXIMATE"

.005 DA-STV
.005 DA-STV-2T
ATMOSPHERIC DESIGN





SUGGESTED VENT PIPING

SELECTED CAPACITIES AND OVERALL DIMENSIONS

STANDARD RECEIVER SIZE	NET RECEIVER GALLONS	SYSTEM SIZE based on 10 min. Storage Capacity		APPROXIMATE OVERALL DIMENSIONS *		
		Boiler Horsepower	lb/hr Steam	Length	Width	Height
24 x 48	38	55	2,000	50	50	134
24 x 60	60	90	3,000	50	50	146
30 x 60	95	145	5,000	56	56	150
36 x 60	132	205	7,000	62	62	152
42 x 60	180	260	9,000	68	68	160

* BASE FOOTPRINT IS APPROXIMATE AND VARIES DEPENDING ON PUMP SELECTION. CONSULT FACTORY FOR CUSTOMIZATION.

MOST TIMES WIDTH CAN BE REDUCED USING VERTICAL STYLE PUMP.

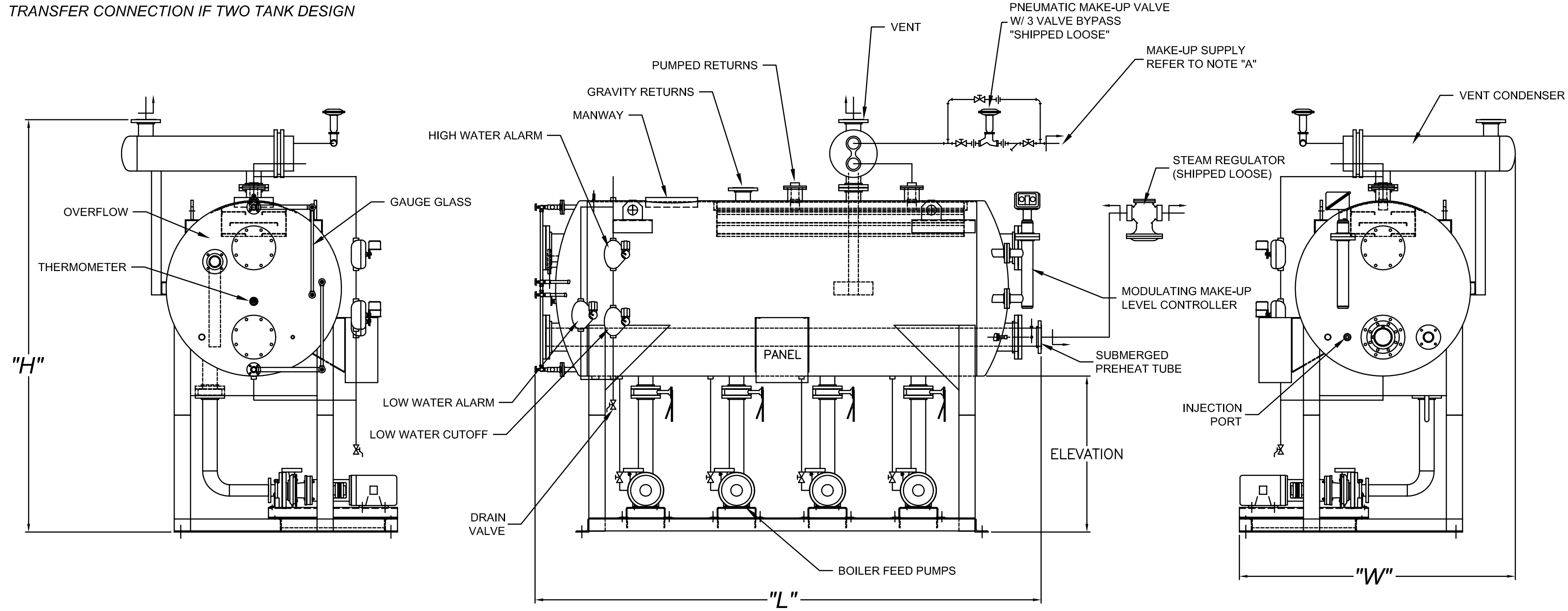
"H" DIMENSION BASED ON 48" ELEVATION

INDICATES WHERE SHIPCO PIPING ENDS

"ALL DIMENSIONS ARE APPROXIMATE"

.005 DA-STVP
.005 DA-STVP-2T
PRESSURIZED DESIGN

NOTE "A"
MAKE-UP CONNECTION IF SINGLE TANK DESIGN
TRANSFER CONNECTION IF TWO TANK DESIGN



SELECTED CAPACITIES AND OVERALL DIMENSIONS

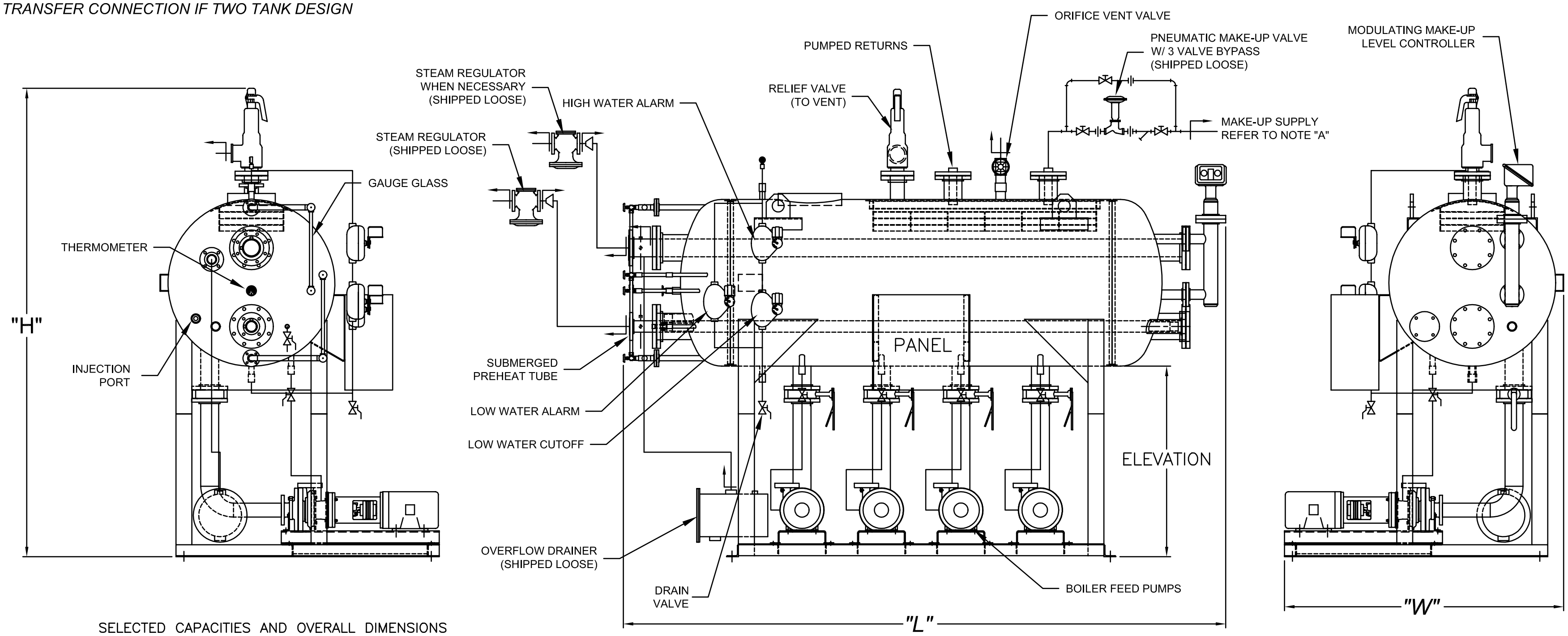
STANDARD RECEIVER SIZE	THICK	NET RECEIVER GALLONS	SYSTEM SIZE based on 10 min. Storage Capacity: Boiler Horsepower	SYSTEM SIZE based on 10 min. Storage Capacity: lb/hr Steam	APPROXIMATE OVERALL DIMENSIONS *: Length	Width	Height
36 x 60	3/16	180	260	9,000	102	90	104
36 x 72	3/16	223	320	11,000	114	90	104
36 x 84	3/16	260	375	13,000	126	90	104
42 x 72	3/16	306	435	15,000	116	93	110
42 x 84	3/16	358	520	18,000	128	93	110
42 x 96	3/16	400	580	20,000	140	93	110
48 x 84	1/4	465	665	23,000	130	96	116
48 x 96	1/4	532	780	27,000	142	96	116
48 x 120	1/4	665	985	34,000	166	96	116
54 x 120	5/16	825	1,215	42,000	170	100	122
60 x 120	5/16	1,025	1,505	52,000	172	102	128
60 x 144	5/16	1,295	1,885	65,000	196	102	128
66 x 120	5/16	1,440	2,085	72,000	174	105	134
66 x 144	5/16	1,670	2,435	84,000	198	105	134
72 x 120	3/8	1,785	2,610	90,000	174	118	140
72 x 144	3/8	2,080	3,015	104,000	198	118	140

* Base footprint is approximate and varies depending on pump selection. Consult factory for customization.
Most times width can be reduced using vertical style pump.

"H" DIMENSION BASED ON 48" ELEVATION
◁⎤ INDICATES WHERE SHIPCO PIPING ENDS ⎡▷
"ALL DIMENSIONS ARE APPROXIMATE"

.005 DA-IST
.005 DA-IST-2T
ATMOSPHERIC DESIGN

NOTE "A"
MAKE-UP CONNECTION IF SINGLE TANK DESIGN
TRANSFER CONNECTION IF TWO TANK DESIGN



SELECTED CAPACITIES AND OVERALL DIMENSIONS

STANDARD RECEIVER SIZE	NET RECEIVER GALLONS	SYSTEM SIZE based on 10 min. Storage Capacity		APPROXIMATE OVERALL DIMENSIONS *		
		Boiler Horsepower	lb/hr Steam	Length	Width	Height
36 x 60	180	260	9,000	108	80	106
36 x 72	223	320	11,000	120	80	106
36 x 84	260	375	13,000	132	80	106
42 x 72	306	435	15,000	124	83	118
42 x 84	358	520	18,000	136	83	118
42 x 96	400	580	20,000	148	83	118
48 x 84	465	665	23,000	139	86	124
48 x 96	532	780	27,000	151	86	124
48 x 120	665	985	34,000	175	86	124
54 x 120	825	1,215	42,000	177	90	136
60 x 120	1,025	1,505	52,000	180	92	142
60 x 144	1,295	1,885	65,000	205	92	142
66 x 120	1,440	2,085	72,000	184	95	148
66 x 144	1,670	2,435	84,000	208	95	148
72 x 120	1,785	2,610	90,000	186	108	154
72 x 144	2,080	3,015	104,000	210	108	154
72 x 168	2,340	3,390	117,000	234	108	154
72 x 192	2,625	3,795	131,000	258	108	154
72 x 204	2,845	4,145	143,000	270	108	154

* BASE FOOTPRINT IS APPROXIMATE AND VARIES DEPENDING ON PUMP SELECTION. CONSULT FACTORY FOR CUSTOMIZATION.

MOST TIMES WIDTH CAN BE REDUCED USING VERTICAL STYLE PUMP.

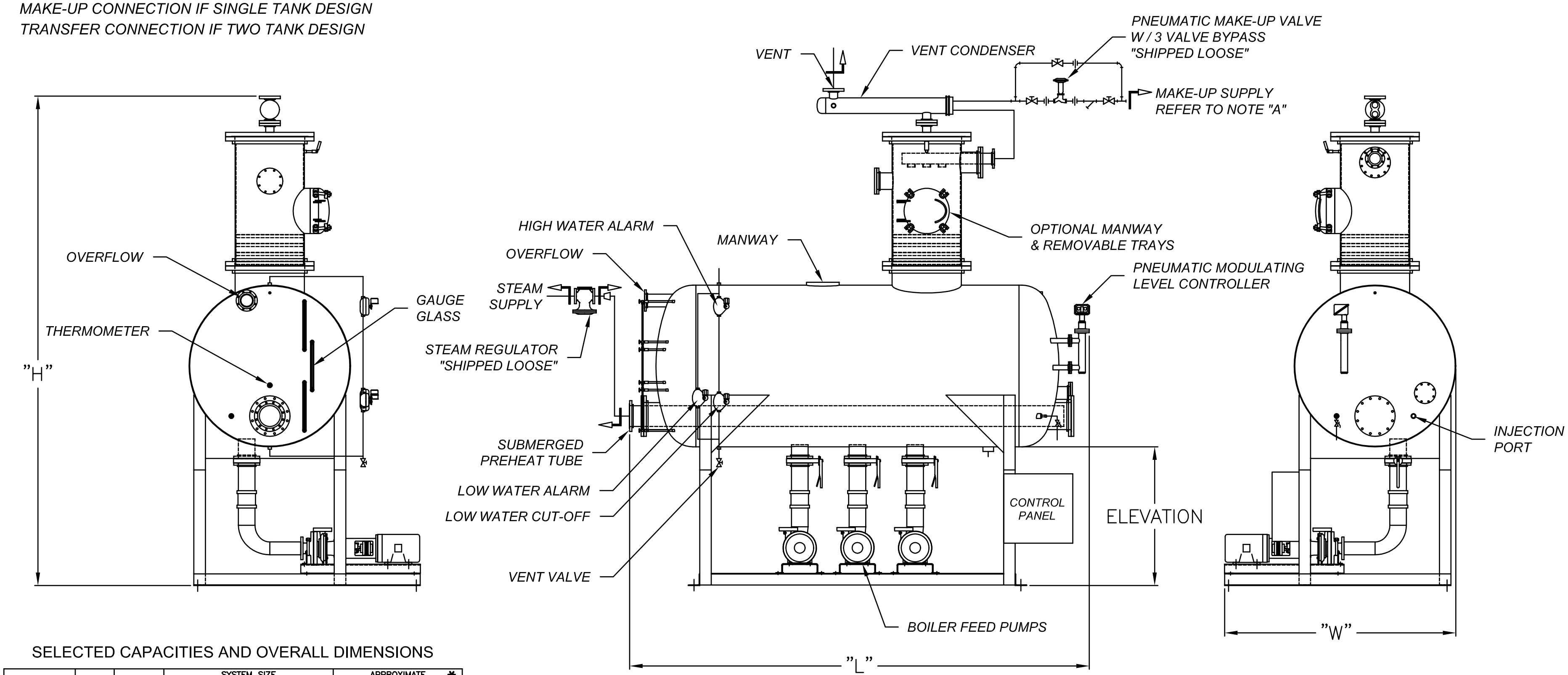
"H" DIMENSION BASED ON 48" ELEVATION

INDICATES WHERE SHIPCO PIPING ENDS

"ALL DIMENSIONS ARE APPROXIMATE"

.005 DA-ISTP
.005 DA-ISTP-2T
PRESSURIZED DESIGN

NOTE "A"
MAKE-UP CONNECTION IF SINGLE TANK DESIGN
TRANSFER CONNECTION IF TWO TANK DESIGN



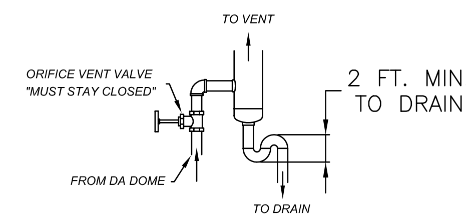
SELECTED CAPACITIES AND OVERALL DIMENSIONS

STANDARD RECEIVER SIZE	THICK	NET RECEIVER GALLONS	SYSTEM SIZE based on 10 min. Storage Capacity		APPROXIMATE OVERALL DIMENSIONS *		
			Boiler Horsepower	lb/hr Steam	Length	Width	Height
36 x 60	3/16	230	350	12,000	112	80	166
36 x 72	3/16	257	375	13,000	122	80	166
36 x 84	3/16	293	435	15,000	134	80	166
42 x 72	3/16	380	580	20,000	126	83	172
42 x 84	3/16	438	640	22,000	138	83	172
42 x 96	3/16	482	695	24,000	150	83	172
48 x 84	1/4	538	810	28,000	142	86	178
48 x 96	1/4	594	870	30,000	154	86	178
48 x 120	1/4	715	1,045	36,000	178	86	178
54 x 120	5/16	987	1,450	50,000	182	90	200
60 x 120	5/16	1,273	1,855	64,000	184	92	206
60 x 144	5/16	1,479	2,145	74,000	210	92	206
66 x 120	5/16	1,641	2,375	82,000	188	95	214
66 x 144	5/16	1,907	2,755	95,000	210	95	214
72 x 120	3/8	2,036	2,955	102,000	190	108	240
72 x 144	3/8	2,375	3,480	120,000	214	108	240
72 x 168	3/8	2,675	3,885	134,000	240	108	240
72 x 192	3/8	3,000	4,350	150,000	262	108	240
72 x 204	3/8	3,250	4,785	165,000	274	108	240
84 x 132	3/8	3,134	4,540	157,000	216	114	250
84 x 144	3/8	3,365	4,875	168,000	220	114	250
84 x 168	3/8	3,828	5,550	190,000	242	114	250
84 x 192	3/8	4,285	6,200	215,000	268	114	250
96 x 204	3/8	5,686	8,260	285,000	284	120	270

"H" DIMENSION BASED ON 48" ELEVATION

INDICATES WHERE SHIPCO PIPING ENDS

"ALL DIMENSIONS ARE APPROXIMATE"

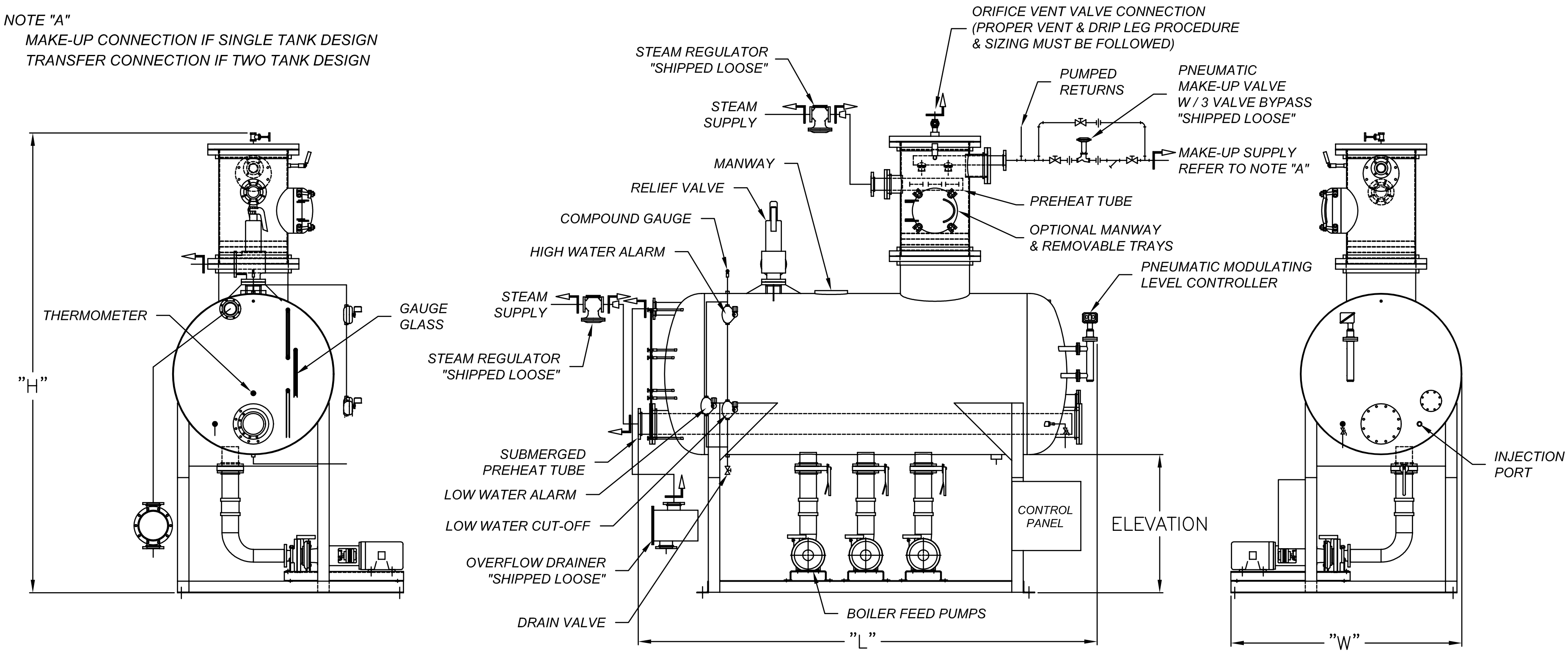


SUGGESTED VENT PIPING

* BASE FOOTPRINT IS APPROXIMATE AND VARIES DEPENDING ON PUMP SELECTION. CONSULT FACTORY FOR CUSTOMIZATION.

MOST TIMES WIDTH CAN BE REDUCED USING VERTICAL STYLE PUMP.

.005 DA-ST
.005 DA-ST-2T
ATMOSPHERIC DESIGN



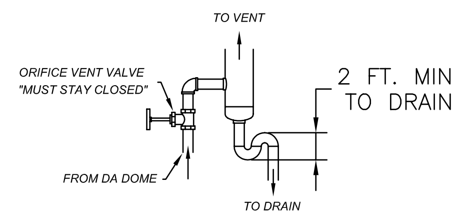
SELECTED CAPACITIES AND OVERALL DIMENSIONS

STANDARD RECEIVER SIZE	NET RECEIVER GALLONS	SYSTEM SIZE based on 10 min. Storage Capacity		APPROXIMATE OVERALL DIMENSIONS *		
		Boiler Horsepower	lb/hr Steam	Length	Width	Height
36 x 60	230	350	12,000	110	80	156
36 x 72	257	375	13,000	122	80	156
36 x 84	293	435	15,000	134	80	156
42 x 72	380	580	20,000	126	83	170
42 x 84	438	640	22,000	138	83	170
42 x 96	482	695	24,000	150	83	170
48 x 84	538	810	28,000	142	86	176
48 x 96	594	870	30,000	154	86	176
48 x 120	715	1,045	36,000	178	86	176
54 x 120	987	1,450	50,000	180	90	190
60 x 120	1,273	1,855	64,000	184	92	196
60 x 144	1,479	2,145	74,000	208	92	196
66 x 120	1,641	2,375	82,000	186	95	204
66 x 144	1,907	2,755	95,000	210	95	204
72 x 120	2,036	2,955	102,000	190	108	235
72 x 144	2,375	3,480	120,000	214	108	235
72 x 168	2,675	3,885	134,000	238	108	235
72 x 192	3,000	4,350	150,000	262	108	235
72 x 204	3,250	4,785	165,000	274	108	235
84 x 132	3,134	4,540	157,000	204	114	260
84 x 144	3,365	4,875	168,000	216	114	260
84 x 168	3,828	5,550	190,000	240	114	260
84 x 192	4,285	6,200	215,000	264	114	260
96 x 204	5,686	8,260	285,000	280	120	270
108 x 168	6,446	9,420	325,000	254	126	285
108 x 180	6,830	9,855	340,000	266	126	285
108 x 198	7,396	10,725	370,000	284	126	285
108 x 216	7,986	11,595	400,000	302	126	285
108 x 264	9,430	14,495	500,000	350	126	285

"H" DIMENSION BASED ON 48" ELEVATION

◅ INDICATES WHERE SHIPCO PIPING ENDS ▻

"ALL DIMENSIONS ARE APPROXIMATE"

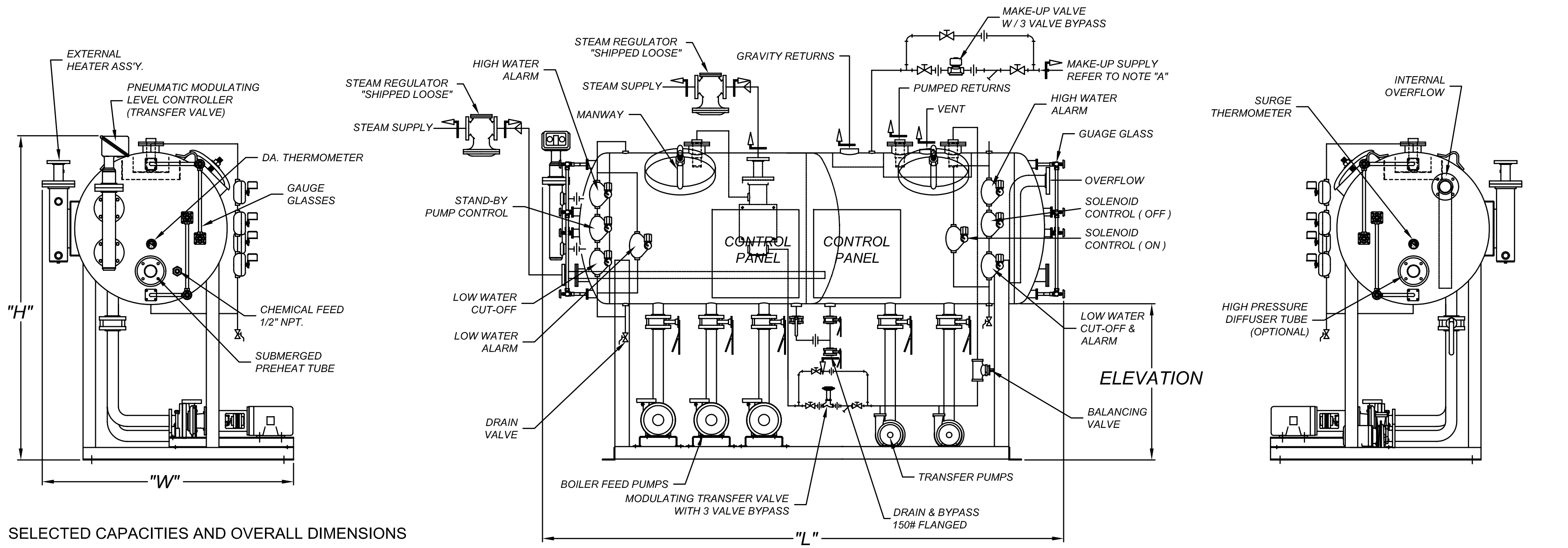


SUGGESTED VENT PIPING

* BASE FOOTPRINT IS APPROXIMATE AND VARIES DEPENDING ON PUMP SELECTION. CONSULT FACTORY FOR CUSTOMIZATION.
MOST TIMES WIDTH CAN BE REDUCED USING VERTICAL STYLE PUMP.

.005 DA-STP
.005 DA-STP-2T
PRESSURIZED DESIGN

NOTE "A"
MAKE-UP CONNECTION IF SINGLE TANK DESIGN
TRANSFER CONNECTION IF TWO TANK DESIGN



SELECTED CAPACITIES AND OVERALL DIMENSIONS

STANDARD RECEIVER SIZE	THICK	NET RECEIVER GALLONS	SYSTEM SIZE based on 10 min. Storage Capacity: Boiler Horsepower	lb/hr Steam	APPROXIMATE OVERALL DIMENSIONS *: Length	Width	Height
36 x 60	3/16	230	145	5,000	102	94	100
36 x 72	3/16	257	175	6,000	114	94	100
36 x 84	3/16	293	220	7,500	126	94	100
42 x 72	3/16	380	275	9,500	116	98	102
42 x 84	3/16	438	320	11,000	128	98	102
42 x 96	3/16	482	350	12,000	140	98	102
48 x 84	1/4	538	390	13,500	130	100	110
48 x 96	1/4	594	435	15,000	142	100	110
48 x 120	1/4	715	520	18,000	166	100	110
54 x 120	5/16	987	725	25,000	170	104	116
60 x 120	5/16	1,273	930	32,000	172	106	124
60 x 144	5/16	1,479	1,070	37,000	196	106	124
66 x 120	5/16	1,641	1,190	41,000	174	110	130
66 x 144	5/16	1,907	1,360	47,000	198	110	130
72 x 120	3/8	2,036	1,480	51,000	174	122	136
72 x 144	3/8	2,375	1,740	60,000	198	122	136
72 x 168	3/8	2,675	1,940	67,000	222	122	136
72 x 192	3/8	3,000	2,175	75,000	246	122	136
72 x 204	3/8	3,250	2,350	81,000	258	122	136
84 x 144	3/8	3,365	2,440	84,000	202	130	148
84 x 168	3/8	3,828	2,775	95,000	226	130	148
84 x 192	3/8	4,285	3,100	107,000	250	130	148
96 x 204	3/8	5,686	4,115	142,000	266	136	160
108 x 168	7/16	6,446	4,695	162,000	240	140	172
108 x 180	7/16	6,830	4,955	171,000	252	140	172
108 x 198	7/16	7,396	5,360	185,000	270	140	172
108 x 216	7/16	7,986	5,795	200,000	288	140	172
108 x 264	7/16	9,430	7,245	250,000	336	140	172

* BASE FOOTPRINT IS APPROXIMATE AND VARIES DEPENDING ON PUMP SELECTION. CONSULT FACTORY FOR CUSTOMIZATION.
MOST TIMES WIDTH CAN BE REDUCED USING VERTICAL STYLE PUMP.

FOR SYSTEMS WITH 25# STEAM PRESSURE AND BELOW CONSULT FACTORY

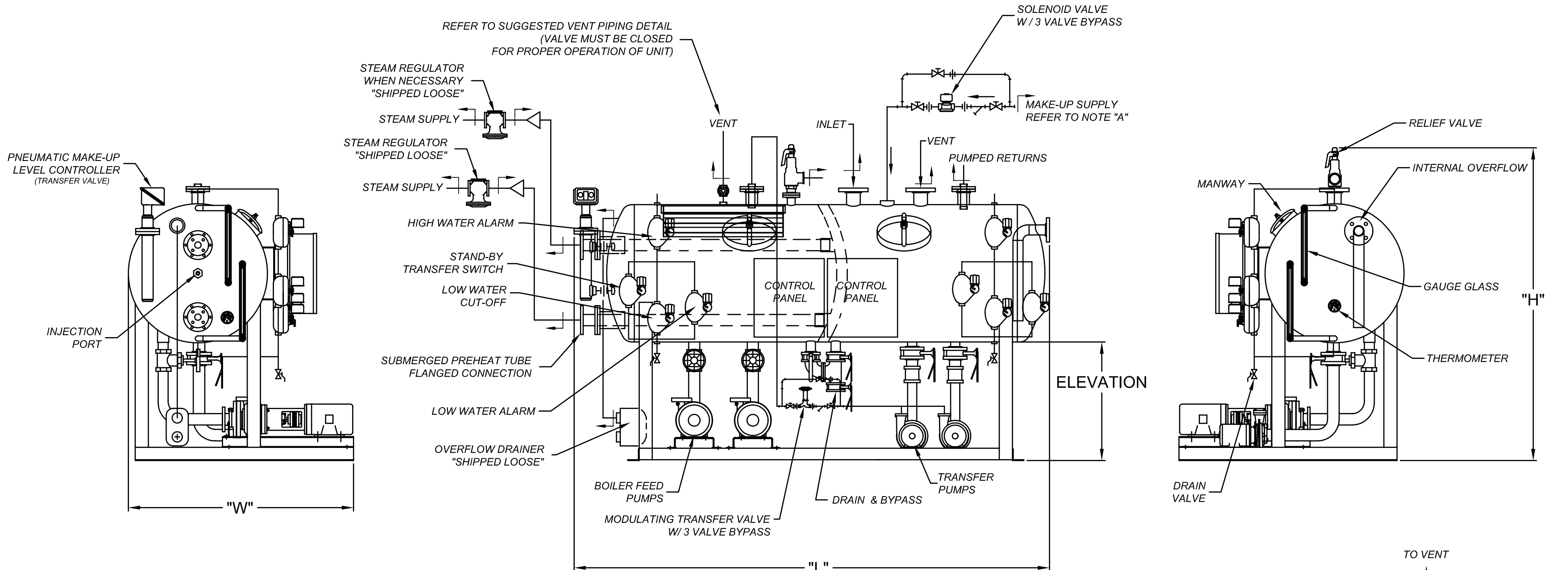
"H" DIMENSION BASED ON 48" ELEVATION

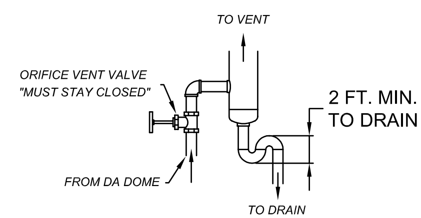
INDICATES WHERE SHIPCO PIPING ENDS

"ALL DIMENSIONS ARE APPROXIMATE"

.005 DA-2C ATMOSPHERIC DESIGN

NOTE "A"
MAKE-UP CONNECTION IF SINGLE TANK DESIGN
TRANSFER CONNECTION IF TWO TANK DESIGN





SUGGESTED VENT PIPING

SELECTED CAPACITIES AND OVERALL DIMENSIONS

STANDARD RECEIVER SIZE	NET RECEIVER GALLONS	SYSTEM SIZE based on 10 min. Storage Capacity		APPROXIMATE OVERALL DIMENSIONS *		
		Boiler Horsepower	lb/hr Steam	Length	Width	Height
36 x 60	220	145	5,000	110	80	110
36 x 72	244	175	6,000	120	80	110
38 x 84	278	205	7,000	134	80	110
42 x 72	361	260	9,000	126	83	116
42 x 84	416	290	10,000	138	83	116
42 x 96	458	335	11,500	150	83	116
48 x 84	511	375	13,000	142	86	130
48 x 96	565	405	14,000	154	86	130
48 x 120	680	495	17,000	178	86	130
54 x 120	938	680	23,500	180	90	136
60 x 120	1,210	870	30,000	184	92	142
60 x 144	1,405	1,015	35,000	208	92	142
66 x 120	1,560	1,130	39,000	186	95	148
66 x 144	1,812	1,305	45,000	210	95	148
72 x 120	1,934	1,390	48,000	190	108	154
72 x 144	2,256	1,640	56,500	214	108	154
72 x 168	2,542	1,840	63,500	238	108	154
72 x 192	2,850	2,060	71,000	262	108	154
72 x 204	3,088	2,260	78,000	274	108	154
84 x 144	3,200	2,300	80,000	216	114	166
84 x 168	3,640	2,600	90,000	240	114	166
84 x 192	4,070	2,950	102,000	264	114	166
96 x 204	5,402	3,915	135,000	280	120	180
108 x 168	6,045	4,495	155,000	254	126	196
108 x 180	6,405	4,785	165,000	266	126	196
108 x 198	6,940	5,130	177,000	284	126	196
108 x 216	7,475	5,505	190,000	302	126	196
108 x 264	8,900	6,955	240,000	350	126	196

* BASE FOOTPRINT IS APPROXIMATE AND VARIES DEPENDING ON PUMP SELECTION. CONSULT FACTORY FOR CUSTOMIZATION.
MOST TIMES WIDTH CAN BE REDUCED USING VERTICAL STYLE PUMP.

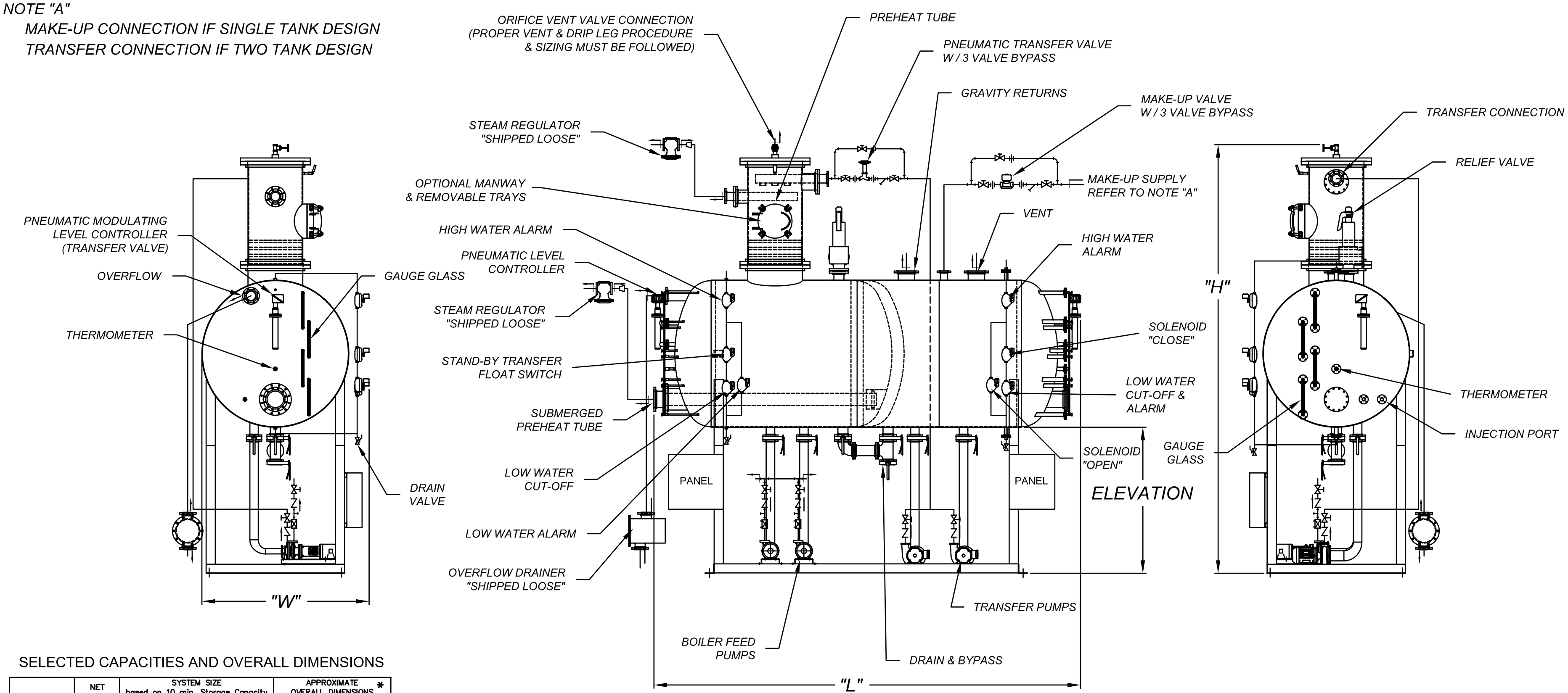
"H" DIMENSION BASED ON 48" ELEVATION

INDICATES WHERE SHIPCO PIPING ENDS

"ALL DIMENSIONS ARE APPROXIMATE"

.005 DA-ISTP-2C PRESSURIZED DESIGN

NOTE "A"
MAKE-UP CONNECTION IF SINGLE TANK DESIGN
TRANSFER CONNECTION IF TWO TANK DESIGN



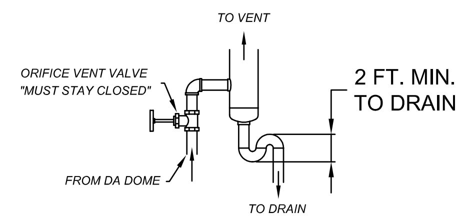
SELECTED CAPACITIES AND OVERALL DIMENSIONS

STANDARD RECEIVER SIZE	NET RECEIVER GALLONS	SYSTEM SIZE based on 10 min. Storage Capacity: Boiler Horsepower	lb/hr Steam	APPROXIMATE OVERALL DIMENSIONS *: Length	Width	Height
36 x 60	230	145	5,000	110	80	156
36 x 72	257	175	6,000	122	80	156
38 x 84	293	220	7,500	134	80	156
42 x 72	380	275	9,500	126	83	170
42 x 84	438	320	11,000	138	83	170
42 x 96	482	350	12,000	150	83	170
48 x 84	538	390	13,500	142	86	176
48 x 96	594	435	15,000	154	86	176
48 x 120	715	520	18,000	178	86	176
54 x 120	987	725	25,000	180	90	190
60 x 120	1,273	930	32,000	184	92	196
60 x 144	1,479	1,070	37,000	208	92	196
66 x 120	1,641	1,190	41,000	186	95	204
66 x 144	1,907	1,360	47,000	210	95	204
72 x 120	2,036	1,480	51,000	190	108	235
72 x 144	2,375	1,740	60,000	214	108	235
72 x 168	2,675	1,940	67,000	238	108	235
72 x 192	3,000	2,175	75,000	262	108	235
72 x 204	3,250	2,350	81,000	274	108	235
84 x 144	3,365	2,440	84,000	216	114	260
84 x 168	3,828	2,775	95,000	264	114	260
84 x 192	4,285	3,100	107,000	264	114	260
96 x 204	5,686	4,115	142,000	280	120	270
108 x 168	6,446	4,695	162,000	254	126	285
108 x 180	6,830	4,955	171,000	266	126	285
108 x 198	7,396	5,360	185,000	284	126	285
108 x 216	7,986	5,795	200,000	302	126	285
108 x 264	9,430	7,245	250,000	350	126	285

"H" DIMENSION BASED ON 48" ELEVATION

⊲ INDICATES WHERE SHIPCO PIPING ENDS ⊳

"ALL DIMENSIONS ARE APPROXIMATE"

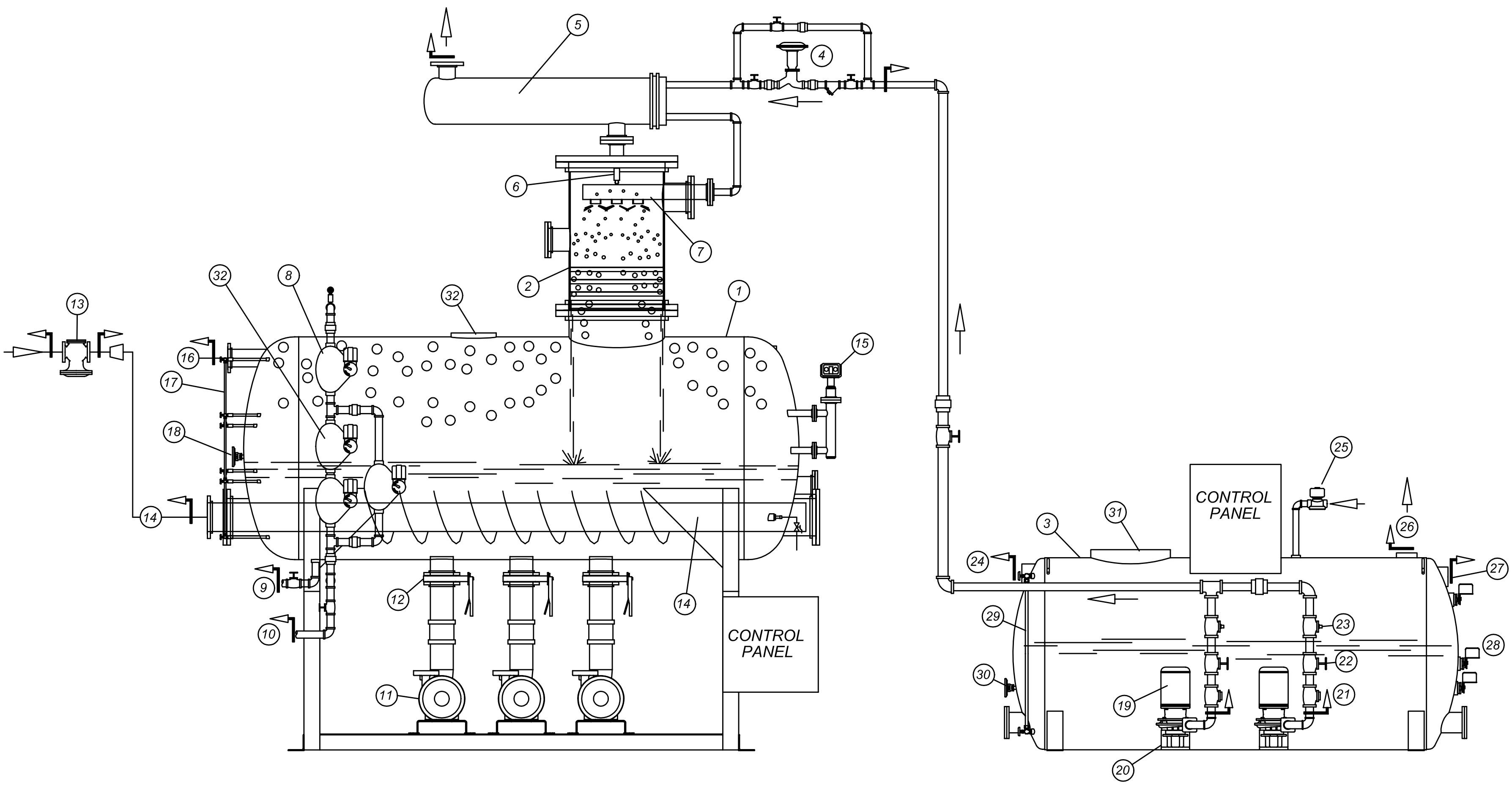


SUGGESTED VENT PIPING

* BASE FOOTPRINT IS APPROXIMATE AND VARIES DEPENDING ON PUMP SELECTION. CONSULT FACTORY FOR CUSTOMIZATION. MOST TIMES WIDTH CAN BE REDUCED USING VERTICAL STYLE PUMP.

.005 DA-STP-2C PRESSURIZED DESIGN

1. DEAERATOR STORAGE RECEIVER
2. DEAERATION DOME
3. SURGE STORAGE RECEIVER
4. DEAERATOR MODULATING INLET WATER
5. SHELL & TUBE VENT CONDENSER
6. DIAL THERMOMETER (DA DOME)
7. SPRAY NOZZLE MANIFOLD
8. EXTERNAL FLOAT CONTROLS
9. DEAERATOR RECEIVER DRAIN
10. EXTERNAL FLOAT CONTROL DRAIN
11. BOILER FEED PUMPS
12. BOILER FEED SUCTION VALVE - ONE PER PUMP
13. STEAM REGULATOR - SHIPPED LOOSE
14. SUBMERGED HEATER TUBE
15. MODULATING LEVEL CONTROLLER
16. OVERFLOW TO DRAIN
17. SIGHT GLASS
18. DIAL THERMOMETER (DA RECEIVER)
19. SURGE TRANSFER PUMPS
20. TRANSFER PUMP SUCTION VALVE - ONE PER PUMP
21. NON SLAM CHECK VALVE - ONE PER B.F & TRANSFER PUMP
22. DISCHARGE SHUT-OFF VALVE - ONE PER B.F. & TRANSFER PUMP
23. DISCHARGE BALANCING VALVE - ONE PER B.F. & TRANSFER PUMP
24. CONDENSATE RETURN INLET
25. SURGE MAKE-UP WATER VALVE
26. SURGE RECEIVER VENT
27. SURGE RECEIVER OVERFLOW
28. FLOAT SWITCH CONTROLS
29. SIGHT GLASS
30. DIAL THERMOMETER (SURGE RECEIVER)
31. MANWAY
32. STAND-BY TRANSFER PUMP CONTROL



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4. DEAERATOR MODULATING INLET WATER
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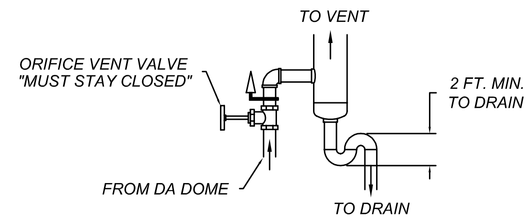
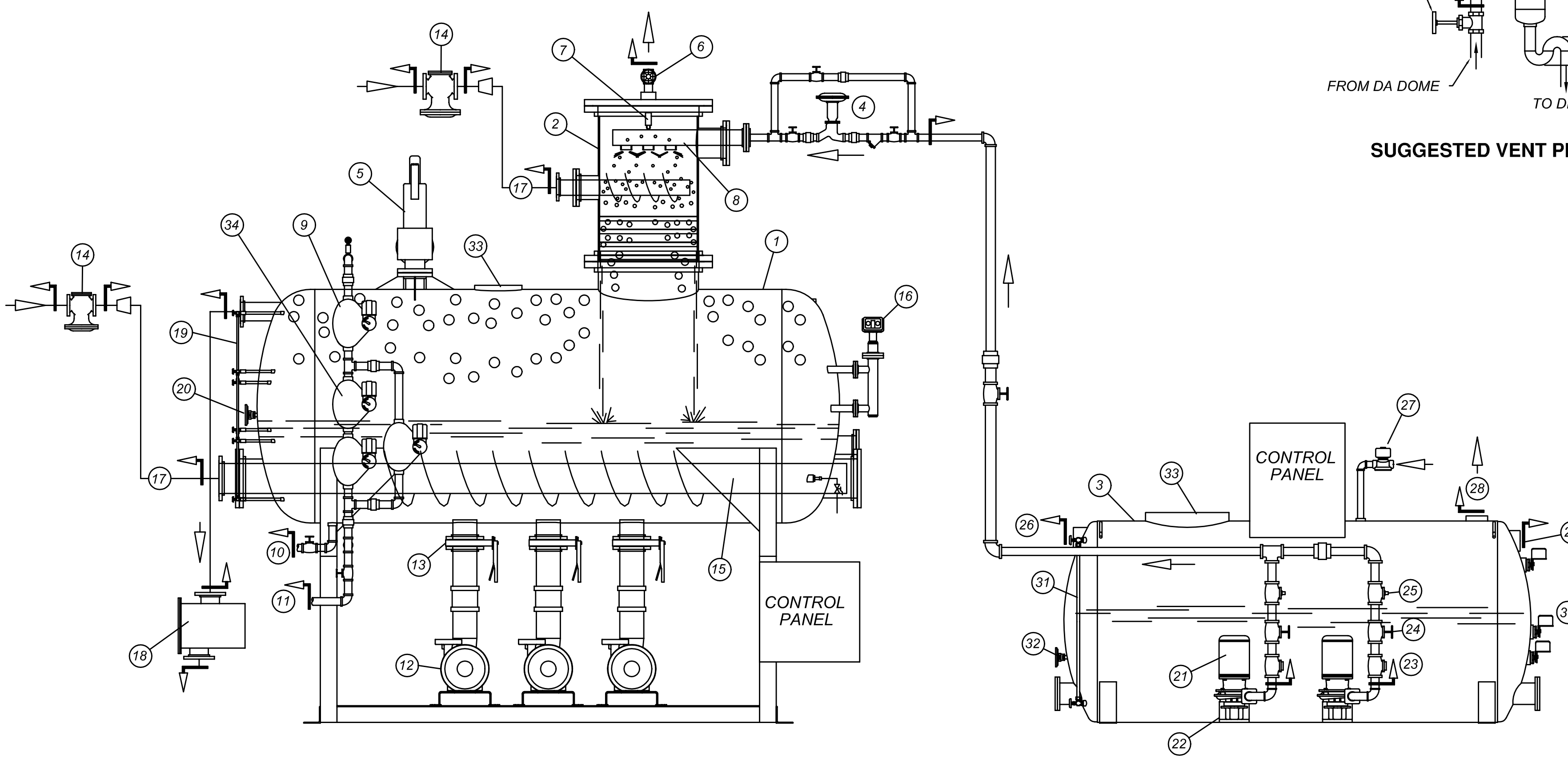


SUGGESTED VENT PIPING



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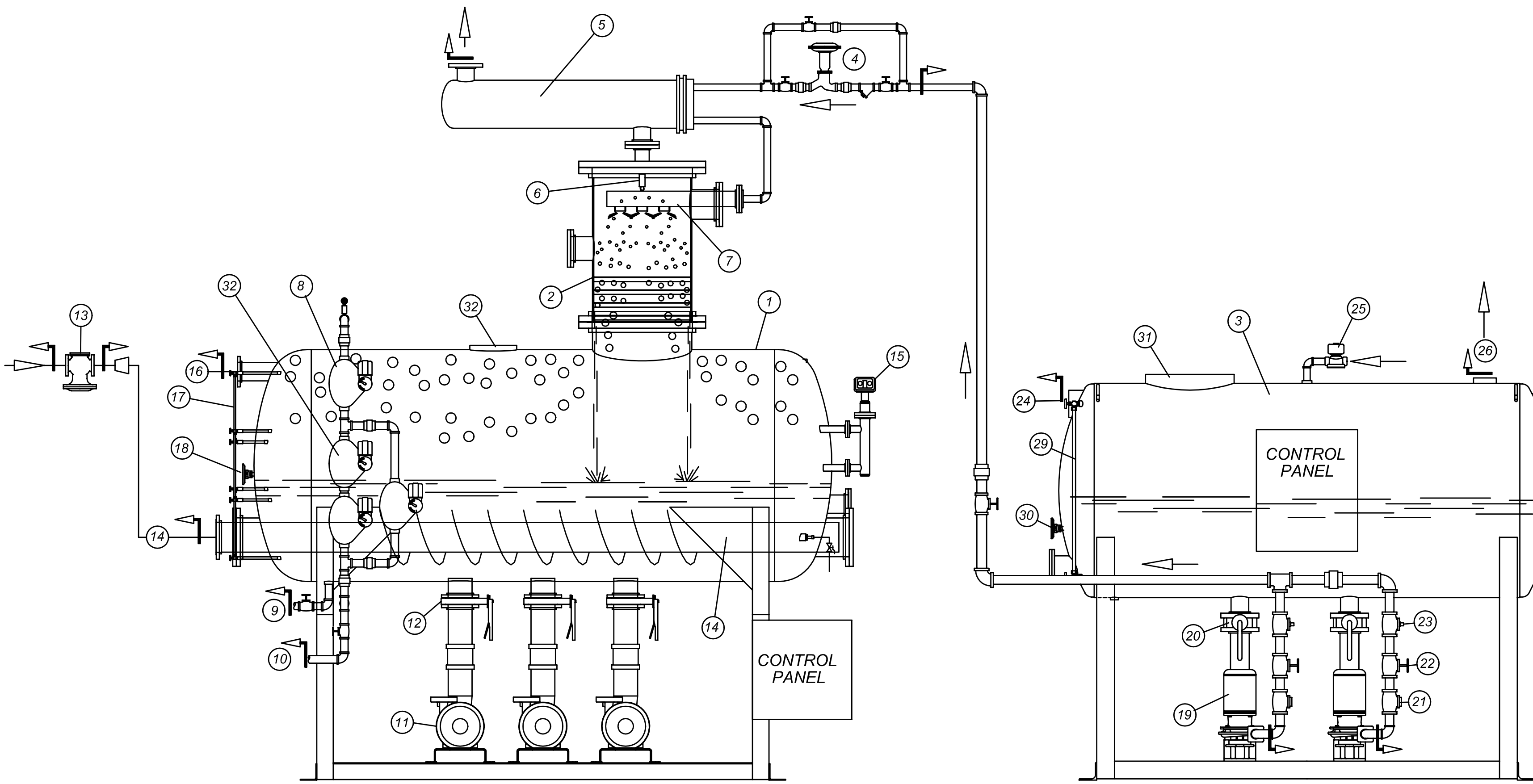

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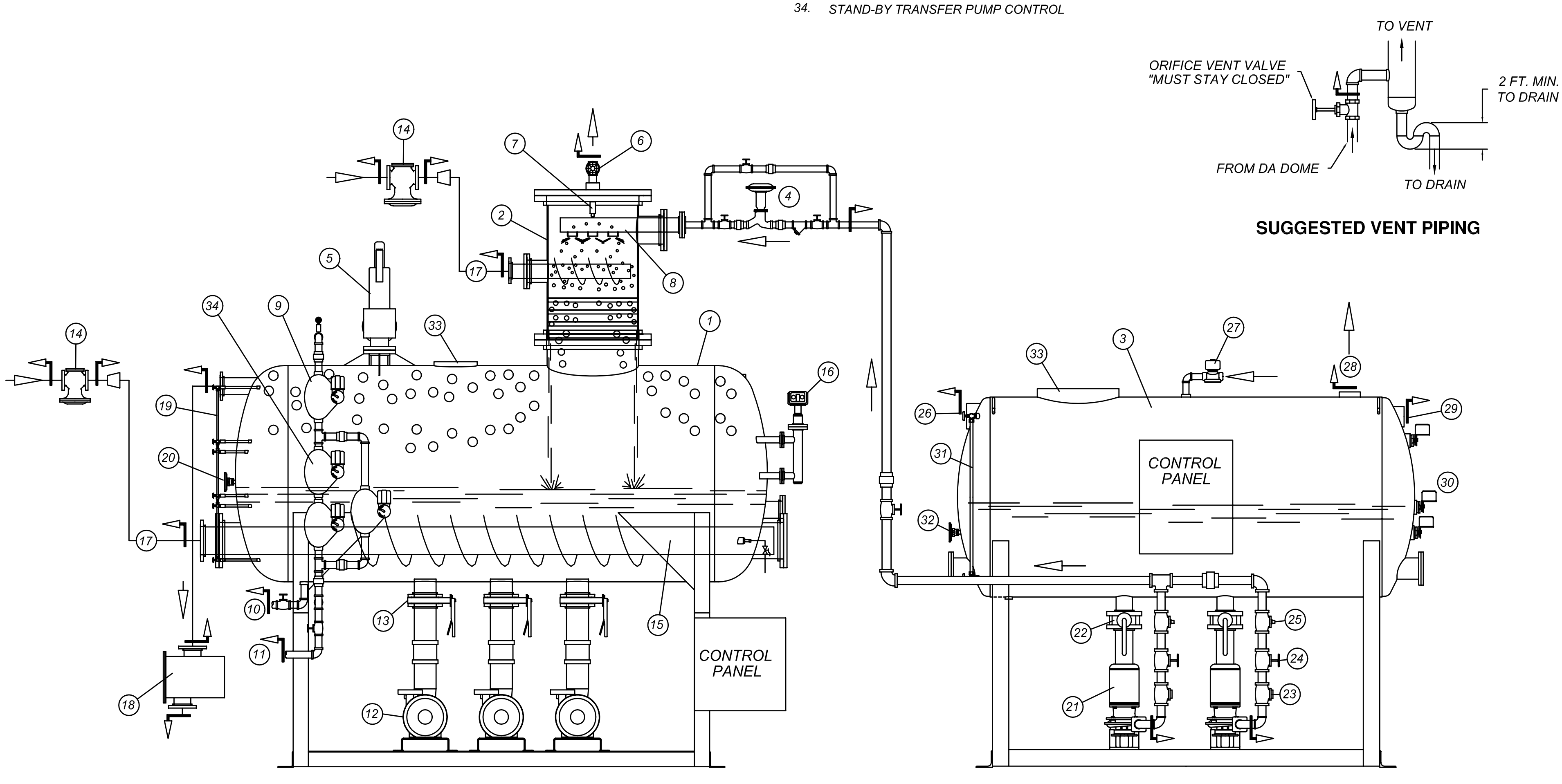


INDICATES WHERE SHIPCO PIPING ENDS

Where Can You Go Wrong?

Following are problems that may occur when the deaerator is used under conditions not intended by its design, or when conditions arise that have not been previously considered:

1) Pressure errors or variations.

   The actual **operating** boiler pressure is the design criterion, not necessarily the boiler design pressure. Often the actual pressure is substantially lower, as when some higher pressure boilers go to a low pressure night setback. This setback drastically affects pumps and steam control valves. In some cases only a reduced pressure is available to the steam control valve.

2) Temperature and capacity variations.

   A surge tank can greatly minimize temperature and capacity variations to the deaeration chamber. Any flow into the surge tank, whether hot pumped returns or cold make-up water, only slightly affects the temperature of the stored volume of water in the tank. The modulated flow out of the surge tank then minimizes capacity variations to the deaeration chamber.

   Boiler blow-down can greatly increase capacity for a short time; if this brings in cold make-up water, temperatures can change drastically. In a single compartment deaerator, this sometimes large transient can reduce temperatures, hurting deaeration, and impose short time loads on the deaerator beyond the intended design.

   If the actual amount of make-up water is higher than anticipated, or if return temperatures are lower, it can substantially affect the sizing of the steam control valve, steam manifold, and other parts.

   If a large condensate pump starts pumping to a single compartment deaerator, it can substantially increase the steam required for the duration of the cycle.

3) Night pressure setback or night shut-offs.

   Night shut-off is self-defeating, as a lot of gases will dissolve overnight in the deaerator water as well as the boiler water, and two to six hours would then be required to restart the deaerator and purge the deaerator and boiler. The best solution is to isolate the boiler and deaerator from the system at night, improve the insulation, and run it on night setback.

   If a high pressure boiler is to be run on night setback at about 15 PSI, low pressure pumps or VFD's with appropriate controls should be used at night. A lower pressure steam valve is needed when operating on low pressure pumps.

4) If boiler loads get very light, continuously running pumps on moderate HP can generate more heat in the pump than the small flow of water can carry away. Steam is then generated in the impeller, and the pumping of water ceases. Therefore consult factory for sizing.

5) Because air lends itself better to modulating controls than electricity, pneumatic controls are our standard. It is therefore important to ascertain whether the installation will have an air supply. If not, electrical controls can be furnished.

6) A deaerator requires steam for heating, and sometimes uncontrolled flows are returned to the deaerator. This is acceptable for drip lines or very small flows; larger uncontrolled flows should go to a flash tank instead, as the steam to the deaerator must be carefully controlled to obtain good deaeration.

7) Returns can flow by gravity into an atmospheric deaerator, but not into a single-compartment pressurized deaerator. If gravity returns are to enter a pressurized deaerator, they must first go to a condensate pump and be pumped into the deaerator with other pumped returns.

8) Deaerators are usually specified for the maximum continuous load, but if condensate pumps are off and then on at a higher than normal flow, or if boiler blowdown results in high peak flows, these peaks must be acknowledged and considered in the design to obtain proper operation. The best solution is a surge tank with modulated output to smooth out these peak loads and provide reliable control of the deaerator.

9) Oversizing the storage in the deaerator tank to avoid using a surge tank. A deaerator is designed to maintain a constant level of water inside, and good deaeration is achieved by controlling the wide temperature variations.

10) Oversizing the deaerator rating will lead to your regulator and modulating valves being oversized and lead them to wire draw. In addition on a pressurized deaerator you lose ½ of 1 percent of the load out the vent, and if you increase rating you lose more steam. Finally, the motor HP required will be more than you actually need, causing the customer to lose more money.

11) Using a lining to protect the steel receiver where the deaerated water lies is a waste of money. By lining this section in your deaerator, somebody is admitting that the deaerator doesn't work. When deaeration levels of .005 are present in the unit very little corrosion will take place (only exception if deaerator is seasonal).

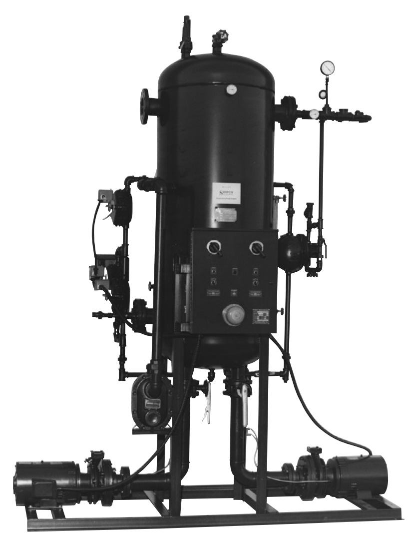
12) Failure to put automatic flow control valves or balancing valves on the discharge of centrifugal boiler feed pumps. The centrifugal pumps discharge pressure must equal what the pump's impeller was trimmed for at the factory. Failure to control the pressure and flow will cause the pump's NPSH characteristics to go up and cause the pump's performance to diminish or stop.

13) Surge tank pumps are to run constantly and pump into the modulating transfer valve on the deaerator unit. Commonly, people want to run these pumps on–off, which in turn makes it no different than a condensate pump providing large temperature and capacity variations.

14) On a two-tank or two-compartment system, make-up water is to be added into the surge chamber and mixed with returns. If make-up water is directly added into the deaerator, every time the unit needs water the temperature will shock the deaerator and cause the regulator to open faster. This shock is caused by the wide temperature variation of having the regulator respond to a temperature of 50˚F when it is used to 150˚F.

15) Suction strainers are never used with centrifugal boiler feed pumps. A suction strainer will cause a pump to destroy itself by doing its job of collecting dirt and debris. No one can calculate the pressure drop through a suction strainer and therefore you can't calculate stand height to avoid NPSH problems. The strainers belong in the return lines and make-up lines to the unit. The reason suction strainers are commonly found is that they are used with turbine pumps. Turbine pumps were the forerunner to today's multi-stage centrifugals, and these turbines had to have suction strainers because of the close tolerance and wear. A little bit of dirt could and would destroy these pumps, causing high maintenance problems. Centrifugal pumps are much more durable and can handle the dirt and debris.

16) In hospital applications a two-tank system is better than a two-compartment or duo-tank design. Hospitals can't go down, and when two compartment units need replaced the customer must get a rental unit. It would be smarter to put in a two-tank system to have the surge tank pumps feed directly into the suction of the boiler feed pumps and inspect or replace the deaerator. If you want the surge tank replaced or to be inspected, run the make-up directly into the deaerator and by-pass the surge.



.005 DA-STVP

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